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Revascularisation in older adult patients with non-ST-segment elevation acute coronary syndrome: effect and impact on 6-month mortality

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Abstract

Although revascularisation in non-ST-segment elevation acute coronary syndrome (NSTEACS) is associated with better outcomes, its impact in older adult patients is unclear. This is a retrospective analyses of three national NSTEACS registries conducted during the past decade in Spain. Patients aged 75 years and older were included: DESCARTES (DES; year 2002; *n*=534), MASCARA (MAS; 2005; *n*=1736) and DIOCLES (DIO; 2012; *n*=593). The adjusted association between revascularisation and total (inhospital and 6-month) mortality was estimated by two-stage meta-analysis (pooled effect across the three registries with inverse-variability weights) and one-stage meta-analysis (multilevel model with random effects across studies). The impact of revascularisation was assessed comparing the observed and the expected mortality based on a logistic regression model in the pooled database. Although revascularisation was associated with a lower risk of mortality in meta-analyses (two-stage: odds ratio 0.44, 95% confidence interval 0.29–0.67; one-stage: odds ratio 0.54, 95% confidence interval 0.36–0.81) and the revascularisation rate increased steadily from 2002 (DES 14.2%) to 2012 (DIO 43.7%), its impact was not patent across registries, probably because this increase was concentrated in low and medium-risk GRACE strata (tertile 1, 2 and 3: MAS 59%, 20% and 6%; DIO 64%, 39% and 19%, respectively). In conclusion, a consistent increase of revascularisation in NSTEACS in older adults was not followed by a decrease in mortality at 6 months, probably because the impact of this strategy is limited to the higher risk population, the stratum with the lowest revascularisation rate in real life.

Keywords

Older adults, acute coronary syndrome, revascularisation

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Introduction

The impact of coronary revascularisation during the acute phase of non-ST-segment elevation acute coronary syndromes (NSTEACS) is well established.[1–4] Moreover, subgroup analyses in clinical trials suggest that the benefit of revascularisation is even higher in older adults,[5] although the rate of recruitment of this subgroup of patients in clinical trials has been low.[6] In the same manner, the rate of use of an invasive strategy in the real world is lower in older adults than in younger patients,[7] which has been attributed, at least in part, to a physician-driven selection of a more conservative strategy in older adults, a population with

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higher rates of comorbidities and a greater haemorrhagic risk.[8]

In the past two decades, a consistent reduction in the mortality rate across all subgroups of patients with NSTEACS has become apparent, even considering that the frequency of comorbidities and the estimated risk in NSTEACS have steadily increased.[6] Although this mortality reduction has been paralleled by an increase in the use of revascularisation across all population groups of NSTEACS, the real impact of revascularisation on older adults and the specific profile of elderly patients more potentially benefitting from revascularisation have not been studied in depth.

Registries constitute a valuable tool to assess temporal trends in clinical characteristics, the use of evidence-based hospital and discharge therapies and clinical outcomes in NSTEACS. The registries DESCARTES (Descripción del estado de los síndromes coronarios agudos en un registro temporal español), MASCARA (Manejo del síndrome coronario agudo. Registro actualizado) and DIOCLES (Descripción de la cardiopatía isquémica en territorio español) were performed in Spain in 2002, 2004–2005 and 2012, respectively.[9–11] They were prospective registries of acute coronary syndromes (ACS) performed from three different random samples of Spanish hospitals.

In the present retrospective analysis of these three registries, we aimed at assessing the change in the patterns of use of revascularisation in older adult (⩾75 years) patients with NSTEACS during the past decade, whether revascularisation is associated with a reduction in 6-month mortality in this population and, more importantly, the prognostic impact of revascularisation and the specific profile of the elder patient more benefitting from revascularisation.

Methods

The analysis was performed on pooled data from the databases of three consecutive national ACS registries: DESCARTES,[9] MASCARA[10] and DIOCLES.[11] The three registries had the following characteristics in common: (a) the main inclusion criterion was patients hospitalised with suspected ACS; (b) participating hospitals were randomly selected from a global database of Spanish hospitals (stratified by hospital complexity); (c) recruitment of patients was consecutive; and (d) a quality control of the exhaustiveness of the recruitment process and a data validity check process was carried out.

The DESCARTES registry was performed between April and May 2002. A total of 70 hospitals were invited to participate, but 18 declined. After a quality control of the minimum facilities needed to accomplish the registry, finally 45 hospitals participated (44.5% with neither coronary care unit (CCU) nor cath lab, 22.2% with CCU but without cath lab and 33% with both facilities). A total of 1877 patients hospitalised at least 24 hours with suspected NSTEACS were consecutively recruited.

The MASCARA registry was performed during 9 months (2004–2005). Sixty randomly selected hospitals were invited to participate, of which three declined, seven abandoned the study during the recruitment phase and 18 were excluded after a quality control data check because of concerns about potential selection bias.[12] Finally, 32 participating centres (68% with cath lab) included consecutively 8014 patients hospitalised at least 24 hours with suspected ACS.

The DIOCLES registry was carried out between January and June 2012. Fifty randomly selected hospitals were invited to participate, but six were excluded during the recruitment phase. Finally, 44 centres (18 with cath lab) consecutively recruited 2557 patients hospitalised with suspected ACS.

NSTEACS diagnosis criteria in the three registries were angina or equivalent anginal symptoms with repolarisation changes in the ECG (excepting persistent ST-elevation), or without repolarisation changes or ECG not assessable (pacemaker rhythm or left bundle branch block) but with elevated myocardium necrosis markers (creatine kinase (CK)-MB in DESCARTES and MASCARA, and CK-MB or troponin T or I in DIOCLES) or, in the DESCARTES registry, with ischaemia induced in a stress test during hospitalisation or with history of coronary artery disease. Demographics, cardiovascular risk factors, medical history, clinical presentation, clinical management before and during hospitalisation and complications during hospitalisation were collected. Six-month mortality was investigated by phone call or personal interview with relatives, or in some cases by searching patients' medical records.

The baseline characteristics of patients aged 75 years or older of each registry were described using counts and percentages for categorical data and means and standard deviations or medians and interquartile ranges for normally and not normally distributed continuous variables. Missing values for heart rate, blood pressure and creatinine were imputed to the average and missing values for ST-segment deviation and cardiac arrest were imputed to absence. We compared differences in baseline risk, clinical management, inhospital complications and 6-month mortality between subgroups of patients using the chi-squared test for categorical variables and t-test or Wilcoxon (Mann–Whitney) rank sum test for continuous variables, and we assessed temporal trends between registries using an extension of the non-parametric Wilcoxon rank sum test.

For the purposes of the present study, we homogenised the categories of the most important variables across the three registries and linked the databases to construct a pooled database. Those variables that were not uniformly collected and defined across the three registries at the coordinating team criteria were not considered for the analysis.

Finally, the following variables were considered adequate for risk assessment of 6-month mortality: age, diabetes mellitus, previous ACS, previous revascularisation, previous stroke, previous claudication, history of congestive heart failure, heart rate and systolic blood pressure at the first medical contact, and all drug therapy at discharge (see Table 1). Unfortunately, the GRACE risk score was only available in the MASCARA and DIOCLES studies. We estimated the expected 6-month mortality from a logistic regression model including the above-mentioned independent variables in the pooled database.

To estimate the association between percutaneous or surgical coronary revascularisation and 6-month mortality in each registry we performed separate logistic regression models with revascularisation as the only independent variable (crude estimate) or together with all risk factors defined above (adjusted estimates).

To estimate the pooled effect of revascularisation on 6-month mortality across the three registries we performed a meta-analysis of individual patient data in two ways: two-stage and one-stage meta-analysis.[13,14] In the two-stage approach, we estimated the effect of revascularisation in each registry separately and estimated the pooled effect with inverse-variability weights. We tested heterogeneity with the Cochrane Q statistic. For the one-stage approach, we modelled individual data from all studies simultaneously while accounting for the clustering of participants within studies with a multilevel model with random effects across studies. In both cases, we obtained crude and adjusted estimates (adjusting by all the risk variables defined above). We tested for significance of the interaction of revascularisation with the registry and for the significance of random slopes for all variables.

As a sensitivity analysis, the revascularisation rate, the observed and expected mortality across the three registries according to revascularisation, as well as the crude and adjusted estimated effect of revascularisation on 6-month mortality were separately estimated in those patients who raised cardiac biomarkers, and in the whole population but excluding those patients who underwent coronary artery bypass grafting (CABG) (see Supplementary analyses, Supplementary Tables 1 to 4).

To estimate the theoretical impact of the revascularisation rate on overall 6-month mortality depending on the baseline risk we performed a simulation study from MASCARA and DIOCLES baseline data: the pooled database of these studies was distributed in tertiles of GRACE score for 6-month mortality (tertile 1 the lowest risk and tertile 3 the highest risk), and the samples in each tertile were bootstrapped with replacement (300 iterations) fixing different revascularisation rates from 10% to 90% (in 10 percentage points steps). Six-month mortality was estimated for each iteration and represented in box plots by revascularisation rate and GRACE tertile.

Results

Overall, 2863 patients aged 75 years and older were included: 534 in DESCARTES, 1736 in MASCARA and 593 in DIOCLES (Figure 1). Table 1 shows the baseline characteristics, procedures, general management and inhospital complications in the three registries. The proportion of women in this population of NSTEACS progressively tended to decrease, whereas hypercholesterolemia, diabetes and hypertension rates clearly increased from DESCARTES to DIOCLES. Similarly, both angina and revascularisation history were more frequent in contemporary populations, as well as the use of secondary prevention drugs, especially statins and beta-blockers. Elevation of myocardial injury biomarkers was more prevalent in MASCARA and DIOCLES, probably reflecting different types of biomarkers and different techniques of laboratory measurement. At the same time, the rates of ST-segment deviation at the first contact decreased during the past decade. The general risk assessed by GRACE score for the prediction of inhospital mortality decreased slightly from MASCARA (166.5±31.3) to DIOCLES (158.8±31.8), and the same was true concerning the GRACE score for 6-month mortality prediction. Nevertheless, considering the accepted thresholds in the GRACE score to stratify the sample in low, medium and high-risk patients, the majority of patients were included in the highest risk stratum. Prescription at discharge of antiplatelet therapies, beta-blockers and statins progressively increased, whereas prescription of calcium antagonists and nitrates decreased and that of angiotensin-converting enzyme inhibitors remained unchanged.

During hospitalisation, the most remarkable finding was an important increase between 2002 and 2012 in the use of coronary angiography (from 26.8% to 68.6%) and percutaneous revascularisation (from 13.5% to 41.8%), which led to an important and steady increase of the total revascularisation rate (14.2%, 27% and 42.8%, respectively). In general, non-revascularised patients were older, more frequently women and had a more frequent history of stroke and heart failure, although differences decreased from DESCARTES to DIOCLES (see Supplementary Table 5). In contrast, the higher rate of myocardial biomarkers elevation and repolarisation changes in the ECG in non-revascularised patients observed in DESCARTES switched to the opposite in DIOCLES. The prescription of aspirin, clopidogrel, beta-blockers and statins at discharge was consistently lower in non-revascularised patients. In any case, the 6-month mortality rate was also consistently lower in patients revascularised across the three registries (Figure 2). Furthermore, the lower risk of 6-month mortality associated with revascularisation in the crude analysis was also present in the adjusted analyses in each registry as well as in pooled adjusted two-stage (odds ratio (OR) 0.44, 95% confidence interval (CI) 0.29–0.67) and one-stage (OR 0.54, 95% CI 0.36–0.81) meta-analyses (Table 2). Supplementary material shows several

Table 1. Characteristics of patients, inhospital management and outcomes in each registry.

	N	DESCARTES	*N*	MASCARA	*N*	DIOCLES	*P* for trend
		N=534		*N*=1736		*N*=593	
Age (mean; SD)	534	80 (4.1)	1736	80.9 (4.3)	593	80.8 (4.4)	0.001
Woman (n; %)	534	225 (42.1)	1735	736 (42.4)	593	217 (36.6)	0.051
Current smokers (*n*; %)	534	25 (4.7)	1735	94 (5.4)	593	28 (4.7)	0.997
Dyslipidemia (*n*; %)	519	212 (40.9)	1736	765 (44.1)	593	349 (58.9)	<0.001
Hypertension (*n*; %)	527	382 (72.5)	1736	1314 (75.7)	593	484 (81.6)	<0.001
Diabetes mellitus (*n*; %)	527	188 (35.7)	1736	689 (39.7)	593	247 (41.7)	0.043
Previous history							
Angina (*n*; %)	527	300 (56.9)	1736	844 (48.6)	593	179 (30.2)	<0.001
Myocardial infarction (*n*; %)	527	186 (35.3)	1736	636 (36.6)	593	189 (31.9)	0.203
Percutaneous revascularisation (*n*; %)	528	61 (11.6)	1736	267 (15.4)	593	139 (23.4)	<0.001
Coronary surgery (*n*; %)	534	42 (7.9)	1736	135 (7.8)	593	51 (8.6)	0.636
Stroke (*n*; %)	534	68 (12.7)	1736	242 (13.9)	593	74 (12.5)	0.867
Claudication (*n*; %)	534	65 (12.2)	1736	254 (14.6)	593	78 (13.2)	0.678
Heart failure (*n*; %)	534	100 (18.7)	1736	214 (12.3)	593	92 (15.5)	0.163
Previous pharmacological treatment							
Aspirin (*n*; %)	529	257 (48.6)	1736	786 (45.3)	593	314 (53)	0.111
Clopidogrel (*n*; %)	534	41 (7.7)	1736	334 (19.2)	593	122 (20.6)	<0.001
Beta-blockers (*n*; %)	534	115 (21.5)	1736	547 (31.5)	593	251 (42.3)	<0.001
Statins (*n*; %)	534	142 (26.6)	1736	605 (34.9)	593	336 (56.7)	<0.001
ACE inhibitors (*n*; %)	534	224 (42)	1736	561 (32.3)	593	220 (37.1)	0.123
First attendance features							
Elevated necrosis markers (*n*; %)	508	308 (60.6)	1736	1490 (85.8)	593	477 (80.4)	<0.001
ST-segment deviation (*n*; %)	451	250 (55.4)	1058	632 (59.7)	593	206 (34.7)	<0.001
Heart rate (bpm) (mean; SD)	527	83.9 (23.4)	1620	82.6 (22)	578	80 (21.3)	0.007
Systolic blood pressure (mmHg) (mean; SD)	527	146 (29)	1718	146 (31)	569	144 (27)	0.406
Heart failure (*n*; %)	534	97 (18.2)	1736	226 (13)	593	168 (28.3)	<0.001
GRACE score for inhospital mortality (mean; SD)		NA	1598	166.5 (31.3)	567	158.8 (31.8)	<0.001
Inhospital procedures							
Echocardiography (*n*; %)	527	308 (58.4)	1736	1249 (72)	593	509 (85.8)	<0.001
Treadmill exercise test (*n*; %)	534	73 (13.7)	1736	105 (6.1)	593	63 (10.6)	0.108
Radioactive isotopes (*n*; %)	534	25 (4.7)	1736	154 (8.9)	593	21 (3.5)	0.342
Coronary angiography (*n*; %)	534	143 (26.8)	1736	776 (44.7)	593	407 (68.6)	<0.001
Percutaneous revascularisation (*n*; %)	534	72 (13.5)	1736	416 (24)	593	248 (41.8)	<0.001
Coronary surgery (n;%)	534	4 (0.8)	1736	54 (3.1)	593	11 (1.9)	0.243
Total revascularisation[a] (*n*; %)	534	76 (14.2)	1736	468 (27)	593	259 (42.8)	<0.001
Drug therapy at discharge							
Aspirin (*n*; %)	507	371 (73.2)	1736	1298 (74.8)	561	519 (92.5)	<0.001
Clopidogrel (*n*; %)	502	142 (28.3)	1736	833 (48)	561	399 (71.1)	<0.001
Beta-blockers (*n*; %)	503	213 (42.4)	1736	1028 (59.2)	560	424 (75.7)	<0.001
Calcium antagonists (*n*; %)	506	222 (43.8)	1736	534 (30.8)	561	138 (24.6)	<0.001
Nitrates (*n*; %)	511	369 (72.2)	1736	1085 (62.5)	561	273 (48.7)	<0.001
ACE inhibitors (*n*; %)	506	250 (49.4)	1736	855 (49.3)	561	290 (51.7)	0.439
Statins (*n*; %)	505	223 (44.2)	1736	1020 (58.8)	561	512 (91.3)	<0.001
GRACE score for 6-month mortality; (mean (SD))		NA	1614	135.4 (20.2)	568	130 (23.1)	<0.001
Lowest risk (GRACE <70) (*n*; %)		NA		0		0	
Low risk (GRACE 70-87) (n;%)		NA		4 (0.3)		6 (1.1)	
Intermediate to high risk (GRACE >87) (*n*; %)		NA		1610 (99.7)		562 (98.9)	
Inhospital mortality (*n*; %)	534	23 (4.3)	1736	124 (7.1)	593	32 (5.4)	0.513
6-Month mortality (*n*; %)	474	54 (11.4)	1320	108 (8.2)	561	57 (10.2)	0.585
Total mortality (*n*; %)	534	77 (14.4)	1736	232 (13.4)	593	89 (15)	0.744

[a]Percutaneous revascularisation or coronary surgery.

Dyslipidemia: documented history of hypercholesterolemia diagnosed and/or treated by a physician. Hypertension: documented history of hypertension diagnosed and/or treated by a physician. Diabetes mellitus: documented history of diabetes mellitus diagnosed prior to the current admission. Angina: documented history of angina and/or previous treatment for angina by a physician. Heart failure: documented history of congestive heart failure and/or previous treatment for congestive heart failure by a physician. ACE inhibitors: angiotensin-converting enzyme inhibitors; GRACE: Global Registry of Acute Coronary Events; NA: not available.

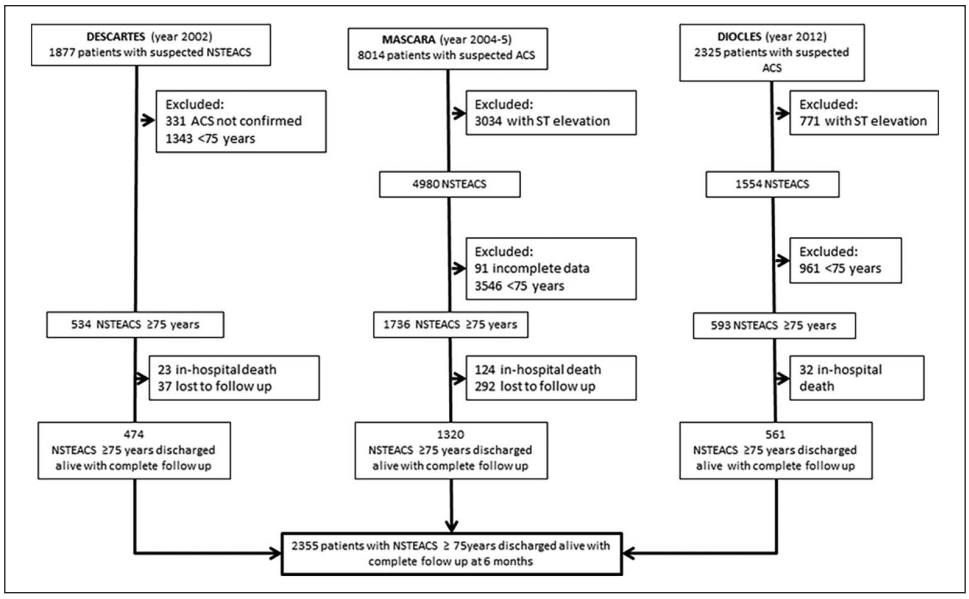

Figure 1. Flow chart of DESCARTES. NSTEACS: non-ST-elevation acute coronary syndrome; ACS: acute coronary syndrome.

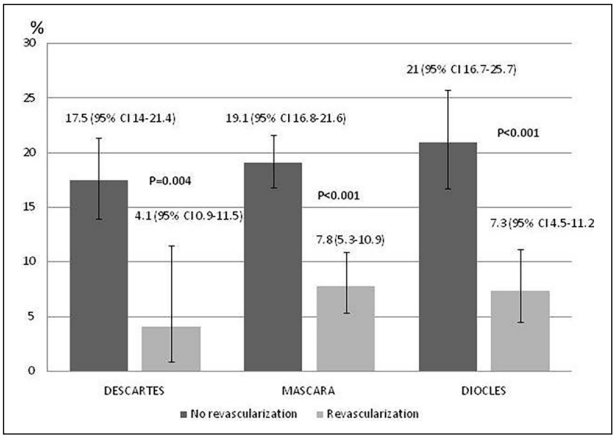

Figure 2. Effect on 6-month mortality rate across the three registries depending on revascularisation during admission.

sensitivity analyses. In particular, the revascularisation rate, observed mortality and expected mortality as well as the crude and adjusted estimated effect of revascularisation on 6-month mortality were assessed across the three registries excluding those patients who underwent CABG. In addition, the same analyses were made for those patients with raised cardiac biomarkers. In general, the results of these analyses did not differ from those obtained in the whole cohort.

In spite of the apparent benefit associated with revascularisation, the important increase in the revascularisation rate was not followed by an impact on the observed 6-month mortality rates, which was 15.5% in DESCARTES, 16.1% in MASCARA and 15% in DIOCLES, and did not significantly differ from the expected mortality, which was similar across registries (Figure 3). Actually, when we compared the revascularisation rate between tertiles of GRACE score in MASCARA and DIOCLES, we found that about 60% of revascularisation procedures were performed in patients with a relatively lower risk (tertile 1 of the GRACE score) in whom the absolute difference in 6-month mortality between revascularised and non-revascularised patients was also lower (Figure 4). In the simulation study, a progressive increase of the revascularisation rate in a theoretical population similar to the pooled population of MASCARA and DIOCLES registries, and assuming the same magnitude of benefit obtained in the pooled analysis, would barely have an impact on 6-month mortality in the lowest and medium GRACE risk strata (tertiles 1 and 2) (Figure 5). By contrast, increasing the revascularisation rate in the highest risk stratum (tertile 3) would have the highest impact, leading to a decrease in overall mortality from about 27% with a 10% revascularisation rate to about 18% with a 90% revascularisation rate, although, even in this case, the revascularisation rate had to increase considerably to have a relevant impact on overall mortality.

Discussion

This study shows that, in spite of a clear association between revascularisation during the index admission and lower risk of 6-month mortality in older adult patients with NSTEACS, a steady increase in revascularisation rates from 2002 to 2012 in this population across three registries was not paralleled by a decrease in the observed 6-month mortality rate, probably because the impact of this strategy is limited to the higher risk population, the stratum with the lowest revascularisation rate in real life. These results suggest that a selective invasive approach might be appropriate in this population.

Table 2. Crude and adjusted estimated effect of revascularisation by study and pooled across studies.

	OR (95% CI)		
	Crude	Adjusted	Weight[a]
DESCARTES	0.20 (0.06–0.66)	0.27 (0.05–1.50)	5.97
MASCARA	0.36 (0.24–0.53)	0.51 (0.29–0.87)	61.30
DIOCLES	0.30 (0.18–0.51)	0.38 (0.18–0.79)	32.73
Global effect: two-stage MA	0.32 (0.24–0.44)	0.44 (0.29–0.67)	Cochrane Q[b]=0.75; *P*=0.688
Global effect: one-stage MA[c]	0.34 (0.25–0.46)	0.54 (0.36–0.81)	

OR: odds ratio; CI: confidence interval; MA: meta-analysis.
[a]Inverse-variance weights for the two-stage MA.
[b]Heterogeneity test for the two-stage MA.
[c]Mixed effects model with fixed effects for all covariables and random effects for the intercept.

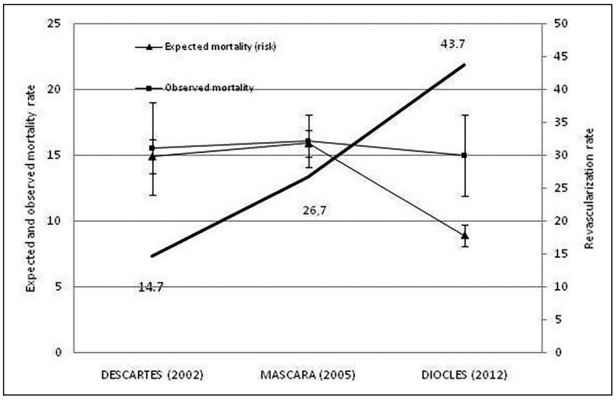

Figure 3. Observed and expected 6-month mortality rate across the three registries.

The three registries analysed reflect the real world concerning clinical characteristics, the use of evidence-based hospital and discharge therapies and clinical outcomes in older adult patients hospitalised by NSTEACS in Spain during 10 years. The DESCARTES registry was performed in a period (2002) when international guidelines restricted the use of revascularisation in this population to patients with angina in spite of the anti-ischaemic therapy or patients who developed congestive heart failure symptoms.[15] At that time there was not any indication concerning the specific management in older adults, and thus the rate of coronary angiography and revascularisation in this population was actually low (14%). At the time of the MASCARA registry (2004–2005), European guidelines recommended the use of coronary angiography in high-risk patients with the following characteristics: recurrent or refractory angina associated with dynamic ST-deviation, troponin elevation, heart failure, life-threatening arrhythmias or haemodynamic instability.[16] Guidelines indicated that an invasive approach in older adults should be individualised according to life expectancy, patient preferences and comorbidities in order to minimise risks in a frail population (class recommendation IC). Finally, in the latter registry (DIOCLES, 2012), European guidelines recommended coronary angiography in high-risk patients according to ECG repolarisation changes or troponin elevation, or in the presence of additional risk factors such as renal function impairment, diabetes, depressed left ventricular ejection fraction, previous revascularisation or in patients with intermediate to high risk according to the GRACE risk score. Seventy-five years is the cut-off used in the majority of registries on ACS in the elderly population. Revascularisation in older adults received a recommendation class IIaB and, again, highlighted the need for a careful balance between potential benefits and risks associated with an invasive approach.[17]

Our study shows that an increase in revascularisation rates from 2002 to 2012 in older adults was not followed by a substantial decrease in the observed 6-month mortality rate. Other European registries focused on the elderly, such as a French registry (2001–2006)[18] and a Polish registry (2003–2009),[19] showed similar results, although a trend to a decrease of inhospital mortality was observed in the latter. As a common finding in all registries, the baseline risk profile in contemporary populations is somewhat lower than that of the populations recruited years ago. Considering the trend to a higher indication of an invasive approach in the lowest risk strata and the strong relationship between the baseline risk and the impact of revascularisation on outcomes, the absence of a significant improvement in short to medium-term prognosis associated with a higher rate of revascularisation in our study could be somehow expected.

Actually, most subgroup analyses in clinical trials have shown that the benefit of the invasive approach in NSTEACS is mainly concentrated in older adults (⩾65 and especially ⩾75 years).[2,5,20] In this respect, a pooled analysis of individual data from FRISC II, ICTUS and RITA-2 showed a benefit of the invasive approach on cardiovascular death and myocardial infarction (MI) rates in older adults, but not in patients under 65 years.[21] Kragholm et al. recently analysed 76141 patients with NSTEACS recruited in 11 clinical trials between 1994 and 2010, 19.7% of them aged 75 years and older,[6] showing an increase over time in the frequency of comorbidities and in the expected mortality. However, that study also showed a high rate of the use of evidence-based therapies, especially coronary angiography, in the

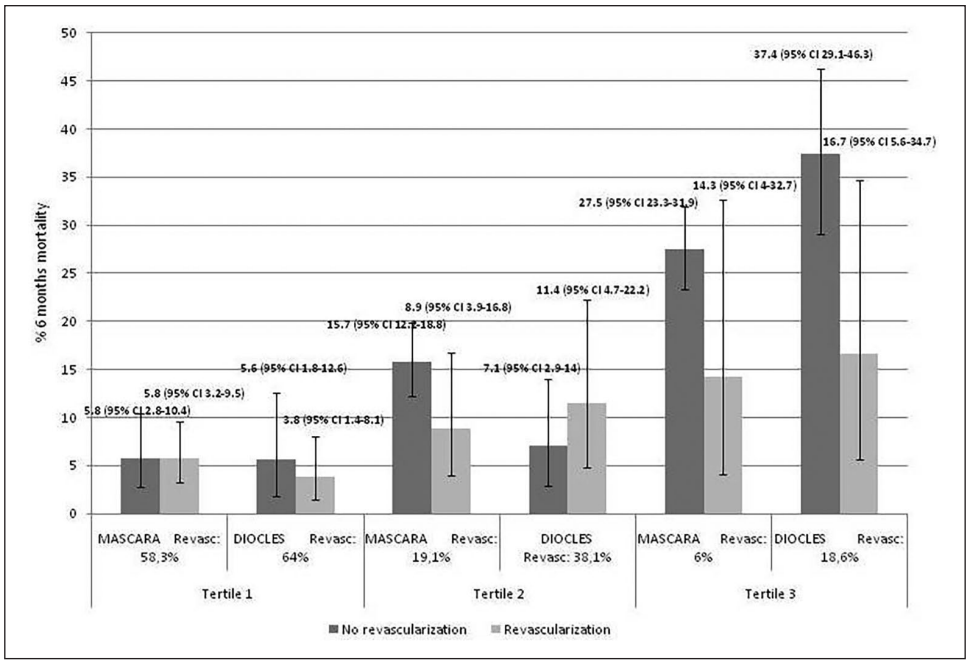

Figure 4. Six-month mortality rate across the MASCARA and DIOCLES registries according to tertiles of GRACE score (tertile 1 lowest risk, tertile 2 intermediate risk and tertile 3 highest risk) and depending on revascularisation during admission.

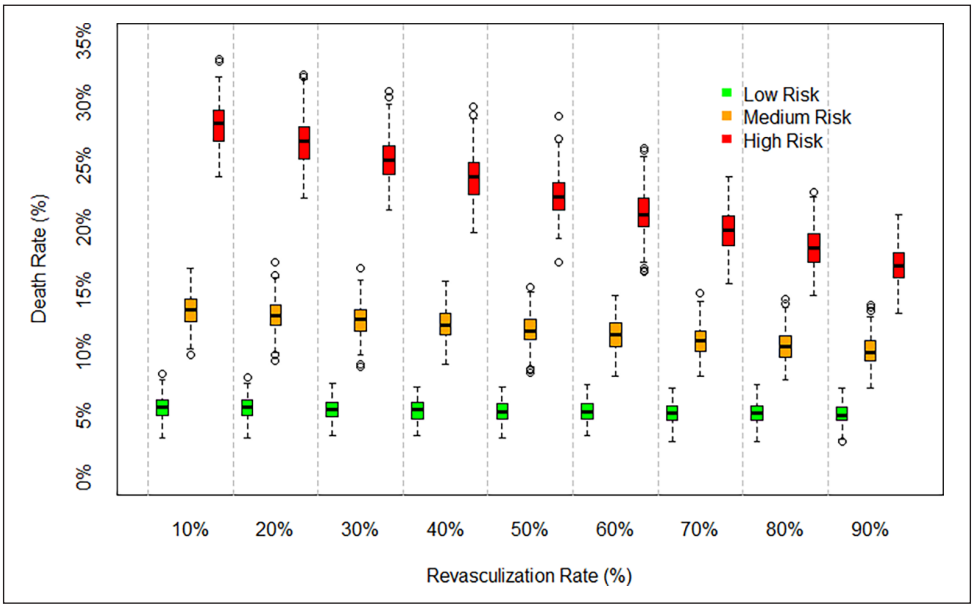

Figure 5. Estimated 6-month mortality rate across tertiles of GRACE score in a theoretical population similar to the pooled population of MASCARA and DIOCLES registries and considering several hypothetical scenarios concerning the revascularisation rate (it was assumed the same magnitude of benefit was obtained in the pooled analysis).

elderly: 75–79 years 75%, 80–84 years 72% and 85 years or older 64%. This was followed by 6-month mortality rates of 6.5%, 8.2% and 12.6%, respectively, which were surprisingly low, probably reflecting a highly selected population for inclusion in a randomised clinical trial. There are only three clinical trials specifically focused on older adults.[22–24] Although an invasive approach was associated with a lower rate of the composite of death, MI or rehospitalisation in both trials, this benefit was driven by a reduction in MI. This is in contrast with the results of some registries such as GRACE, in which revascularisation was associated with lower mortality but without changes in the MI rate.[25]

Several studies have shown that the use of coronary angiography and revascularisation is lower in older adults.[25,26] This has been attributed, at least in part, to a perception of a lower impact of an invasive approach in the elderly,[8] which could explain the paucity of octogenarians finally recruited in the AFTER EIGHTY study among those who were potentially eligible (11% of 4187 patients).[23] Although our study does not address the differences between young and older adult patients, it is the only one that analysed the pattern of use of coronary angiography and revascularisation considering different risk strata specifically in the elderly population. Interestingly, the majority of revascularisation procedures were performed in the stratum of the population in which the impact of an invasive approach is expected to be lower. Moreover, although revascularisation was associated with lower 6-month mortality in the three registries (pooled estimate OR 0.39, 95% CI 0.25–0.62), a higher rate of revascularisation did not imply better outcomes overall. This was reinforced by the findings of our simulation study, in which the expected mortality rate in the lower tertiles of risk in a population similar to MASCARA and DIOCLES barely changed by increasing the revascularisation rate. It was in the tertile with the highest risk in which the potential benefit of revascularisation was concentrated. This finding may imply two things. The first is that the perception of a higher rate of complications in the population with greater risk perhaps should not limit the use of an invasive approach because this perception has not actually been translated into poorer outcomes in clinical trials[5] and this is the stratum with the highest potential benefit. The second and most important is that older adult patients with NSTEACS actually constitute a heterogeneous group, and thus the potential impact of an invasive approach can be extremely different depending on the baseline risk. Although several studies have addressed potential factors associated with the selection by physicians of a more conservative or invasive approach in the elderly,[27] maybe it is time to go one step further.

This was an observational study and, thus, we cannot rule out confounding bias. Selection bias is also possible, although in the original studies a quality control of the exhaustiveness of the recruitment to minimise such a potential risk was carried out. Definitions of some variables varied between studies. Although we tried to homogenise the three databases, this was a post-hoc process, and thus 100% of coincidence is not possible. However, we were able to calculate the simplified GRACE score in the three registries as an indicator of expected mortality, and the main results were virtually the same after stratifying for this score (data not shown). Given that the hospitals participating in the three registries were different, with differences in biomarker assays, non-cardiac comorbidities, availability of cath lab, etc., the temporal relationship in rates of revascularisation cannot be reliably evaluated. Unfortunately, variables related to global comorbidity, angiographic data and frailty were not collected in the original registries, so the models developed were adjusted only for cardiovascular risk factors, cardiovascular clinical history and the severity of the index episode. However, given that the average age in these older samples of the three registries was very similar and that differences in the rates of other clinically relevant variables were not important, we expect that the three populations do not differ to a great extent concerning other comorbidities, and thus a change in the results would not be expected if we were able to adjust for non-cardiac comorbidities. The duration of follow-up was only 6 months, which could be insufficient to evaluate the effect of revascularisation on mortality and could diminish the difference in mortality between the three registries. Finally, there were patients lost to follow-up in the three registries and we do not have information on the cause of death and on the occurrence of other cardiac events after discharge.

This study shows a clear association between revascularisation in NSTEACS and a lower risk of 6-month mortality in older adults. However, this association does not necessarily imply a positive impact on hard outcomes. Actually, the important increase in revascularisation rates from 2002 to 2012 in this population across three registries was not paralleled by a decrease in the observed 6-month mortality rate because the highest rate of revascularisation was concentrated on patients at lower risk. These results suggest that a risk-driven invasive approach based on objective data such as the GRACE score would be appropriate in this population to improve prognosis and to avoid complications.

Conflict of interest

The authors declare that there is no conflict of interest.

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Supplementary material

Supplementary material for this article is available online.

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