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Clinical characteristics and outcomes of percutaneous coronary intervention in octogenarians: real-world data from nationwide Thai PCI registry

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ABSTRACT

Objective Due to the growing ageing population worldwide, more percutaneous coronary interventions (PCI) are being performed on elderly patients; however, current national data in Southeast Asian developing countries regarding patient characteristics, procedural details and PCI outcomes in elderly patients are insufficient.

Design Observational study.

Setting Nationwide registry from 39 primary PCI facilities across Thailand.

Participants Between May 2018 and August 2019, the Thai PCI registry enrolled a total of 22 741 patients who underwent PCI. We examined patient characteristics, PCI technique and in-hospital outcomes in octogenarians (≥80 years) and non-octogenarians (18–79 years).

Results There were 2099 patients (9.2%) over the age of 80. Octogenarians were at greater risk for atherosclerosis and calcified coronary lesions that required plaque modification and a higher risk of cardiogenic shock during presentation than non-octogenarians. The success rate of PCI in octogenarians was high (95.5%) and comparable to non-octogenarians (96%). The respective PCI failure rate in non-octogenarians and octogenarians was 4% and 4.5% (p=0.251). Octogenarians had a substantially greater incidence of periprocedural problems (5.6% vs 4.5%, p=0.011). PCI was linked with more than threefold increase in in-hospital mortality in octogenarians compared with non-octogenarians (7.67% vs 2.3%, p 0.001). Nonetheless, revascularisation with PCI in octogenarians increased the EQ-5D (European Quality of Life 5 Dimensions) score by 15.7 after PCI and before hospital discharge.

Conclusions According to the Thai PCI registry, octogenarians had more complicated coronary anatomy, as well as higher procedural complications and mortality than non-octogenarians. Nonetheless, PCI in the octogenarian had a high success rate and potentially improved the patient's quality of life.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The Thai percutaneous coronary intervention (PCI) registry is one of Southeast Asia's largest nationwide PCI registries.
⇒ Real-world data reflected the contemporary PCI practices in the octogenarian population of developing countries
⇒ Given the nature of the registry, the study focused on the patients who only underwent PCI and excluded those who underwent coronary arterial bypass grafting or conservative medical therapy.
⇒ The rate of the radial approach was lower than the current trend of contemporary PCI compared with developed countries, which might affect the mortality and complication risk of PCI, such as bleeding risk.
⇒ The Thai PCI registry lacks patient frailty data, which might substantially influence patient outcomes.

BACKGROUND

One of the most significant healthcare changes worldwide is population ageing. Improving primary care has resulted in a 4.4-year increase in life expectancy by 2040.[1] Over the next three decades, developing Southeast Asian countries, including Thailand, are expected to see a 264.1% rise in the population aged 80 and older.[2] According to the most recent figures, the average life expectancy in Thailand is 75 years for males and 79 years for women.[3 4]

Coronary artery disease (CAD) is one of the primary causes of morbidity and death in the aged population, with the majority of cases presenting with acute coronary syndrome.[5 6] According to the National Health and Nutrition Examination Survey,[7] the prevalence of symptomatic CAD increases with age, reaching 30.6% in men and 21.7% in women over 80. However, medical research has typically excluded this particular group,[8] primarily those over 80 and older, described as 'octogenarians' or 'extremely elderly'. There is disagreement on the optimum therapy management, standards and best practices for octogenarians.[9] Percutaneous

coronary intervention (PCI) becomes difficult for this demographic group as well. Both mortality and morbidity are much more significant in octogenarians than in non-octogenarian groups[10] or even in individuals aged 75–80.[11 12] In patients aged 80–84 years, the 30-day death rate rises to 31.2%.[13] Ageing is thus associated with a more significant number of medical comorbidities and more complex CAD, such as left main CAD, multivessel CAD and left ventricular systolic dysfunction,[14–16] leading to more complicated and high-risk PCIs.[7 17–19] These comorbidities also obscure the diagnosis of acute myocardial infarction (MI) in 20% of people over the age of 85, which can delay treatment and worsen the outcomes following MI.[20]

The Thai National Registry of Percutaneous Coronary Interventions (TPCIR) obtained Thailand's previous national PCI data on senior people in 2006–2007.[21 22] According to that study, the death rate within 24 hours of admission was 5.3% among patients 75 years old. However, with the revolution in interventional cardiology practice and the fast expansion of PCI-capable institutions in Thailand, along with the expansion of the Thai national universal health coverage programme, a greater number of octogenarians have received PCI in the nation since then. Using data from the existing Thai PCI registry,[23] the current study aims to examine the features, kinds of PCI procedures, and PCI results in the octogenarian group. Our findings would give current data on the standard of care, PCI practice and results leading to enhanced PCI quality in the senior population.

METHODS

Study design

This was a descriptive comparative analysis of the Thai PCI registry database, which included 22 741 patients aged 18 and above who had PCI from May 2018 to August 2019. The Thai PCI registry is a multicentre prospective research launched by the Cardiac Intervention Association of Thailand, recruiting 39 institutions around Thailand.[24] As necessary, the study was authorised by Thailand's Central Research Ethics Committee (CREC) by the Foundation for Human Research Promotion in Thailand (COA-CREC 006/2018) (https://www.crecthailand.org), as well as the local Ethics Committee (EC) in some institutes if required for approval (online supplemental file).

After the written or verbal informed consent, all consecutive adult patients aged 18 years or older who got PCI at these participating facilities were recruited. Data on patient characteristics, procedure details, equipment, medication usage, complications and in-hospital outcomes were gathered; see the Thai PCI registry research design for additional information.[24]

Our research factor of interest was octogenarian versus non-octogenarian, defined as age 80 versus 18–79 years. The outcomes of interest were procedure failure, complications, quality of life improvement and in-hospital death. More than 50% residual stenosis following balloon angioplasty or more than 20% after stent implantation was considered procedure failure. Procedural complication was defined as any of the following: cardiogenic shock, heart failure, cerebrovascular accident, cardiac tamponade, acute kidney injury requiring haemodialysis, infection at the access site, anaemia requiring blood transfusion, clinically significant arrhythmia and respiratory failure requiring endotracheal intubation.

Statistical analysis

Patient characteristics (categorical and continuous) were summarised using frequencies and means (with SD). Univariate analyses comparing octogenarians and non-octogenarians used χ^2 tests for categorical variables (age, sex, healthcare coverage, comorbidities) and t-tests for continuous variables. Similar analyses were used to compare the CAD presentation, PCI urgency, coronary lesion characteristics, PCI access site, use of intravascular imaging, use of physiological guidance, PCI treatment modalities, plaque modification and type of antiplatelet therapy. Univariate analysis also examined the association of octogenarian status and each covariate with outcomes (death, PCI complications, PCI success). Covariates with $p<0.10$ in univariate analysis were entered into a multivariate logistic regression model; backward stepwise selection using likelihood ratio tests retained only variables with $p<0.05$. All analyses were performed using STATA V.17.0, with $p<0.05$ indicating statistical significance.

Patient and public involvement

None

RESULTS

Patient population

Octogenarians made up a total of 2099 (or 9.2%) of the 22 741 patients. Among the octogenarians, 1948 (92.8%) were aged 80–89, 151 (7.2%) were aged 90 or more (nonagenarians) and 11 were aged 100 or greater (centenarians). Univariate analyses showed that males outnumbered females in all age groups, but the proportion of females increased after menopause, from 7.1% in premenopause to 62.9% in post-menopause (age 50 years). Overall, the proportion of females in the octogenarian group outnumbered males by a wide margin (13.7% vs 7.2%) (figure 1).

As expected, octogenarians had a higher prevalence of comorbidities and risk factors for atherosclerotic cardiovascular disease (ASCVD) (table 1). Octogenarians had a higher percentage of patients with prior surgical revascularisation (2.4% vs 1.6%, p=0.003), history of heart failure (21.1% vs 13%, p 0.001), hypertension (77.2% vs 66.4%, p 0.001) and history of cerebrovascular disease (8.6% vs 5.4%, p 0.001). Certain ASCVD risks were also approximately twofold higher in octogenarians than in non-octogenarians, such as a history of peripheral arterial disease (3.3% vs 1.5%, p 0.001), chronic lung disease (6.3% vs 3.0%, p 0.001) and chronic kidney disease with

Age groups, n (%)	Male n=15,701	Female n=7,040
18-29	36 (0.2)	11 (0.2)
30-39	389 (2.5)	56 (0.8)
40-49	1,711 (10.9)	427 (6.1)
50-59	4,220 (26.9)	1,317 (18.7)
60-69	5,083 (32.4)	2,268 (32.2)
70-79	3,130 (19.9)	1,994 (28.3)
80-89	1,052 (6.7)	896 (12.7)
≥90	80 (0.5)	71 (1.0)

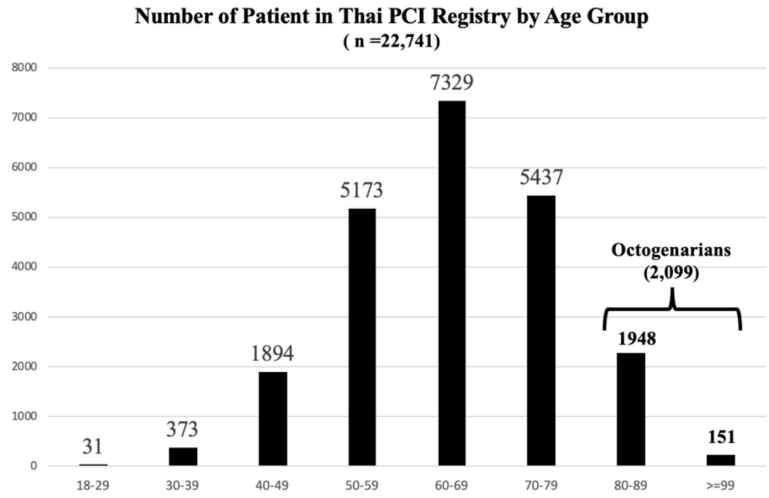

Figure 1 Patients in the Thai PCI registry were categorised by sex and 10-year age intervals from 18 years to ≥90 years in the last patient group. The octogenarians (≥ 80 years) comprised 2099 (9.2%) of the 22 741 patients. Among the octogenarians, 1948 (92.8%) were aged 80–89, and 151 (7.2%) were aged ≥90 (nonagenarians). Males outnumbered females in all age groups, but the proportion of females significantly increased after menopause, from 7.1% in the pre-menopause to 62.9% in the post-menopause (≥50 years). The proportion of females in the octogenarian group was greater than males (13.7% vs 7.2%).

creatinine level more than 1.5 mg/dL or estimated GFR 60 mL/min/m^2 (63.6% vs 29.4%, p<0.001).

However, several risk factors for ASCVD were less in octogenarians, such as morbid obesity (18.8% vs 40.5%, p<0.001), diabetes mellitus (39.4% vs 44.7%, p<0.001), and history of smoking (39.3% vs 56.7%, p<0.001) in octogenarians and non-octogenarians, respectively.

Thailand's universal health coverage scheme covered the majority of patients in both age groups. Octogenarians had more patients who used the government or state enterprise officer scheme for reimbursement (40.4% vs 25.7%) than non-octogenarians. Conversely, non-octogenarians used more social security schemes than octogenarians (7.5% vs 0.5%).

CAD presentation and lesion characteristics

Although univariate analysis showed that chronic coronary syndrome (CCS) was the most common indication for PCI in both age groups, 36.9% in octogenarians and 42.6% in non-octogenarians, older patients had a significantly higher rate of non-ST elevation acute coronary syndrome (NSTE-ACS) than the younger patients (36.1% vs 29.3%). Meanwhile, ST elevation myocardial infarction (STEMI) was 27% in octogenarians compared with 28.1% in non-octogenarians.

Notably, the Thai PCI registry found no significant variations in lesion type complexity between octogenarians and non-octogenarians based on the updated American College of Cardiology (ACC)/American Heart Association (AHA) categorisation of coronary lesions.[25] In both age groups, more than 80% of the patients in this registry had complicated coronary lesions (types C and B2). The type C coronary lesion was the most prevalent lesion that underwent PCI, accounting for more than 60% of the patients in both groups, followed by type B2, type B1 and type A lesions with the prevalence of 18%, 15% and 4%, respectively (table 2).

PCI procedure characteristic

Univariate analysis showed that the femoral approach remained the primary arterial access route in both age groups, particularly in the octogenarian group, where it was nearly twice as common as radial access (64.1% vs 34%) (table 2). The radial approach was adopted substantially more frequently in non-octogenarians than octogenarians (45.3% vs 34%, respectively).

Even though the recommendations encourage imaging and physiological guidance for PCI operations, actual practice in Thailand revealed that it was not widespread among patients in both categories (table 2). Only 13.3% and 15% of PCI patients in octogenarians and non-octogenarians employed at least one imaging-guided PCI modality, and fewer than 2% of both groups used physiological-guided PCI, whereas the decision for angioplasty was the same. A drug-eluting stent (DES) was used in about 90% of all PCIs. Only 8–9% of total PCI procedures employed balloon angioplasty alone, and bare-metal stent (BMS) was seldom used in the present registry.

There were nearly twice as many plaque modifications in octogenarians as in non-octogenarians (7.1% vs 4.5%, p<0.001), with rotational atherectomy being the most common tool for severely calcified lesions (3.7% vs 1.8%, p<0.001) (table 2).

Clopidogrel, the most often used antiplatelet therapy during PCI, remains the most commonly used P2Y12 inhibitor, accounting for more than 90% of patients in both age groups (table 2). Patients in both groups comparably received ticagrelor (7.8% vs 9%, p=0.081), while prasugrel usage was considerably lower in octogenarians than in non-octogenarians (0.4% vs 1.9%, p<0.001). GP IIb/IIIa inhibitors and adjunctive antiplatelet therapy were used in less than 7% of participants in the registry.

Table 1 Baseline demographics of octogenarians compared with non-octogenarians in the Thai PCI registry (n=22 741)

Characteristic	Octogenarian (age ≥80) N (%)	Non-octogenarian (age 18–79) N (%)	P value
Number of patients	2099 (9.2)	20 642 (90.8)	
Female	967 (46.1)	6070 (29.4)	<0.001
Male	1132 (53.9)	14 569 (70.6)	
Health coverage scheme			
Universal coverage	1131 (53.9)	13 218 (64.0)	<0.001
Government service/state enterprise	848 (40.4)	5258 (25.5)	
Social security service	10 (0.5)	1547 (7.5)	
Others	110 (5.2)	691 (3.0)	
Obesity (BMI ≥23 kg/m^2)	394 (18.8)	8359 (40.5)	<0.001
Prior myocardial infarction	476 (22.7)	4891 (23.7)	0.298
Known CAD*	720 (34.3)	7004 (33.9)	0.729
Prior PCI	611 (29.1)	6126 (29.7)	0.587
Prior CABG	51 (2.4)	322 (1.6)	0.003
Heart failure	442 (21.1)	2689 (13.0)	<0.001
Diabetes mellitus	826 (39.4)	9224 (44.7)	<0.001
Hypertension	1620 (77.2)	13 703 (66.4)	<0.001
Dyslipidaemia	1337 (63.7)	13 526 (65.5)	0.094
Cerebrovascular disease	181 (8.6)	1115 (5.4)	<0.001
Peripheral arterial disease	70 (3.3)	319 (1.5)	<0.001
Chronic lung disease	132 (6.3)	609 (3.0)	<0.001
Chronic kidney disease	1335 (63.6)	6063 (29.4)	<0.001
History of smoking	824 (39.3)	11 700 (56.7)	<0.001
CAD presentation			
STEMI	566 (27.0)	5807 (28.1)	<0.001
NSTE-ACS	759 (36.1)	6047 (29.3)	
CCS	774 (36.9)	8788 (42.6)	
Cardiogenic shock	250 (11.9)	1562 (7.6)	<0.001
PCI status			
Elective	1204 (57.3)	12 722 (61.6)	0.001
Urgent	356 (17)	3171 (15.4)	
Emergency	539 (25.7)	4749 (23)	

*Coronary stenosis >50%.
BMI, body mass index; CABG, coronary arterial bypass grafting; CAD, coronary artery disease; CCS, chronic coronary syndrome; NSTE-ACS, non-ST elevation acute coronary syndrome; PCI, percutaneous coronary intervention; PCI, percutaneous coronary intervention; STEMI, ST elevation myocardial infarction.

PCI outcomes and complications

Given the high success rate of up to 95.5% in octogenarians, the two groups had no significant differences in procedural failure (4.5% vs 4.0%, p=0.251) as per a univariate analysis. However, the elderly had a greater rate of morbidity and death following PCI operations. PCI complications were more common in octogenarians than in non-octogenarians (5.6% vs 4.6%, p=0.011). Regarding the death rate, octogenarians outnumbered non-octogenarians (7.67% vs 2.3%, p 0.001). Cardiogenic shock, heart failure, cerebrovascular accident, cardiac tamponade, acute kidney injury requiring haemodialysis, infection at the access site, anaemia requiring blood transfusion, clinically significant arrhythmia and respiratory failure requiring endotracheal intubation were significantly more common in octogenarians than in non-octogenarians (table 3).

After a multivariable logistic regression adjustment, octogenarians showed non-significant increases in procedural complication risk compared with the 60–79 and 45–59 years age groups (OR 1.1, 95% CI 0.9 to 1.4 and 1.2, 95% CI 0.9 to 1.5, respectively) (table 4). However, octogenarians had a significantly higher risk of death compared with patients aged <45 years (OR 7.3, 95% CI 3.4 to 15.6) and those aged 60–79 years (OR 2.1, 95% CI 1.6 to 2.7) (table 5).

Table 2 Lesion characteristics and procedural details of octogenarians compared with non-octogenarians in the Thai PCI registry (n=22 741)

Characteristic	Octogenarian (age ≥80) N (%)	Non-octogenarian (age 18–79) N (%)	P value
Coronary lesion characteristic*			
A	82 (3.9)	886 (4.3)	0.226
B1	319 (15.3)	3030 (14.8)	
B2	538 (17.1)	3828 (18.6)	
C	1331 (63.7)	12 782 (62.3)	
Ostial lesion	352 (13.5)	2842 (11.1)	0.001
Bifurcation lesion	334 (12.8)	3535 (13.9)	0.086
Previously treated lesion	146 (5.6)	1621 (6.3)	0.221
Need for IABP	121 (5.8)	651 (3.2)	<0.001
Temporary pacemaker insertion during PCI	39 (1.9)	203 (1.0)	<0.001
Initial access site			
Radial artery	714 (34.0)	9348 (45.3)	<0.001
Brachial artery	5 (0.2)	42 (0.2)	
Femoral artery	1345 (64.1)	10 854 (52.6)	
Combination approach	35 (1.7)	398 (1.9)	
Imaging-guided PCI			
IVUS-guided PCI	334 (12.8)	3597 (14)	0.086
OCT-guided PCI	12 (0.5)	257 (1.0)	0.053
Physiologic-guided PCI	31 (1.2)	475 (1.9)	0.074
PCI techniques			
Balloon angioplasty	234 (9)	2056 (8)	0.079
DES	2308 (88.6)	22 906 (89.3)	0.347
BMS	5 (0.2)	26 (0.1)	0.468
Plaque modification	185 (7.1)	1141 (4.5)	<0.001
Rotational atherectomy	96 (3.7)	460 (1.8)	<0.001
Cutting balloon angioplasty	20 (0.8)	177 (0.7)	0.646
Laser angioplasty	0 (0.0)	17 (0.1)	0.204
Aspiration thrombectomy	161 (6.2)	1823 (7.1)	0.076
Ancillary medications			
Aspirin	2075 (98.9)	20 483 (99.2)	0.072
P2Y12 inhibitors			
Clopidogrel	1965 (93.8)	19 018 (92.3)	0.014
Ticagrelor	164 (8.0)	1849 (9.1)	0.081
Prasugrel	8 (0.4)	382 (1.9)	<0.001
GP IIb/IIIa inhibitor	141 (6.9)	1250 (6.3)	0.248

*Modified ACC/AHA lesion-specific classification of the primary target stenosis.
ACC/AHA, American College of Cardiology /American Heart Association; BMS, bare-metal stent; DES, drug-eluting stent; IABP, intra-aortic balloon pump; IVUS, intravascular ultrasound; OCT, optical coherence tomography; PCI, percutaneous coronary intervention.

Pre-discharge management

The majority of patients in the registry were sent home on dual antiplatelet treatments, such as aspirin and clopidogrel (table 6). Aspirin was taken less frequently for octogenarians than non-octogenarians (94.1% vs 97.8%, p 0.001). Potent P2Y12 inhibitors such as ticagrelor and prasugrel were used more regularly in non-octogenarians, although in a smaller proportion, less than 10%. Warfarin was used more than novel oral anticoagulants in octogenarians who needed anticoagulants. Non-octogenarians were more likely to be prescribed statins, beta-blockers and angiotensin-converting enzyme inhibitors/angiotensin II receptor blockers as adjuvant pharmacological treatments for cardiovascular disorders.

Table 3 PCI outcomes in octogenarians compared with non-octogenarians in the Thai PCI registry (n=22 741)

PCI outcome	Octogenarian (age ≥80) N (%)	Non-octogenarian (age 18–79) N (%)	P value
Procedural success			
PCI success	2490 (95.5)	24 620 (96)	0.251
PCI failure	116 (4.5)	1020 (4.0)	
Total in-hospital mortality	161 (7.67)	471 (2.3)	0.011
Procedural complications	146 (5.6)	1144 (4.5)	<0.001
Myocardial infarction	144 (6.9)	1231 (6.0)	0.1
Cardiogenic shock (post-procedure)	278 (13.2)	1507 (7.3)	<0.001
Heart failure	413 (19.7)	2345 (11.4)	<0.001
Cerebrovascular disease within 24 hours after PCI	15 (0.7)	70 (0.3)	0.007
Cardiac tamponade	8 (0.4)	28 (0.1)	0.015
Renal complication requiring haemodialysis	18 (0.9)	101 (0.5)	0.026
Vascular complications required treatment	8 (0.4)	61 (0.3)	0.497
AV fistula	2 (0.1)	13 (0.1)	0.643
Pseudoaneurysm	3 (0.1)	12 (0.1)	0.155
Infection at the access site	18 (0.9)	86 (0.4)	0.004
Need of blood transfusion	53 (2.5)	184 (0.9)	<0.001
Bleeding event within 72 hours	139 (6.6)	963 (4.7)	<0.001
Arrhythmia required treatment	108 (5.1)	689 (3.3)	<0.001
Need of cardioversion or defibrillation	39 (1.9)	268 (1.3)	0.034
Temporary pacemaker	39 (1.9)	203 (1.0)	<0.001
Repeat coronary angiogram in the same visit	19 (1.1)	180 (1.0)	0.061
Respiratory failure requiring ETT intubation	182 (8.7)	793 (3.8)	<0.001

AV, arteriovenous; ETT, endotracheal tube; PCI, percutaneous coronary intervention.

After being discharged, less than 40% of PCI patients were referred for cardiac rehabilitation, and the elderly were less likely to be recommended for this treatment. However, patient quality of life, as measured by the mean EQ-5D (European Quality of Life 5 Dimensions) score,[26] improved comparably in octogenarians and non-octogenarians following PCI (15.7 and 15.6, respectively) (table 6).

DISCUSSION

The Thai PCI registry is one of Thailand's largest statewide current PCI datasets, with 2099 patients aged 80 years, or 9.2% of the total 22 741 PCI patients, or as high as 18.7% for patients 75 or older. This result is greater than the Malaysian NCVD-PCI registry, which reported that around 1% of the 24 469 PCI patients were octogenarians.[27] This database was more extensive than the previous research based on Thai National Percutaneous Coronary Intervention Registry (TPCIR) data between 2006 and 2007, with 639 patients, or 15.7% of the total 4156 patients, designated as old by age 75 years. This group's mean age was 79 years, compared with 80.8 years in our present study.[21] The more significant percentage of older patients reflected improved access to basic healthcare, increased PCI-capable facilities and Thailand's expanding elderly population over the last decades. Thailand's current health policies on the Universal Coverage Scheme and Universal Coverage for Emergency Patients programme allow all Thai elderly patients free access to coronary intervention in elective and emergency PCIs if they do not have any other healthcare coverage. However, people who use the national universal healthcare programme have fewer treatment options or access to particular medications, such as newer P2Y12 inhibitors or anticoagulants.

According to our registry, sex influences the incidence of CAD in different age groups. Although the majority of the patients enrolled in the research were men, the percentage of PCI in women rose significantly after menopause, with over half of the cases occurring in octogenarians. The sex-specific risk factors for CAD at genetic and epigenetic levels[28 29] may have less influence on the elderly population.

According to our data, most octogenarians underwent PCI due to ACS rather than CCS. While NSTE-ACS was significantly more common than STEMI, STEMI

Table 4 Factors associated with PCI procedural complications: a multivariate analysis from the Thai PCI registry

Factors	Procedural complication OR (95% CI)	P value
Age group		
Age≥80	1.2 (0.9 to 1.5)	0.158
Age 60–79	1.1 (0.9 to 1.3)	0.125
Age 45–59	1	
Age<45	1.5 (1.1 to 2.0)	0.01
Gender (female vs male)	1.2 (1.1 to 1.4)	0.002
Hypertension	0.8 (0.7 to 0.9)	0.001
Prior myocardial infarction	1.4 (1.3 to 1.7)	<0.001
No myocardial infarction	1	
Prior CABG	1.5 (1.0 to 2.3)	0.049
Cardiogenic shock	1.7 (1.4 to 2.1)	<0.001
Need for IABP	1.5 (1.1 to 1.9)	0.004
Access site cross over	1.6 (1.2 to 2.1)	0.001
Respiratory failure requiring ETT intubation	1.7 (1.4 to 2.2)	<0.001
Total volume of contrast, per 10 mL	1.0056 (1.0046 to 1.0065)	<0.001
PCI status (vs Elective)		
Emergency	1.8 (1.5 to 2.1)	<0.001
Urgent	1.5 (1.3 to 1.8)	<0.001
GP IIb/IIIa inhibitor	1.9 (1.6 to 2.3)	<0.001
Lesion complexity* (vs type A)		
C	2.1 (1.4 to 3.2)	<0.001
B2	1.6 (1.1 to 2.5)	0.027
B1	1.0 (0.6 to 1.5)	0.865

*Modified ACC/AHA lesion-specific classification of the primary target stenosis.
ACC/AHA, American College of Cardiology (ACC)/American Heart Association (AHA) ; CABG, coronary arterial bypass grafting; ETT, endotracheal tube; IABP, intra-aortic balloon pump; PCI, percutaneous coronary intervention.

remained prevalent among octogenarians, leading to a higher incidence of cardiogenic shock requiring MCS, arrhythmogenic complications, mechanical myocardial infarction sequelae and ultimately an increased risk of death. Nevertheless, the majority of studies and meta-analyses supported primary PCI for this elderly patient population.[30 31 32] The results also confirmed the feasibility and mortality benefit of PCI in senior subpopulations with NSTE-ACS.[33 34 35] Surprisingly, CCS-indicated PCI accounted as much as 36.9% of octogenarians despite a history of poor outcomes. Unsurprisingly, the elderly had a higher incidence of multivessel coronary artery disease, ostial lesions and calcified lesions, necessitating more complex PCIs and coronary atherectomy. However, the lesion complexity in this PCI registration based on the ACC/AHA categorisation did not reflect actual practice. Due to the nature of the PCI registry, many complex coronary patients were not included in the research, as they were instead referred for coronary bypass revascularisation or managed medically. Advances in the contemporary PCI methods and experience with senior populations have improved safety and outcomes for CCS-indicated PCI. In elective PCI cases such as CCS, the risks and benefits should be thoroughly discussed with patients. PCI should only be performed when there is favourable supporting evidence for patients.

Despite the 2020 Thai Acute Coronary Syndromes guideline recommendation that novel P2Y12 inhibitors be the first-line P2Y12 inhibitor unless there is a higher risk of bleeding,[36] dual antiplatelet therapy with aspirin and clopidogrel remained the treatment of choice in octogenarians and non-octogenarians. The treatment choice might be related to the universal coverage policy, payment issues and the availability of innovative P2Y12 inhibitors outside of major metropolitan institutions. Patients with Thai national universal coverage were prohibited from taking prasugrel during data collection.

Given the baseline characteristic, the intricacy of the lesion, the degree of lesion calcification and the patients' ageing variables, death and PCI complications were greater in octogenarians. PCI in the elderly presents a higher risk of intervention and complications. These findings contradict the prior TPCIR data,[21] which found no age effect on in-hospital mortality following PCI. When compared with non-octogenarians, octogenarians had higher periprocedural complications and worse short-term outcomes after myocardial infarction.

With the current PCI techniques and instruments available in most PCI facilities in Thailand, PCI for octogenarians may have a high success rate of up to 95.5%. Our study found that PCI enhanced the quality of life for both octogenarians and non-octogenarians, even in the short period of time before hospital discharge. However, the success rate remained lower than the data from the J-PCI (Japanese Percutaneous Coronary Intervention) registry,[37 38] which reported a PCI success rate of over 98% among patients over 80. Nevertheless, ageing did increase the risk of PCI mortality, cardiogenic shock and bleeding complications and is associated with more complex and calcified lesions, as indicated in the Thai PCI registry. The rate of radial approach in the J-PCI registry was over 66%, almost twice the 34% reported in the Thai PCI registry, and was linked to lower hospital mortality and reduced bleeding complications in these groups of patients. This highlights one solution for improving PCI quality in developing countries by increasing the adoption of the transradial approach among octogenarian patients, despite some concerns regarding the tortuosity of the subclavian artery and difficulty in obtaining radial access in the elderly population.

Table 5 Factors associated with death: a multivariate analysis from the Thai PCI registry

Factors	Procedural complication	
	OR (95% CI)	P value
Age group		
Age≥80	7.3 (3.4 to 15.6)	<0.001
Age 60–79	3.5 (1.7 to 7.3)	0.001
Age 45–59	2.4 (1.1 to 5.0)	0.023
Age<45	1	
Gender (female vs male)	1.3 (1.1 to 1.7)	0.006
Referral case from other centres	0.5 (0.4 to 0.6)	<0.001
Chronic kidney disease	2.1 (1.7 to 2.6)	<0.001
Diabetes mellitus	1.1 (0.9 to 1.4)	0.273
Initial access site (vs radial artery)		
Brachial artery	2.6 (0.3 to 20.2)	0.356
Femoral artery	1.4 (1.1 to 1.8)	0.011
Combination approach	2.0 (1.1 to 3.5)	0.018
Vital sign on admission		
Admission HR, per 10 bpm	1.14 (1.09 to 1.19)	<0.001
Admission SBP, per 5 mm Hg	0.95 (0.93 to 0.97)	<0.001
Dyslipidaemia	0.7 (0.6 to 0.9)	0.001
Peripheral arterial disease	2.0 (1.2 to 3.5)	0.013
CAD presentation (vs CCS)		
STEMI	2.8 (1.7 to 4.6)	<0.001
NSTE-ACS	2.0 (1.3 to 3.2)	0.002
Number of severely diseased vessel (vs SVD)		
Left main disease	1.6 (1.1 to 2.1)	0.005
TVD	1.0 (0.7 to 1.3)	0.921
DVD	1.1 (0.8 to 1.4)	0.588
Cardiogenic shock	2.4 (1.9 to 3.1)	<0.001
PCI status (vs elective PCI)		
Emergency	3.4 (2.2 to 5.2)	<0.001
Urgent	2.9 (1.9 to 4.3)	<0.001
Respiratory failure requiring ETT intubation	5.2 (4.1 to 6.6)	<0.001
Renal complication requiring haemodialysis	2.7 (1.6 to 4.3)	<0.001
Need for IABP	2.8 (2.2 to 3.6)	<0.001
Arrhythmia (vs no arrhythmia)		
Arrhythmia required treatment	2.0 (1.5 to 2.6)	<0.001
Arrhythmia without treatment	1.5 (1.0 to 2.4)	0.053
Procedural failure	2.3 (1.6 to 3.2)	<0.001
Procedure complications	1.8 (1.3 to 2.4)	<0.001

CAD, coronary artery disease; CCS, chronic coronary syndrome; DVD, double-vessel disease; ETT, endotracheal tube; HR, heart rate; IABP, intra-aortic balloon pump; NSTE-ACS, non-ST elevation acute coronary syndrome; PCI, percutaneous coronary intervention; SBP, systolic blood pressure; STEMI, ST elevation myocardial infarction; SVD, single-vessel disease; TVD, triple-vessel disease.

LIMITATIONS

Our research has a few limitations. This registry includes individuals who had PCI in 39 cardiac catheterisation facilities. As a result, there is a selection bias that may not represent the entire population of octogenarians with cardiovascular disease. Some individuals may have undergone CABG or medical treatment and were not included in the registry. There may be unmeasured confounders that influence clinical outcomes. Another significant limitation of the Thai PCI registry is no data on frailty, which is important for patient evaluation in the

Table 6 Post PCI care and patient quality of life of octogenarians compared with non-octogenarians in the Thai PCI registry (n=22 741)

Post PCI care and patient quality of life	Octogenarian (age ≥80) N (%)	Non-octogenarian (age 18–79) N (%)	P value
Antiplatelet therapy			
Aspirin	1876 (94.1)	19 880 (97.8)	<0.001
Clopidogrel	1659 (83.2)	16 204 (79.7)	<0.001
Ticagrelor	203 (10.2)	2980 (14.7)	<0.001
Prasugrel	21 (1.1)	615 (3.0)	<0.001
Vitamin K antagonist	64 (3.2)	476 (2.3)	0.016
NOAC	38 (1.9)	165 (0.8)	<0.001
Statin	1781 (89.4)	18 979 (93.3)	<0.001
Beta blocker	1088 (54.6)	12 569 (61.8)	<0.001
ACEI or ARBs	813 (40.8)	10 299 (50.7)	<0.001
Cardiac rehabilitation referral	670 (31.9)	7858 (43.6)	<0.001
Patient quality of life			
EQ-5D before PCI, mean (SD)	61.8 (19.0)	67.0 (19.3)	<0.001
EQ-5D after PCI, before discharge, mean (SD)	77.5 (14.6)	82.6 (17.7)	<0.001

ACEI, angiotensin-converting enzyme inhibitors; ARB, angiotensin II receptor blockers; EQ-5D, European Quality of Life 5 Dimensions score; NOAC, novel oral anticoagulant; PCI, percutaneous coronary intervention.

elderly group and might substantially influence patient outcomes.

CONCLUSIONS

The Thai PCI registry focuses on real-world practice data on persons over the age of 80 in Thailand. When compared with non-octogenarians, octogenarians experienced more difficult PCI, a greater risk of PCI complications and unfavourable in-hospital mortality. Nonetheless, PCI in the octogenarians had a high success rate and potentially improved the patient's quality of life. Given the increasingly ageing population, further research into octogenarians will be essential to determine the optimal approach for revascularisation and treatment in this patient group.

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Ethics approval This study involves human participants and ethics approval was obtained from CREC (COA-CREC 006/2018) by the Central Research Ethical Committee of the Foundation for Human Research Promotion in Thailand (HRPT) (https://www.crecthailand.org). Local ethics approval was also obtained at each registry site according to their specific requirements. Details on ethics approval are also mentioned in the Thai PCI study design (Sansanayudh et al. J Med Assoc Thai 2021). Participants gave informed consent to participate in the study before taking part.

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