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Primary percutaneous coronary intervention for ST elevation myocardial infarction in octogenarians: trends and outcomes

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► See Editorial, p 813

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ABSTRACT

Objective The general population is gradually ageing in the western world. Therefore, the number of octogenarians undergoing primary percutaneous coronary intervention (PCI) for ST-elevation myocardial infarction (STEMI) is increasing. We aim to provide insight into temporal trends in the annual proportions of octogenarians among STEMI patients undergoing primary PCI and their clinical characteristics and outcomes over an 11-year observational period.

Design Single-centre observational study.

Patients Between 1997 and 2007, 4506 STEMI patients were treated with primary PCI at the authors' institution. Patients aged over 80 years were identified.

Main outcome measures Temporal trends in the annual proportion of octogenarian STEMI patients and their baseline characteristics, 30-day and 1-year mortality were analysed.

Results A total of 379 octogenarians (8.4% of the total population) was treated with primary PCI between 1997 and 2007. Over time, the annual proportion of octogenarians gradually increased from four of 113 (3.5%) in 1997 to 51 of 579 (8.8%) in 2007 (*p* for trend <0.01). In the total cohort of 379 patients, 30-day mortality was 21% (81 patients) and 1-year mortality was 28% (107 patients). There was no improvement in survival among octogenarian STEMI patients over the 11-year study period.

Conclusion The annual proportion of octogenarian STEMI patients increased significantly over the 11-year study period. Mortality among these high-risk patients was high and did not improve during the study period. Unfortunately, little is known about the optimal treatment of the elderly as they are underrepresented in many randomised clinical trials. Further studies into the optimal STEMI management strategy for the elderly are warranted.

The general population is gradually ageing in the western world. The proportion of octogenarians in the general population is expected to triple by the year 2050.¹ Advanced age is associated with an increased incidence of myocardial infarction and the presence of severe cardiovascular comorbidities. Even though octogenarians constitute an important high-risk subgroup of ST-elevation myocardial infarction (STEMI) patients, they are underrepresented in randomised clinical trials investigating optimal reperfusion and adjunctive treatment

strategies for STEMI.^{2,3} Furthermore, only very few retrospective analyses have focused on octogenarians, all hampered by small patient numbers.^{4–7} As a result, little is currently known about the clinical characteristics and outcome of octogenarians undergoing primary percutaneous coronary intervention (PCI).

In this paper, we provide an insight into trends in the annual proportion of octogenarians in the STEMI population undergoing primary PCI and their clinical characteristics and outcomes over an observational period of 11 years.

METHODS

Between 1997 and 2007, a total of 4931 consecutive and unselected patients was admitted to our hospital with STEMI. Acute STEMI was diagnosed when patients had symptoms of an acute myocardial infarction lasting 30 minutes to 6 h, accompanied by an electrocardiogram with ST-segment elevation greater than 1 mm (0.1 mV) in two or more contiguous leads. Patients were immediately transported to the cardiac catheterisation laboratory and underwent immediate coronary angiography with a view to perform primary PCI. PCI was performed by standard techniques, if the coronary anatomy was suitable. All procedural decisions, including device selection and adjunctive pharmacotherapy, such as glycoprotein IIb/IIIa inhibitors, were made at the discretion of the operator. All patients were treated with heparin (5000 IU) and aspirin (900 mg) before PCI. If a coronary stent was implanted, ticlopidine or clopidogrel was prescribed according to the guidelines.

BASELINE DATA

All patients undergoing PCI at our institution were prospectively followed. Baseline clinical (ie, gender, age, risk factors and cardiac history), angiographic (ie, multivessel disease) and procedural (ie, stent implantation) information was entered by qualified cardiac catheterisation laboratory personnel and interventional cardiologists in a dedicated electronic database.

FOLLOW-UP

We obtained information on the vital status from the institutional follow-up database of PCI patients. Patients were surveyed 1 year after

primary PCI using a mailed, self-administered questionnaire. Information on mortality was synchronised with the computerised records from the national population registry (Statistics Netherlands, Voorburg, The Netherlands) and was verified until 1 January 2008. We reviewed the outpatient files and contacted general practitioners by telephone in the case of conflicting or missing data.

STUDY COHORT

Data for the 4931 patients were checked for consistency and completeness. For patients who underwent more than one primary PCI during the study period ($n=147$), only the first intervention was included in this analysis. Patients treated with rescue PCI for failed intravenous thrombolysis ($n=145$), patients without a confirmed diagnosis of STEMI ($n=76$) and patients lost to follow-up ($n=57$) were excluded, resulting in a final cohort of 4506 STEMI patients. To provide insight into the differences in baseline, angiographic and procedural characteristics, and 30-day and 1-year mortality, between younger and elderly STEMI patients we stratified patients into four age groups (≥ 80 years, 60–79 years, 40–59 years, <40 years).

DEFINITIONS

Multivessel disease was defined as at least one stenosis of 70% or greater in a non-infarct-related epicardial artery. Shock was defined according to the criteria used in the SHould we emergently revascularize Occluded Coronaries for cardiogenic shock? (SHOCK) trial.⁸

PRIMARY OUTCOME

The primary outcome for the present analysis was all-cause 30-day and 1-year mortality.

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS statistical software, version 15.0. Discrete variables are summarised as percentages (frequency). Temporal trends in the proportion of octogenarians in the STEMI population, temporal trends in baseline characteristics and differences in baseline characteristics between the four age groups were tested for significance using the χ^2 test. Statistical significance was defined as a p value less than 0.05.

Cumulative event rates of all-cause death were estimated using the Kaplan–Meier method. A ‘landmark analysis’ with a landmark set at 30 days was used to provide further insight into differences between early (<30 days) and long-term (1-year) mortality. The log rank statistic was used to test for significant differences in mortality between the four age groups.

Logistic regression models were used to analyse the relationship between age and 1-year mortality. First, an unadjusted odds ratio (OR) and 95% CI for 1-year mortality was calculated for age as a continuous variable. Subsequently, adjusted OR and 95% CI were calculated using forward stepwise selection multivariate logistic regression analysis. The covariates included were: age, gender, hypertension, smoking, diabetes mellitus, hypercholesterolaemia, family history of cardiovascular disease, previous myocardial infarction, shock, left anterior descending coronary artery-related infarction, multivessel disease and a postprocedural thrombolysis in myocardial infarction (TIMI) flow grade less than 3. A covariate was included in the model if it influenced the model with $p<0.10$ by the Wald test and was removed if its significance level exceeded $p=0.15$. For both unadjusted and adjusted mortality models, the

shape and strength of the relationships between age and probability of death at 1 year were plotted graphically. If the relationship was non-linear, a model fitting approach involving cubic polynomials (splines) was used, as previously employed by the Global Utilisation of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries (GUSTO-I) trial investigators.^{9–13}

RESULTS

Trends in octogenarian STEMI patients

Between 1997 and 2007 we treated 379 patients aged 80 years or over (8.4%), 2020 patients aged 60–79 years (45%), 1896 patients aged 40–59 years (42%) and 211 patients aged under 40 years (4.7%). Over time, the annual proportion of octogenarians gradually increased from four of 113 (3.5%) in 1997 to 51 of 579 (8.8%) in 2007 (p for trend <0.01). Figure 1 shows the proportion of octogenarians in the annual total STEMI population for our 11-year STEMI experience.

Clinical characteristics

Baseline, angiographic and procedural characteristics are shown in table 1. The majority of octogenarian STEMI patients were women. Furthermore, octogenarians had a higher prevalence of diabetes, hypertension and multivessel disease, and more often had a history of a previous infarction when compared with younger patients. When compared with younger patients, primary PCI in octogenarians was associated with a lower rate of attaining postprocedural TIMI flow grade 3. Between 1997 and 2007 the rates of postprocedural TIMI flow grade 3 increased significantly from 75% in 1997 to 82% in 2007 (p for trend 0.02). We observed no other significant trends in the composition of baseline, clinical and procedural characteristics during our 11-year STEMI experience (data not shown).

Clinical outcome

One-year follow-up was complete for all patients ($n=4506$). Table 2 shows mortality rates at 30 days, from 30 days to 1 year and at 1 year. As expected, mortality was very high in octogenarians when compared with patients in the younger age groups. For octogenarians, the 1-year mortality rate was 28.2% compared with 12.8%, 6.3% and 4.3% in patients aged 60–79, 40–59 and less than 40 years, respectively. Figure 2a shows cumulative 1-year mortality stratified by age group. Figure 2b

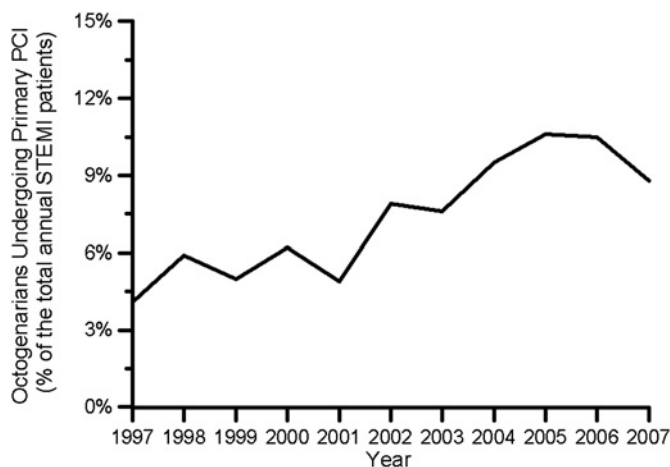


Figure 1 Eleven-year trend in the proportion of octogenarians undergoing primary percutaneous coronary intervention (PCI).

Table 1 Baseline clinical, angiographic and procedural characteristics of 379 octogenarians treated with primary PCI between 1997 and 2007

Baseline characteristics N, (%)	Patients <40 Years N=211 (4.7%)	Patients 40–59 Years N=1896 (42%)	Patients 60–79 years N=2020 (45%)	Patients ≥80 years N=379 (8.4%)	p Value
Male	165 (78)	1517 (80)	1368 (68)	171 (45)	<0.01
Hypertension	34 (16)	504 (27)	720 (36)	132 (35)	<0.01
Smoker	151 (72)	1119 (59)	653 (32)	47 (12)	<0.01
Diabetes	12 (5.7)	161 (8.5)	300 (15)	66 (17)	<0.01
Known hypercholesterolaemia at admission	37 (18)	449 (24)	449 (22)	43 (11)	<0.01
Family history of CVD	118 (56)	929 (49)	663 (33)	72 (19)	<0.01
Previous MI	13 (6.2)	189 (10)	330 (16)	79 (21)	<0.01
Shock	15 (7.1)	118 (6.2)	183 (9.1)	44 (12)	<0.01
Angiographic characteristics					
LAD-related MI	106 (50)	836 (44)	843 (42)	180 (48)	0.03
Pre-PCI TIMI flow grade					0.28
TIMI 0	135 (64)	1265 (67)	1319 (65)	227 (60)	
TIMI 1	16 (7.7)	152 (8.0)	168 (8.3)	44 (12)	
TIMI 2	29 (14)	204 (11)	229 (11)	52 (14)	
TIMI 3	31 (14)	275 (15)	304 (15)	56 (15)	
Post-PCI TIMI flow grade					<0.01
TIMI 0	2 (0.9)	38 (2.0)	67 (3.3)	19 (5.0)	
TIMI 1	2 (0.9)	8 (0.4)	29 (1.4)	10 (2.6)	
TIMI 2	12 (5.7)	113 (6.0)	188 (9.3)	54 (14.2)	
TIMI 3	195 (92)	1737 (92)	1736 (86)	296 (78)	
Multivessel disease	30 (14)	498 (26)	821 (41)	202 (53)	<0.01
Procedural					
Glycoprotein IIb/IIIa inhibitor	62 (29)	485 (26)	535 (27)	88 (23)	0.36
Thrombosuction performed	71 (34)	616 (33)	614 (30)	96 (25)	0.03
Intra-aortic balloon counterpulsation	14 (6.6)	128 (6.8)	201 (10)	51 (14)	<0.01
Stent placement	142 (67)	1433 (76)	1499 (74)	285 (75)	0.05

CVD, cardiovascular disease; LAD, left anterior descending coronary artery; MI, myocardial infarction; PCI, percutaneous coronary intervention; TIMI, thrombolysis in myocardial infarction.

shows cumulative mortality until the landmark set at 30 days and mortality between 30 days and 1-year follow-up. Both early (<30 days) and late (from 30 days to 1 year) mortality was significantly higher in the octogenarian groups when compared with the other three groups (log rank p value <0.01). Interestingly, mortality was comparable in male and female octogenarians as illustrated by the Kaplan–Meier curve in figure 3 (log rank p value 0.24). As shown in figure 4 the probability of death at 1-year follow-up increased with age (unadjusted OR 1.054 per year increase, 95% CI 1.045 to 1.06; p<0.01). After adjustment for other predictors of mortality, the relationship between age and 1-year mortality somewhat weakened as a result of the interaction with other risk factors. However, age remains a strong and independent predictor of 1-year mortality with an OR of 1.032 per year increase in age. Table 3 shows unadjusted and adjusted OR for all variables included in the model.

Table 2 30-Day, 30-day to 1-year, and overall 1-year mortality

	30-Day mortality (N=4506) (%)	30-Day to 1-year mortality* (N=4131) (%)	Overall 1-year mortality (N=4506) (%)
<40 years	3.80	0.50	4.30
40–59 years	5.10	1.30	6.30
60–79 years	9.40	3.80	12.80
≥80 years	21.40	8.70	28.20

*For 30-day to 1-year mortality, only patients who survived the first 30 days after myocardial infarction were included.

DISCUSSION

In this study conducted in a cohort of 4506 STEMI patients, covering 11 years of observations from a single centre, we showed that the annual proportion of octogenarians among patients undergoing primary PCI for STEMI has gradually increased from four of 113 patients (3.5%) in 1997 to 51 of 579 patients (8.8%) in 2007 (p for trend <0.01). Furthermore, we showed that age is both an independent predictor of mortality and is associated with a higher prevalence of cardiovascular risk factors. Therefore, 1-year mortality among patients aged 80 years or over was high (28.2%). Noteworthy, 1-year mortality was comparable in male and female octogenarians and remained unchanged during the study period of 11 years.

To our knowledge, this is the first paper investigating temporal trends regarding the proportion of octogenarians and their clinical characteristics and outcomes. The proportion of STEMI patients aged 80 years and older increased significantly during the study period of 11 years. The increasing number of octogenarians being referred for primary PCI for STEMI can be explained by the ageing of the general population (the fastest rate of growth in any segment of the population in the USA is occurring in octogenarians) and the fact that the incidence of STEMI in elderly patients is high.³

Previous papers concerning primary PCI in octogenarians studied only small series of patients, ranging from 40 to 63 patients.^{4–7} These small studies report 1-year mortality rates varying from 10% to 43%. In the current study, the 30-day and 1-year mortality rates for octogenarians were 21.4% and 28.2%, respectively. Moreover, we performed a landmark survival

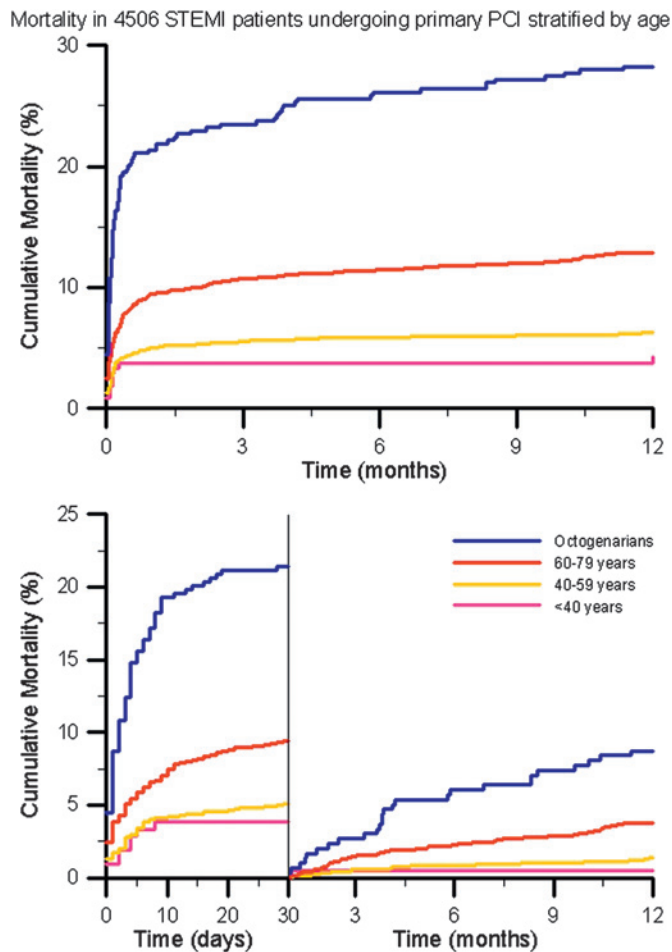


Figure 2 Overall 1-year mortality, 30-day and 30-day to 1-year mortality in 4506 ST-elevation myocardial infarction (STEMI) patients. Log rank p values for overall 1-year mortality: octogenarians versus ages 60–79 years, $p < 0.01$; octogenarians versus ages 40–59 years, $p < 0.01$; octogenarians versus ages over 40 years, $p < 0.01$; ages 60–79 versus 40–59 years, $p < 0.01$; ages 60–79 versus over 40 years, $p < 0.01$; ages 40–59 versus ages under 40 years, $p = 0.6$.

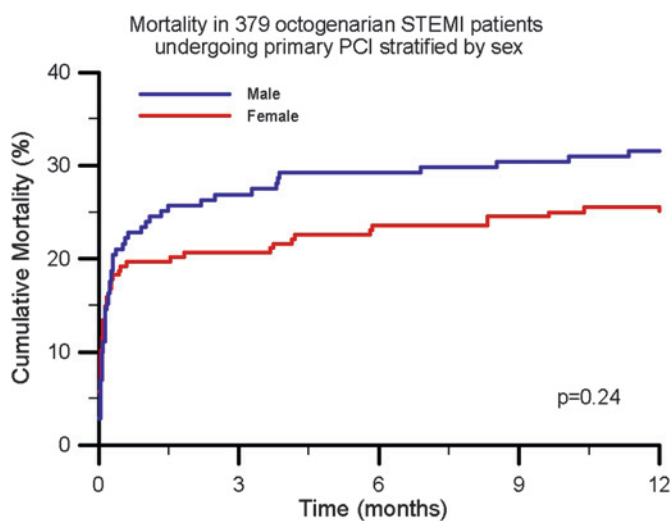


Figure 3 Mortality in 379 octogenarian ST-elevation myocardial infarction (STEMI) patients undergoing primary percutaneous coronary intervention (PCI) stratified by sex.

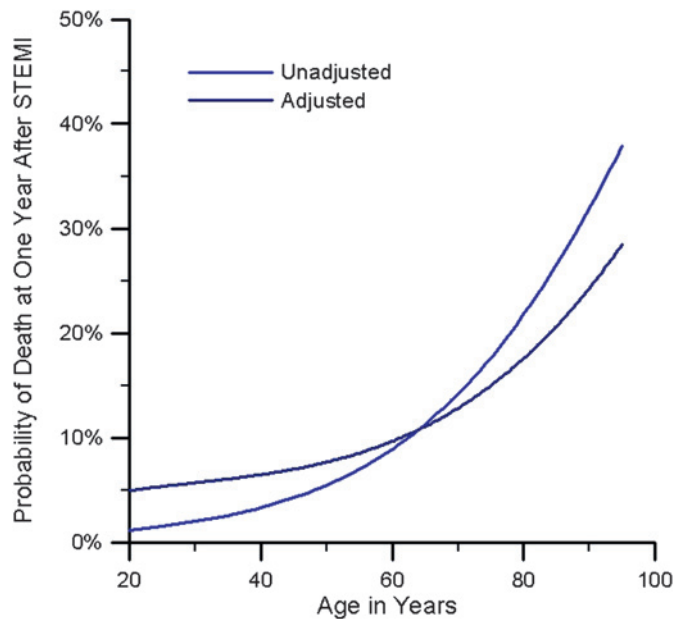


Figure 4 Probability of death at 1 year after ST-elevation myocardial infarction (STEMI) as a function of age. Adjusted for gender, hypertension, smoking, diabetes mellitus, hypercholesterolaemia, family history of cardiovascular disease, previous myocardial infarction, shock, left anterior descending coronary artery-related infarction, multivessel disease, and postprocedural thrombolysis in myocardial infarction flow grade or less than 3. PCI, percutaneous coronary intervention.

analysis to provide further insight into early (<30 days) and late mortality (from 30 days to 1 year). The majority of deaths occurred within 30 days; however, the mortality rates continued to diverge significantly between 30 days and 1 year. Interestingly, we observed no difference in mortality between male and female octogenarians.

The high mortality rates can partly be explained by the effects of advancing age itself, and partly by the higher incidence of cardiogenic shock complicating STEMI, the higher prevalence of multivessel coronary artery disease, previous myocardial infarction, and other co-morbidities such as hypertension and diabetes mellitus. This is demonstrated in table 3 and shown graphically in figure 4 which shows that after adjusting for other known risk factors, the relationship between age and 1-year mortality somewhat weakens, although it remains significant (unadjusted OR 1.054 per year increment, adjusted OR 1.032 per year increment). Furthermore, octogenarians more often had a suboptimal angiographic result (postprocedural TIMI flow grade <3) after primary PCI. Although we observed a significant improvement in postprocedural TIMI flow grade 3 rates from 75% in 1997 to 82% in 2007, this is still lower than in younger patients. Finally, elderly patients with an acute myocardial infarction are less likely to present with ST-segment elevation and chest pain on presentation. Many present with dyspnoea as the principal complaint.^{3 14} The lack of symptoms may delay presentation, causing a delay in the administration of treatment.

Limitations

The retrospective nature of this study prohibits us from speculating on how the prognosis of octogenarians treated with primary PCI for STEMI could be improved. Furthermore, although follow-up for 1-year mortality was complete for all patients, we do not have detailed information on the causes of death. Therefore, the exact causes of the high case-fatality rates

Table 3 Univariate and multivariate forward stepwise logistic regression analysis for the prediction of 1-year mortality

	Unadjusted			Adjusted		
	OR	95% CI	p Value	OR	95% CI	p Value
Age (per year increment)	1.054	1.045 to 1.062	<0.01	1.035	1.025 to 1.0441	<0.01
Hypertension	0.77	0.62 to 0.95	0.02	0.72	0.56 to 0.91	<0.01
Smoking	0.41	0.33 to 0.50	<0.01	0.72	0.56 to 0.92	<0.01
Diabetes mellitus	1.74	1.35 to 2.23	<0.01	1.34	1.00 to 1.78	0.05
Hypercholesterolemia	0.55	0.42 to 0.72	<0.01	0.70	0.52 to 0.95	<0.01
Family history of CVD	0.35	0.28 to 0.44	<0.01	0.54	0.42 to 0.67	<0.01
Previous MI	1.90	1.54 to 2.35	<0.01	1.47	1.14 to 1.90	<0.01
Shock	9.37	7.40 to 11.86	<0.01	6.73	5.17 to 8.74	<0.01
LAD-related MI	1.42	1.18 to 1.78	<0.01	1.39	1.13 to 1.71	<0.01
Multivessel disease	2.63	2.18 to 3.18	<0.01	1.77	1.42 to 2.21	<0.01
Post-PCI TIMI 3 flow	0.22	0.18 to 0.28	<0.01	0.33	0.26 to 0.43	<0.01

CVD, cardiovascular disease; LAD, left anterior descending coronary artery; MI, myocardial infarction; PCI, percutaneous coronary intervention; TIMI, thrombolysis in myocardial infarction.

currently remain unknown. Moreover, a patient selection bias may have been introduced as this paper focuses on STEMI, and octogenarians are less likely to develop ST-elevation on the electrocardiogram in the setting of acute myocardial infarction. Data on time from symptom onset to treatment were unavailable; therefore we were not able to investigate differences in time from symptom onset to treatment between age groups. Detailed information on peri and post-procedural medication was not available; therefore we were not able to assess differences in adherence to guideline-based post-STEMI therapies.

Conclusion

The annual proportion of STEMI patients aged 80 years and older has significantly increased during the 11-year study period and it will keep increasing in the years to come. Octogenarians constitute a rapidly growing subgroup of patients with a high incidence of STEMI and a high case-fatality rate, which did not improve during the study period. As octogenarians were either excluded from or were underrepresented in major randomised clinical trials, the optimal treatment strategy remains unknown. This paper underscores the importance of future research into the optimal STEMI treatment for octogenarians.

Competing interests None.

Provenance and peer review Not commissioned; externally peer reviewed.

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