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ORIGINAL ARTICLE

Clinical Outcomes in Older Patients Undergoing Percutaneous Coronary Intervention for Non-ST-Elevation Acute Coronary Syndromes

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Background Distinguishing the subgroup of older, comorbid patients presenting with non-ST-elevation acute coronary syndromes (NSTEACS) who will benefit from percutaneous coronary intervention (PCI) remains challenging. Identifying risk factors for major adverse cardiac or cerebrovascular events (MACCE) post PCI may help define this cohort. The objective of this study was to describe contemporary outcomes of older patients with NSTEACS undergoing PCI and identify pre-procedural risk factors for MACCE.

Methods We retrospectively reviewed data for 1,875 patients aged ≥80 years entered in the Victorian Cardiac Outcomes Registry (VCOR) who underwent PCI for NSTEACS between 1 January 2013 and 31 December 2017. MACCE was a composite outcome comprising 30-day mortality, myocardial infarction, stroke, major bleeding, target lesion revascularisation or target vessel revascularisation; in-hospital cardiogenic shock or stent thrombosis; and new requirement for dialysis. Patient demographic data and pre-procedural comorbidities were compared between the groups with and without a MACCE.

Results The rate of MACCE at 30 days was 8.0% (n=150). Thirty-day (30-day) mortality was 3.0% (n=57). Pre-procedural left ventricular ejection fraction (LVEF)<45% (OR 2.32; 95% CI 1.47–3.68; p<0.001) and eGFR≤30 mL/min/1.73m^2 or renal replacement therapy (OR 2.10; 95% CI 1.27–3.46; p<0.01) were independent predictors of a MACCE.

Conclusions Older patients presenting with NSTEACS who have left ventricular systolic dysfunction or renal impairment are at increased risk of MACCE post PCI. Randomised studies are required to determine if invasive management remains beneficial for these patents compared with medical therapy.

Keywords Octogenarian • Non-ST-Elevation acute coronary syndromes • Percutaneous coronary intervention

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Introduction

Data from large, international, multicentre randomised controlled trials have established early invasive management as best practice for the management of non-ST-elevation acute coronary syndromes (NSTEACS) [1–3]. They also demonstrated that this benefit was greatest in patients most at risk for myocardial infarction (MI) or cardiovascular death [1]. Age is a non-modifiable risk factor for ischaemic heart disease and is the main driver of baseline risk [4]. However, older patients were either excluded or significantly under-represented in the aforementioned randomised controlled trials [1–3]. Furthermore, real world observational studies have identified a 'risk-treatment paradox' in which older patients presenting with NSTEACS are significantly less likely than younger patients to receive both early invasive management and guideline-directed optimal medical therapy despite being at higher risk [4–7].

Recently, the 'After-Eighty' randomised controlled trial indicated that the benefit of early invasive management for NSTEACS extends to older patients in terms of reducing recurrent myocardial infarction and need for revascularisation, and several observational studies and meta-analyses also suggest reductions in stroke and mortality [4,8–12]. However, given the increased risks of procedural complications and significant heterogeneity in the older population in terms of physiological ageing, comorbidities, frailty and life expectancy, doubt remains regarding how to best identify the subgroup of older patients most at risk for poor outcomes following invasive management and for whom medical management may be more appropriate [6,8,11,13,14]. Accordingly, despite consideration of comorbidities being key to decision-making around adopting an invasive or conservative management approach to older NSTEACS patients, current guidelines do not provide any specific advice regarding older patients with comorbidities [15]. In the setting of ageing populations around the world and NSTEACS being the most common presentation of acute ischaemic heart disease in older populations, identification of this subgroup is particularly pertinent [4,8].

The objective of this study was to describe contemporary outcomes of older patients with NSTEACS undergoing percutaneous coronary intervention (PCI) and identify pre-procedural risk factors for major adverse cardiac or cerebrovascular events, using a large, multi-centre, real-world cohort of patients.

Methods

Data were obtained from the Victorian Cardiac Outcomes Registry (VCOR) [16]. VCOR was established in 2012 as a state-wide clinical quality registry in Victoria, Australia, with the aim to improve safety and quality of care provided to patients admitted with cardiovascular conditions. The VCOR PCI module catalogues data related to PCI procedures gathered from public and private hospitals across Victoria. As of December 2017, data have been collected for more than 40,000 PCI cases. All patients undergoing PCI are given information on the registry and an opt-out consent process is used. A steering committee with representation from contributing centres oversees the registry activities and a peer-review committee audits and monitors data collection and outcomes from each site. Data collection methods and audit processes to ensure accuracy and completeness of registry data have been previously described in detail [16].

All patients in VCOR aged 80 years or older who had PCI performed for a primary indication of non-ST-elevation myocardial infarction (NSTEMI) or unstable angina between 1 January 2013 and 31 December 2017 were included in the present study (n=1,875). In accordance with VCOR definitions, the diagnosis of unstable angina required symptoms including at least one of 'angina that occurred at rest and was prolonged, usually lasting >20 minutes', 'new-onset angina of at least Canadian Cardiovascular Society (CCS) class III severity' or 'recent acceleration of angina reflected by an increase in severity of at least 1 CCS class (to at least CCS class III)'. The diagnosis of NSTEMI required biomarker elevation (troponin, CK-MB) plus either ST segment depression/T wave abnormalities in the electrocardiograph (ECG) or ischaemic symptoms (nausea and vomiting, persistent shortness of breath secondary to left ventricular failure, chest discomfort) [16]. Twenty (20) patients who presented intubated post out-of-hospital cardiac arrest or with pre-procedural cardiogenic shock were excluded.

'Major adverse cardiac or cerebrovascular event' (MACCE) was a composite outcome comprising 30-day mortality; MI; stroke; major bleeding; target vessel revascularisation (TVR) or target lesion revascularisation (TLR); in-hospital cardiogenic shock or stent thrombosis; and new requirement for dialysis. Standardised definitions for all outcomes have been described previously [16].

Patient demographic data and pre-procedural comorbidities were compared between the groups with and without a MACCE. In order to assess for possible confounders, medications pre-procedurally, at discharge and at 30-day follow-up, procedural details and culprit lesion characteristics were also compared between the two groups.

Continuous variables are presented as means ± standard deviations (SD). Categorical variables are expressed as the number of patients with proportions according to the presence or absence of a MACCE at 30-day follow-up. Univariate analyses were performed using the t-test or Mann-Whitney test for continuous variables and Chi-squared test for categorical variables. Pre-procedural patient characteristics which differed significantly between the groups with and without a MACCE were included in a multivariable logistic regression analysis to determine independent predictors of MACCE. All statistical analyses were performed using IBM SPSS Statistics software (IBM Corp, version 22, Armonk, NY, USA).

This study was approved by The Alfred Hospital Human Research Ethics Committee as well as each participating

hospital, including the use of opt-out consent, as previously described [16].

Results

Between 1 January 2013 and 31 December 2017, 1,875 patients aged ≥80 years (mean age 84.2±3.4 years) in VCOR underwent angiography for NSTEACS. Of these, 1,112 (59.3%) were male, 449 (23.9%) presented with unstable angina and 1,426 (76.1%) presented with NSTEMI. The sample included 144 (7.7%) patients aged ≥90 years. Baseline characteristics are outlined in Table 1.

Patients underwent PCI an average of 2.52 days post admission. Coronary intervention via the radial artery was performed in 733 (40.2%) cases, compared with 1,086 (59.6%) via femoral access. Of the cohort, 1,477 (78.8%) received at least one drug-eluting stent, while 293 (15.6%) received bare-metal stents only. The majority of lesions (61.0%) were of American Heart Association/American College of Cardiology (AHA/ACC) B2 or C complexity, with procedural success achieved in 1,777 (94.8%) patients. Medications, procedural details and lesion characteristics are shown in Table 2.

MACCE occurred in 150 (8.0%) patients at 30-day follow-up. Thirty-day (30-day) mortality (3.0%), major bleeding (2.1%) and myocardial infarction (1.3%) were the most common adverse events.

Pre-procedural characteristics listed in Table 1 were assessed for correlation with post-PCI MACCE. Age (p=0.04), pre-procedural at least moderate left ventricular systolic dysfunction as defined by a left ventricular ejection fraction (LVEF) less than 45% (p<0.01) and stage 3b or worse chronic kidney disease (CKD) as defined by an eGFR less than or equal to 45 mL/min/1.73m^2 or need for renal replacement therapy (RRT) (p=0.01) were associated with MACCE at 30-day follow-up on univariate analyses. Nonagenarian status, medication-requiring diabetes, peripheral vascular disease and previous coronary artery bypass grafts (CABG) were not significantly associated with having a MACCE at 30-day follow-up.

Compared to patients with no MACCE, those with MACCE at 30-day follow-up were significantly more likely to have received pre-procedural glycoprotein IIb/IIIa inhibitors (p<0.001) and to have been on mechanical ventricular support (p=0.01). They were also more likely to have had significant left main coronary artery lesions (p=0.01), AHA/ACC B2 or C complexity lesions (p<0.001) and failed PCI (p<0.001). Time from admission to PCI was significantly longer, on average 11.13 hours, in the MACCE group (p<0.01). Significantly fewer patients in the MACCE group received bare metal stents only (p<0.05) or were receiving dual-antiplatelet therapy at both discharge (p≤0.01) and 30-day follow-up (p<0.001). Medications administered, procedural details and lesion complexity were otherwise similar between the two groups.

On multivariable analysis, LVEF<45% (p<0.001) and eGFR≤30 mL/min/1.73m^2 or renal replacement therapy (p<0.01) remained independent predictors of MACCE at 30-day follow-up as demonstrated in Table 3. The individual components of the composite MACCE outcome and their

Table 1 Baseline characteristics (all n (%) unless stated otherwise).

	All	No MACCE N=1,725	MACCE N=150	P-value
Mean Age±SD	84.24±3.41	84.21±3.43	84.67±3.23	0.04
Age ≥90	144 (7.68)	130 (7.53)	14 (9.33)	0.43
Male	1,112 (59.31)	1,020 (59.13)	92 (61.33)	0.60
Indigenous	3 (0.18)	3 (0.18)	0 (0.00)	0.86
Mean BMI±SD	26.48±4.31	26.49±4.30	26.40±4.45	0.92
Diabetes on medication	452 (24.11)	411 (23.82)	41 (27.33)	0.36
Peripheral vascular disease	168 (8.96)	153 (8.87)	15 (10.00)	0.64
Cerebrovascular disease	138 (7.36)	124 (7.19)	14 (9.33)	0.36
Previous PCI	627 (33.44)	581 (33.68)	46 (30.67)	0.45
Previous CABG	285 (15.20)	266 (15.42)	19 (12.67)	0.37
eGFR ≤60 or on RRT	1,306 (69.65)	1,200 (69.57)	106 (70.67)	0.78
eGFR ≤45 or on RRT	709 (37.81)	638 (36.99)	71 (47.33)	0.01
eGFR ≤30 or on RRT	181 (9.65)	154 (8.93)	27 (18.00)	<0.001
LVEF (%)				<0.001
Normal (≥50)	917 (60.41)	853 (61.59)	64 (48.12)	
Mild (45-49)	316 (20.82)	293 (21.16)	23 (17.29)	
Moderate (35-44)	205 (13.50)	173 (12.49)	32 (24.06)	
Severe (<35)	80 (5.27)	66 (4.77)	14 (10.53)	

Abbreviations: CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; RRT, renal replacement therapy; BMI, body mass index; SD, standard deviation; MACCE, major adverse cardiac or cerebrovascular events.

Table 2 Medications, procedural details and lesion characteristics (all n [%] unless stated otherwise).

	All	No MACCE N=1,725	MACCE N=150	P-value
Medications (Pre-Procedural)				
Oral anticoagulant	210 (11.20)	190 (11.01)	20 (13.33)	0.39
Antithrombin therapy	1,660 (89.49)	1,527 (89.56)	133 (88.67)	0.73
Glycoprotein IIb/IIIa inhibitor	74 (3.95)	60 (3.48)	14 (9.33)	<0.001
Aspirin	1,690 (90.37)	1,553 (90.29)	137 (91.33)	0.68
Thienopyridine	943 (50.29)	874 (50.67)	69 (46.00)	0.27
Ticagrelor	595 (31.73)	550 (31.88)	45 (30.00)	0.63
Dual Antiplatelet				0.89
No	447 (23.84)	409 (23.71)	38 (25.33)	
Aspirin/Thienopyridine	864 (46.08)	797 (46.20)	67 (44.67)	
Aspirin/Ticagrelor	564 (30.08)	519 (30.09)	45 (30.00)	
Medications (At Discharge)				
ACE-Inhibitor/Angiotensin Receptor Antagonist	1,265 (69.93)	1,194 (70.28)	71 (64.55)	0.20
Beta blocker	1,253 (69.65)	1,173 (69.45)	80 (72.73)	0.47
Statin	1,594 (87.58)	1,499 (87.61)	95 (87.16)	0.89
Other lipid lowering therapy	134 (7.35)	129 (7.54)	5 (4.50)	0.24
Oral anticoagulant	243 (13.33)	227 (13.25)	16 (14.55)	0.70
Dual antiplatelet				<0.01
No	119 (6.53)	105 (6.13)	14 (12.73)	
Aspirin/Thienopyridine	1,106 (60.67)	1,034 (60.36)	72 (65.45)	
Aspirin/Ticagrelor	598 (32.80)	393 (30.90)	24 (21.82)	
Medications (At 30-Day Follow-Up)				
Dual antiplatelet				<0.001
No	322 (17.66)	283 (16.52)	39 (35.45)	
Aspirin/Thienopyridine	990 (54.31)	937 (54.70)	53 (48.18)	
Aspirin/Ticagrelor	511 (28.03)	493 (28.78)	18 (16.36)	
Procedural Details				
Mean Days from Admission to PCI±SD	2.52±3.32	2.48±3.38	2.95±2.56	0.01
Access				0.39
Radial	733 (40.21)	695 (40.57)	38 (34.55)	
Femoral	1,086 (59.57)	1,014 (59.19)	72 (65.45)	
Brachial	4 (0.22)	4 (0.22)	0 (0.00)	
Thrombus aspiration device	15 (0.82)	13 (0.76)	2 (1.82)	0.23
Rotational atherectomy	30 (1.65)	28 (1.63)	2 (1.82)	0.88
Mechanical ventricular support	7 (0.38)	5 (0.29)	2 (1.82)	0.01
Lesion successfully treated	1,777 (94.77)	1,657 (96.06)	120 (80.00)	<0.001
Drug-eluting stent	1,477 (78.77)	1,365 (79.13)	112 (74.67)	0.20
Bare-metal stent only	293 (15.63)	278 (16.12)	15 (10.00)	<0.05
Mean number of stents implanted±SD	1.29±0.73	1.30±0.72	1.19±0.81	0.56
Mean total stent length (mm)±SD	23.75±15.54	23.76±15.08	23.53±20.13	0.30
Lesion Characteristics				
Lesion Location				0.01
Left main	56 (2.99)	45 (2.61)	11 (7.33)	
Left anterior descending	706 (37.65)	650 (37.68)	56 (37.33)	
Left circumflex	464 (24.75)	434 (25.16)	30 (20.00)	
Right coronary artery	512 (27.31)	463 (26.84)	49 (32.67)	
Graft	137 (7.31)	133 (7.71)	4 (2.67)	
AHA/ACC B2/C complexity lesion	1,143 (60.96)	1,031 (59.77)	112 (74.67)	<0.001
Chronic total occlusion lesion	34 (1.81)	32 (1.86)	2 (1.33)	0.65
Stent thrombosis lesion	11 (0.64)	11 (0.64)	0 (0.00)	0.33
In-stent restenosis sesion	126 (6.72)	119 (6.90)	7 (4.67)	0.30

Abbreviations: PCI, percutaneous coronary intervention; SD, standard deviation; MACCE, major adverse cardiac or cerebrovascular events; AHA, American Heart Association; ACC, American College of Cardiology.

Table 3 Independent predictors of major adverse cardiac or cerebrovascular events.

	Odds Ratio (OR)	95% Confidence Interval	P-value
LVEF (%)			
Mild (45-49)	1.01	0.62-1.67	0.96
Moderate (35-44)	2.32	1.47-3.68	<0.001
Severe (<35)	2.55	1.35-4.84	<0.01
eGFR≤30 or on RRT	2.10	1.27-3.46	<0.01

Abbreviations: LVEF, left ventricular ejection fraction; RRT, renal replacement therapy.

frequency stratified by eGFR and LVEF grade are outlined in Table 4. As illustrated in Figure 1, the increased rate of MACCE in the LVEF<45% and eGFR≤30 mL/min/1.73m^2 or renal replacement therapy groups was driven predominantly by higher rates of in-hospital mortality and cardiogenic shock, and 30-day mortality and MI. Notably, in patients with both eGFR ≤30 mL/min/1.73m^2 or renal replacement therapy and LVEF<45%, 30-day mortality was 20.9% compared to 1.7% in those patients with eGFR >30 mL/min/1.73m^2 and LVEF≥45%.

Discussion

The present study aimed to identify risk factors for poor short-term PCI outcomes in patients aged ≥80 years presenting with NSTEACS. Outcomes were chosen that were thought to represent complications serious enough in an older patient that they would warrant considering avoiding invasive management. Distinct from the majority of previous studies that defined 'elderly' as age greater than 75 years, given the age definition of 'elderly' has progressively increased, octogenarian status was used as the 'elderly' cut-off [4,6,10,11,13,15]. Consistent with previous trials in younger populations, the present study observed that pre-procedural renal impairment and left ventricular systolic dysfunction remained predictive of MACCE post PCI in an octogenarian population [17–19].

The finding that Stage 4 or worse CKD was predictive of MACCE post PCI in the VCOR study population, which included 181 patients with pre-procedural eGFR≤30 mL/min/1.73m^2 or on RRT, is particularly pertinent given these patients were underrepresented in the 'After Eighty' trial (n=24) which was the only large, randomised controlled trial to demonstrate benefit of an invasive strategy in the octogenarian population [8]. Similarly, only 19 patients with LVEF<30% were included in the 'After Eighty' trial compared with 80 patients with LVEF<35% in the present study [8]. It is, therefore, unclear if the benefits of an invasive strategy demonstrated in the 'After Eighty' trial would apply to octogenarians with significant renal impairment or left ventricular systolic dysfunction [8].

The present study also adds to the growing evidence for the safety of PCI for NSTEACS in older patients, with 92.0% of the 1,875 included octogenarians who underwent PCI avoiding any MACCE at 30-day follow-up. Compared to the 4,158 octogenarians in the SWEDEHEART register who underwent PCI during their index hospital stay for NSTEMI between 2011–2014, a greater proportion of patients included in the

Table 4 Major adverse cardiac or cerebrovascular events.

	Event Rate (%)				
	All Patients	eGFR≤30 or on RRT and LVEF<45	LVEF<45	eGFR≤30	eGFR>30 and LVEF≥45
New requirement for dialysis	9/1,465 (0.61)	1/39 (2.56)	3/243 (1.23)	5/158 (3.16)	1/836 (0.12)
In-hospital cardiogenic shock	23/1,875 (1.23)	4/43 (9.30)	13/285 (4.56)	6/181 (3.31)	8/1,106 (0.72)
In-hospital stent thrombosis	2/1,875 (0.11)	0/43 (0.00)	1/285 (0.35)	0/181 (0.00)	1/1,106 (0.09)
In-hospital TVR (CABG)	7/1,875 (0.37)	0/43 (0.00)	1/285 (0.35)	1/181 (0.55)	5/1,106 (0.45)
In-hospital major bleeding	30/1,875 (1.60)	0/43 (0.00)	3/285 (1.05)	3/181 (1.66)	20/1,106 (1.81)
In-hospital stroke	7/1,875 (0.37)	1/43 (2.33)	2/285 (0.70)	1/181 (0.55)	5/1,106 (0.45)
In-hospital MI	15/1,875 (0.80)	0/43 (0.00)	7/285 (2.46)	0/181 (0.00)	8/1,106 (0.72)
In-hospital mortality	38/1,875 (2.03)	8/43 (18.60)	18/285 (6.32)	10/181 (5.52)	13/1,106 (1.18)
30-day TVR (PCI)/TLR	16/1,875 (0.85)	1/43 (2.33)	5/285 (1.75)	1/181 (0.55)	7/1,106 (0.63)
30-day TVR (CABG)	6/1,875 (0.32)	1/43 (2.33)	4/285 (1.40)	1/181 (0.55)	2/1,106 (0.18)
30-day major bleeding	40/1,875 (2.13)	0/43 (0.00)	3/285 (1.05)	3/181 (1.66)	29/1,106 (2.62)
30-day stroke	4/1,762 (0.23)	0/33 (0.00)	2/256 (0.78)	0/162 (0.00)	2/1,051 (0.19)
30-day MI	22/1,755 (1.25)	1/32 (3.13)	5/255 (1.96)	4/159 (2.52)	10/1,047 (0.96)
30-day mortality	57/1,875 (3.04)	9/43 (20.93)	27/285 (9.47)	13/181 (7.18)	19/1,106 (1.72)

Abbreviations; MI, myocardial infarction; CABG, coronary artery bypass graft; TVR, target vessel revascularisation; TLR, target lesion revascularisation; LVEF, left ventricular ejection fraction.

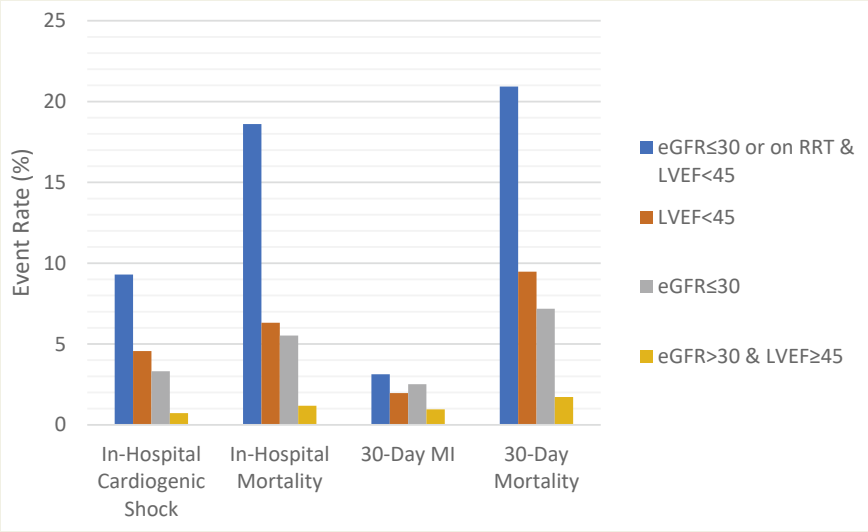

Figure 1 Major adverse cardiac or cerebrovascular events stratified by pre-procedural eGFR and LVEF.
Abbreviations: LVEF, left ventricular ejection fraction; RRT, renal replacement therapy; eGFR, estimated glomerular filtration rate.

VCOR cohort had a reduced LVEF (39.6% vs 14%) and eGFR≤30 mL/min/1.73m^2 (9.7% vs 5%) [12]. Baseline characteristics recorded in both registries were otherwise similar [12]. Despite pre-procedural LVEF<45% and eGFR≤30 mL/min/1.73m^2 or RRT being independent predictors of MACCE post-PCI in the present study, 30-day mortality (3.0% vs 3.4%), in-hospital MI (0.8% vs 0.9%) and in-hospital major bleeding (1.6% v 1.4%) rates were similar between the VCOR and SWEDEHEART patient cohorts [12]. In support of this being potentially reflective of progressively improving safety outcomes of PCI in more recent years, the in-hospital mortality rate in the VCOR population also compared favourably to the 161,640 octogenarians with NSTEACS managed with an early invasive strategy in the 2003–2010 US Nationwide Inpatient Sample database (2.03% vs 4.7%) [9]. Notably, while in the 'After Eighty' study there was a trend towards harm for an invasive strategy in patients older than 90 years (n=34), in the present study (n=144), age ≥90 was not a significant predictor of MACCE with 9.7% of 144 nonagenarians having a MACCE, similar to the overall event rate of 8.0% [8]. Furthermore, possibly indicative of improving safety in complex PCI, in contrast to previous studies, traditional risk factors for complications post PCI such as diabetes, peripheral vascular disease and previous CABG did not predict MACCE in the VCOR octogenarian population [20–22].

While randomised controlled trials have demonstrated benefit of an invasive approach to managing NSTEACS in older patients, in real world practice, the heterogeneity of this population in terms of comorbidities and frailty make it impractical to conduct randomised controlled trials in various subpopulations of octogenarians to confirm benefit. Furthermore, ongoing advances in interventional technology that make PCI increasingly safe in frail, comorbid older patients are shifting the risk-benefit ratio of an invasive strategy at a rate faster than prospective trials can generate results [11]. As an example, while major bleeding accounted for 26.7% of MACCE in the present study, femoral access was utilised in 63.4% of VCOR cases between 2013–2016. For comparison, only 39% of PCI cases recorded in VCOR were done via a transfemoral approach in 2017. The increasing uptake of transradial access for PCI and its demonstrated effect on reducing bleeding complications may alter risk-benefit decision making [23]. It is likely that clinical registries, with their capacity to evaluate a wide variety of potential outcome predictors, are important in assisting clinicians in providing an accurate portrayal of individualised peri-procedural risk.

The main limitation of the present study is the fact that the VCOR Registry was designed to only capture the population of octogenarians with NSTEACS who underwent PCI. Consequently, the study population may differ from the general population of octogenarians presenting with NSTEACS, particularly since patients with multiple comorbidities are more likely to be managed conservatively. Nonetheless, the 8% rate of MACCE in our study population, despite being a selected population, adds strength to the argument that age alone should not preclude an invasive strategy. Rather, identification of risk factors for adverse outcomes, such as renal impairment and left ventricular systolic dysfunction as revealed in this study, are key to risk stratification. Significant differences between the groups with and without MACCE in terms of pre-procedural GPIIb/IIIa inhibitor use, mechanical ventricular support, lesion location and AHA/ACC complexity, rates of successful PCI, time from admission to PCI and dual antiplatelet use at discharge and 30-day follow-up may also have introduced an element of confounding. However, the groups were comparable apart from minor differences in medications, and observed differences in the groups

with and without MACCE with regards to mechanical support, rates of successful PCI and lesion location and complexity are somewhat expected given they are inherently associated with an increased risk of adverse events.

Conclusions

The present study of patients aged ≥80 years undergoing PCI for NSTEACS demonstrated that >90% of patients, including selected patients ≥90 years of age, avoid short-term major cardiac or cerebrovascular adverse events. Pre-procedural LVEF<45% and eGFR≤30 mL/min/1.73m^2 or renal replacement therapy were independent predictors of a major adverse cardiac or cerebrovascular event post PCI. Randomised studies are required to determine if invasive management remains beneficial over medical therapy for older patients with significant renal impairment or left ventricular systolic dysfunction presenting with NSTEACS.

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Conflicts of Interest

None.

References

[1] Fox KAA, Clayton TC, Damman P, Pocock SJ, de Winter RJ, Tijssen JGP, et al. Long-term outcome of a routine versus selective invasive strategy in patients with Non-ST-segment elevation acute coronary syndrome. A meta-analysis of individual patient data. J Am Coll Cardiol 2010;55:2435–45.

[2] Roffi M, Patrono C, Collet J-P, Mueller C, Valgimigli M, Andreotti F, et al. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. Eur Heart J 2016;37:267–315.

[3] Amsterdam EA, Wenger NK, Brindis RG, Casey DE, Ganiats TG, Holmes DR, et al. 2014 AHA/ACC Guideline for the management of patients with non-ST-elevation acute coronary syndromes: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation 2014;130:2354–94.

[4] Damman P, Clayton T, Wallentin L, Lagerqvist B, Fox KAA, Hirsch A, et al. Effects of age on long-term outcomes after a routine invasive or selective invasive strategy in patients presenting with non-ST segment elevation acute coronary syndromes: a collaborative analysis of individual data from the FRISC II - ICTUS - RITA-3 (FIR) trials. Heart 2012;98:207–13.

[5] Bagnall AJ, Goodman SG, Fox KAA, Yan RT, Gore JM, Cheema AN, et al. Influence of age on use of cardiac catheterization and associated outcomes in patients with non-st-elevation acute coronary syndromes. Am J Cardiol 2009;103:1530–6.

[6] Negers A, Boddaert J, Mora L, Golmard J-L, Moïsi L, Cohen A, et al. Determinants of invasive strategy in elderly patients with non-ST elevation myocardial infarction. J Geriatr Cardiol 2017;14.

[7] Alexander KP, Newby LK, Cannon CP, Armstrong PW, Gibler WB, Rich MW, et al. Acute coronary care in the elderly, part I. Non-ST-segment-elevation acute coronary syndromes: a scientific statement for healthcare professionals from the American Heart Association Council on Clinical Cardiology. Circulation 2007;115:2549–69.

[8] Tegn N, Abdelnoor M, Aaberge L, Endresen K, Smith P, Aakhus S, et al. Invasive versus conservative strategy in patients aged 80 years or older with non-ST-elevation myocardial infarction or unstable angina pectoris (After Eighty Study): an open-label randomised controlled trial. Lancet 2016;387:1057–65.

[9] Kolte D, Khera S, Palaniswamy C, Mujib M, Fonarow GC, Ahmed A, et al. Early invasive versus initial conservative treatment strategies in octogenarians with UA/NSTEMI. Am J Med 2013;126:1076–1083.e1.

[10] Saraswat A, Rahman A, Singh K. An Invasive vs a conservative approach in elderly patients with non–ST-segment elevation myocardial infarction: systematic review and meta-analysis. Can J Cardiol 2018;34:330–2.

[11] Gnanenthiran SR, Kritharides L, D'Souza M, Lowe HC, Brieger DB. Revascularisation compared with initial medical therapy for non-ST-elevation acute coronary syndromes in the elderly: a meta-analysis. Heart 2017;103:1962–9.

[12] Reinius P, Mellbin L, Holzmann MJ, Siddiqui AJ. Percutaneous coronary intervention versus conservative treatment for non ST-segment elevation myocardial infarction in patients above 80 years of age. Int J Cardiol 2018;267:57–61.

[13] Murena E, Antonicelli R, Sacco A, Daniotti A, Piscione F, Morici N. Early aggressive versus initially conservative treatment in elderly patients with non – ST-Segment elevation acute coronary syndrome. JCIN 2012;5:906–16.

[14] Sanchis J, Núñez E, Antonio J, Marín F, Consuegra-sánchez L, Ventura S, et al. European Journal of Internal Medicine randomized comparison between the invasive and conservative strategies in comorbid elderly patients with non-ST elevation myocardial infarction. Eur J Intern Med 2018;35:89–94.

[15] Dégano IR, Subirana I, Fusco D, Tavazzi L, Kirchberger I, Farmakis D, et al. Percutaneous coronary intervention reduces mortality in myocardial infarction patients with comorbidities : implications for elderly patients with diabetes or kidney disease. Int J Cardiol 2017;249:83–9.

[16] Stub D, Lefkovits J, Brennan AL, Dinh D, Brien R, Duffy SJ, et al. The establishment of the Victorian Cardiac Outcomes Registry (VCOR): monitoring and optimising outcomes for cardiac patients in Victoria. Hear Lung Circ 2018;27:451–63.

[17] Singh M, Rihal CS, Lennon RJ, Spertus J, Rumsfeld JS, Holmes DR. Bedside estimation of risk from percutaneous coronary intervention: the new Mayo Clinic risk scores. Mayo Clin Proc 2007;82:701–8.

[18] Best PJM, Lennon R, Ting HH, Bell MR, Rihal CS, Holmes DR, et al. The impact of renal insufficiency on clinical outcomes in patients undergoing percutaneous coronary interventions. J Am Coll Cardiol 2002;39:1113–9.

[19] Yu J, Dangas G, Baber U, Vlachojannis G, Clayton T, Pocock S, et al. Impact of ejection fraction on mortality in patients undergoing PCI: a patient-level pooled analysis from the REPLACE-2, ACUITY and HORIZONS-AMI Trials. J Am Coll Cardiol 2012;59:E289.

[20] Mathew V, Gersh BJ, Williams BA, Laskey WK, Willerson JT, Tilbury RT, et al. Outcomes in patients with diabetes mellitus undergoing percutaneous coronary intervention in the current era: a report from the Prevention of REStenosis with Tranilast and its Outcomes (PRESTO) Trial. Circulation 2004;109:476–80.

[21] Rihal CS, Sutton-Tyrrell K, Guo P, Keller NM, Jandova R, Sellers MA, et al. Increased incidence of periprocedural complications among patients with peripheral vascular disease undergoing myocardial revascularization in the bypass angioplasty revascularization investigation. Circulation 1999;100:171–7.

[22] Scarsini R, Zivelonghi C, Pesarini G, Vassanelli C, Ribichini FL. Repeat revascularization: percutaneous coronary intervention after coronary artery bypass graft surgery. Cardiovasc Revasc Med 2016;17:272–8.

[23] Asrar ul Haq M, Tsay IM, Dinh DT, Brennan A, Clark D, Cox N, et al. Prevalence and outcomes of trans-radial access for percutaneous coronary intervention in contemporary practise. Int J Cardiol 2016;221:264–8.