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Title Resolving inequalities in care? Reduced mortality in the elderly after acute coronary syndromes. The Myocardial Ischaemia National Audit Project 2003 - 2010

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Abstract

Aims : To examine age-dependent in-hospital mortality for hospitalization with acute coronary syndromes (ACS) in England and Wales.

Methods and results : Mixed-effects regression analysis using data from 616011 ACS events at 255 hospitals as recorded in the Myocardial Ischemia National Audit Project (MINAP) 2003–2010. 102,415 (16.7%) patients were aged <55 years and 72,721 (11.9%) ≥85 years. Patients ≥85 years with ST-elevation myocardial infarction (STEMI) were less likely to receive emergency reperfusion therapy than those <55 years (RR=0.27, 95% CI: 0.25-0.28). Older patients had greater lengths of stay (*P*<0.001) and higher in-hospital mortality (*P*<0.001). For STEMI and non ST-elevation myocardial infarction (NSTEMI) there were reductions in in-hospital mortality from 2003-2010 across all age groups including the very elderly. For STEMI ≥85 years, in-hospital mortality reduced from 30.1% in 2003 to 19.4% in 2010 (RR=0.54, 95% CI: 0.38-0.75, *P*<0.001), and for NSTEMI ≥85 years from 31.5% in 2003 to 20.4% in 2010 (RR=0.56, 95% CI: 0.42-0.73, *P*<0.001). Findings were upheld after multi-level adjustment (base = 2003): male STEMI 2010 OR=0.60, 95% CI: 0.48-0.75, female STEMI 2010 OR=0.55, 95% CI: 0.42-0.71, male NSTEMI OR=0.50, 95% CI: 0.42-0.60, female NSTEMI OR=0.49, 95% CI: 0.40-0.59.

Conclusion : For patients hospitalized with ACS in England and Wales, there have been substantial reductions in in-hospital mortality rates from 2003 to 2010 across all age groups. The temporal improvements in mortality were similar for sex and type of acute myocardial infarction. Age-dependent inequalities in the management of ACS were apparent.

Key words: Acute coronary syndrome; STEMI; NSTEMI; age; in-hospital mortality; MINAP; quality of care

Introduction

Data from international studies suggest that elderly patients who are admitted to hospital with an acute coronary syndrome (ACS) are less likely to receive evidence-based care and that they have higher mortality rates than their younger counterparts [1-7]. Recently however, there have been substantial improvements in the treatment and outcome of ACS among a range of developed and developing countries [8,9]. In part, this has been attributed to increased use of evidence-based ACS therapies [8-11]. For the elderly, it has been advocated that improvements in hospital care may translate into a reduction in mortality and research has highlighted the need for quality-of-care programs that reinforce the use of evidence-based therapies among this group [2].

With the advent of the new definition of acute myocardial infarction (AMI) and a greater emphasis placed on the results of the cardiac troponin concentration [12], a contemporary analysis of patients admitted to hospital with an ACS may reveal a changing burden of disease and early outcomes. Moreover, it is not known whether the effects of reported improvements in ACS care have occurred equally across the spectrum of ACS ages. This study, therefore, aimed 1) to establish whether, in light of international recommendations [13,14], age-dependent inequalities in care continue to exist in a modern national healthcare system, and 2) to quantify and compare temporal effects in in-hospital mortality by age for patients who present to hospital with an ACS.

Methods

Study design

The analyses were based on data from the Myocardial Ischaemia National Audit Project (MINAP) whose national database was established in 1999 to examine the quality of management of acute myocardial infarction (AMI) in England and Wales and to meet the audit requirements of the National Service Framework (NSF) for Coronary Heart Disease [15-18]. MINAP data collection and management has previously been described [19,20].

Data for patients admitted with an ACS are collected prospectively at each acute hospital by a secure electronic system, developed by the Central Cardiac Audit Database (CCAD), electronically encrypted and transferred on-line to a central database [21]. CCAD is part of the National Institute for Cardiovascular Research (NICOR) based at University College London. MINAP is overseen by a multi professional steering group representing the stakeholders [16].

Each patient entry offers details of the patient journey, including the method and timing of admission, in-patient investigations, treatment, and date of all-cause death (from linkage to the National Health Service Central Register (NHSCR) using a unique National Health Service (NHS) number). Data entry is subject to routine on-line error checking. There is a mandatory annual data validation exercise for each hospital [22].

Ethics

NICOR which includes the Myocardial Ischaemia National Audit project (MINAP) (Ref: NIGB: ECC 1-06 (d)/2011) has support under section 251 of the NHS Act 2006. On seeking advice from Leeds (West) Research Ethics Committee, formal ethical approval was not required under NHS research governance arrangements for the study.

Cohort description

The investigators had access to data in which patient identity was protected. The MINAP cohort comprised 616011 index patient events admitted to 238 acute hospitals in England and 17 acute hospitals in Wales between 1st January 2003 and 2nd October 2010.

Ages on admission were categorised into 5 groups: <55 years, 55 to 64 years, 65 to 74 years, 75 to 84 years and ≥85 years of age. The initial diagnosis was based on the working diagnosis generated by a paramedic or first attending physician who was in a position to provide definitive treatment. The final diagnosis was formed from the patients' presenting history, clinical examination and the results of inpatient investigations, and made by a senior member of the medical staff. The consensus document of the Joint European Society of Cardiology / American College of Cardiology [23] was used as the diagnostic standard for AMI and provided the basis for categorisation into STEMI. Non ST-elevation acute coronary syndrome (NSTEACS) was defined as a troponin positive (NSTEMI) or troponin negative (unstable angina) ACS.

Statistical methods

The population was described without adjustment and by percentages with respect to discrete data, and by medians and interquartile range or mean and 95% range for continuous variables. Pearson's Chi-squared test was used to determine whether there was a significant difference between the expected frequencies and the observed frequencies in one or more categories. The Kruskall-Wallis rank test was used to test the difference in distributions across groups. The analysis of variance test was use to ascertain whether the means of several groups were all equal.

Given that there was a significant interaction between age, in-hospital mortality and sex for STEMI ($P<0.001$) and NSTEMI ($P<0.001$), models were fitted by sex. To account for variations at the hospital level, a linear mixed-effects regression model was used to quantify the relationship between age category and ACS final diagnosis at discharge from hospital, and between age category and in-hospital all-cause mortality. The model fitted included age, history of diabetes, hypertension, previous AMI, angina, history of heart failure, previous revascularisation (percutaneous coronary intervention (PCI) and / or coronary artery bypass grafting (CABG)), admitting consultant, admission ward and emergency reperfusion (primary PCI and / or thrombolysis). The temporal risk of in-hospital mortality was quantified by STEMI and NSTEMI after adjustment for age category and consideration of hospital random effects. Finally, the risk of in-hospital mortality was estimated for each age category after adjustment for the final diagnosis and consideration of hospital random effects. We used STATA IC version 11.0 (Stat Corp LP, Texas, USA) for the analyses.

Results

Of the 616011 patients, 102415 (16.7%) were <55 years and 72721 (11.9%) were ≥85 years of age. Data for age were missing for 4.2% of men and 4.5% of women, and in-hospital status was missing for 5.6% of the cohort. The proportion of men reduced from 79.4% among patients aged <55 years to 41.9% among patients aged ≥85 years (Table 1). There were 208358 (33.8%) patients with a final diagnosis of STEMI, 325299 (52.8%) NSTEACS, 24320 (3.9%) unconfirmed ACS, 35783 (5.8%) non-ACS / other, and 19217 (3.1%) with a missing final diagnosis.

Cardiovascular risk factors

The distribution of baseline risk factors varied by age groups and sex (Table 1). Older patients were less often current smokers and more often had hypertension, prior AMI, angina, chronic heart failure and chronic renal failure. Compared with men ≥85 years, women ≥85 years of age were less often current smokers. They less often had diabetes, previous AMI, angina, previous revacularisation (PCI or CABG) and chronic renal failure.

Diagnoses, presentation and provision of care

Table 2 shows the distribution of initial and final diagnoses, method of presentation and provision of care by age group. Younger patients more often had an initial diagnosis of STEMI. Older patients more often had a final diagnosis of NSTEACS. Compared with men ≥85 years of age, women ≥85 years of age less often had an initial diagnosis of NSTEACS. Older patients were less likely to call the emergency services or make their own way to the hospital, and more likely to have an ACS in hospital than their younger counterparts. Also, older patients were less likely to be admitted to the Cardiac Care Unit, a Cardiology ward, and be under the care of a Consultant Cardiologist. For STEMI and NSTEMI, the proportion of patients ≥85 years of age with cardiogenic shock was higher than that for patients <55 years of age, STEMI: <55 years, ≥85 years = 2.1%, 5.0%, $P<0.001$: NSTEMI: <55 years, ≥85 years = 1.2%, 3.1%, $P<0.001$.

Management and in-hospital mortality

Table 3 shows the distribution of evidence-based management and outcomes by age category. For all ACS combined, older patients had greater lengths of stay (df=5, $P<0.001$) and higher in-hospital mortality rates ($P<0.001$). For those with an initial diagnosis of STEMI, older patients were less likely to receive primary PCI, pre-hospital thrombolysis, and to a lesser extent in-hospital thrombolysis. They too had greater lengths of stay (df=5, $P<0.001$) and higher in-hospital mortality rates (df=5, $P<0.001$). Patients ≥85 years of age with an initial diagnosis of STEMI were up to 75% less likely to be reperfused (by either primary PCI or thrombolysis) compared with those <55 years of age with STEMI: RR=0.27, 95% CI: 0.25-0.28).

For patients with AMI (STEMI or NSTEMI), the risk (RR, 95% CI) of being prescribed aspirin (0.54, 0.53-0.56), clopidogrel (0.59, 0.57-0.62), β blockers (0.38, 0.37-0.39), statins (0.41, 0.40-0.42) or ACE inhibitors (0.50, 0.49-0.51) was considerably lower for those ≥85 years of age with AMI compared with those <55 year of age with AMI. The elderly were less likely to undergo coronary angiography (df=5, $P<0.001$) and echocardiography (df=5, $P<0.001$), and had greater lengths of stay (df=5, *P*<0.001) and higher in-hospital mortality rates (*P*<0.001) than their younger counterparts (Table 4).

Risk of STEMI and in-hospital mortality

For males and less so females, increasing age predicted a lower risk of a final diagnosis of STEMI (males ≥85 years OR=0.33, 95% CI: 0.32-0.34; females ≥85 years OR=0.62, 95% CI: 0.60-0.65). For both sexes, the risk of in-hospital mortality increased with age for STEMI (males OR=20.31, 95% CI: 17.97-22.95; females OR=14.98, 95% CI: 12.44-18.03) and NSTEMI (males OR=18.10, 95% CI: 16.05-20.41; females OR=13.47, 95% CI: 11.27-16.08). The highest risk of death occurred in males ≥85 years old with STEMI (OR=20.31, 95% CI: 17.97-22.95).

Year of admission and ACS care

For patients with AMI, the proportion with cardiogenic shock increased between 2003 and 2010: <55 years of age: 0.6% (2003) to 1.7% (2010), RR=2.80, 95% CI: 1.79-4.32, *P*<0.001; ≥85 years of age: 1.6% (2003) to 3.1% (2010), RR=2.00, 95% CI: 1.36-2.89, *P*<0.001. For patients with an admission diagnosis of STEMI, rates of primary PCI increased from 1.6% in 2003 to 60.9% in 2010 (RR=92.41, 95% CI: 71.11-120.99, *P*<0.001) for patients aged <55 years and from 0.2% to 48.5% (RR=376.79, 95% CI: 140.18-1412.26, *P*<0.001) in patients aged ≥85 years. For patients with AMI, there were significant increases in the rates of use of evidence-based pharmacological therapies rates from 2003 to 2010 (Table 5).

Year of admission and in-hospital mortality

For patients with STEMI, in-hospital mortality reduced from 2.0% in 2003 to 1.5% in 2010 (RR=0.72, 95% CI: 0.39-1.25, *P*=0.24) for patients aged <55 years, from 4.0% to 1.6% (RR=0.28, 95% CI: 0.14-0.52, *P*<0.001) for patients aged 55-64 years, from 19.6% to 10.6% (RR=0.47, 95% CI: 0.36-0.60, *P*<0.001) for patients aged 75-84 years, and from 30.1% to 19.4% (RR=0.54, 95% CI: 0.38-0.75, *P*<0.001) in patients aged ≥85 years (Table 5). For patients with NSTEMI, in-hospital mortality reduced from 1.9% in 2003 to 0.9% in 2010 (RR=0.89, 95% CI: 0.48-1.34, *P*=0.43) for patients aged <55 years, from 3.5% to 1.8% (RR=0.40, 95% CI: 0.23-0.65, *P*=0.001) for patients aged 55-64 years, from 19.6% to 10.6% (RR=0.49, 95% CI: 0.39-0.61, *P*=0.001) for patients aged 75-84, and from 31.5% to 20.4% (RR=0.56, 95% CI: 0.42-0.73, *P*<0.001) in patients aged ≥85 years (Table 5). These findings were upheld after multi-level adjustment (base = 2003, adjusted odds ratio for age group, diabetes, hypertension, previous AMI, angina, previous revascularization, chronic heart failure, reperfusion (primary PCI or thrombolysis) during admission, admitting ward, admitting consultant, with hospital random intercept effects.): male STEMI 2010 OR=0.60, 95% CI: 0.48-0.75, female STEMI 2010 OR=0.55, 95% CI: 0.42-0.71, male NSTEMI OR=0.50, 95% CI: 0.42-0.60, female NSTEMI OR=0.49, 95% CI: 0.40-0.59. After adjustment for final diagnosis and hospital-level effects, there was a reduction in in-patient mortality from 2003 to 2010 across all age groups including patients ≥85 years of age: OR, 95% CI; 2004: 0.94, 0.88-1.01; 2010: 0.52, 0.44-0.61, 75-84 years of age 2004: 0.98, 0.93-1.03; 2010: 0.52, 0.45-0.60, and patients <55 years of age: 2004: 0.94, 0.79-1.13; 2010: 0.64, 0.44-0.93 (Figure 1).

Discussion

Despite earlier research from Europe which has highlighted the need to address age-dependent inequalities in ACS quality of care [2], when compared to their younger counterparts the elderly hospitalized with an ACS continue to be disadvantaged. This is important when the old comprise over a third of the ACS admissions in England and Wales. Yet, there was good evidence to suggest that all age groups including the old and very old have benefited from improvements in ACS management – for AMI, there were substantial year-on-year reductions in in-hospital mortality. Notably, the temporal improvements in the risk of in-hospital mortality were similar for males and females, and for STEMI and NSTEMI.

To date, many studies have described the differential presentation, management and outcome of elderly versus young ACS patients [2,24-28]. This research corroborates these findings; revealing that the profile of the elderly hospitalized with an ACS has not changed greatly. What has changed is the reduction in in-hospital mortality. We refute findings from a recent single centre observational study which suggested that no temporal improvements in mortality rates were evident for the elderly who underwent primary PCI [29]. Our research readily highlights that although age-dependent biases in quality of care exist, in England and Wales significant improvements in ACS care have occurred. From 2003 to 2010, improvements in the application of evidence-based ACS care were evident across all age groups – this is despite the increased proportion of patients presenting with cardiogenic shock. The unadjusted risk of in-hospital mortality after an ACS admission in 2010 was half that of 2003 (RR=0.50, 95% CI: 0.45-0.54).

Several studies have suggested that improvements in hospital care for the elderly would reduce elderly ACS mortality rates [2,24-28]. Our analyses using contemporary MINAP data demonstrate this association. The reductions in in-hospital mortality over time were unlikely to be due to reduction in lengths of hospital stay. For STEMI and NSTEMI, we found no significant relationships between the length of hospital stay and in-hospital mortality and there was no significant interaction between the length of hospital stay and in-hospital mortality by year of hospital admission. Furthermore, from 2003 to 2010, 30-day mortality rates fell for STEMI (RR=0.43, 95% CI: 0.34-0.54, P<0.001) and NSTEMI (RR=0.66, 95% CI: 0.55-0.78, P<0.001) suggesting that the reduction in in-hospital mortality rates were unlikely to be related to hasty (or inappropriate) discharge from hospital care. It is possible, however, that some of the improvements in NSTEMI mortality rates related to a lower risk profile in later years: the median (IQR) troponin concentration for NSTEMI decreased from 0.57 (2.80) in 2003 to 0.48 (2.56), $P < 0.001$.

Whilst the adjusted risk of the temporal decline in in-hospital mortality for STEMI and NSTEMI <55 years of age were statistically significant, we found there was only a non-significant trend in the decline of the absolute risk (20% and 47% respectively) in this group. In 2003, mortality rates in the young were already low (2.0%) and it is possible that in-hospital mortality rates lower than 1.6% (2010) are now reaching a '*plateau of achievable care*' [30,31], and that a statistically significant association would require much greater numbers of patients or evaluation of survival beyond the hospital stay.

Overall our findings are in keeping with international advances in the provision of evidence-based acute cardiac care. They herald the accomplishment in England and Wales of the NSF for Coronary Heart disease (2000-2010) [15]. This was a nationwide implementation strategy of changes to the delivery of care for patients with coronary heart disease and encouraged the adoption of the translation of contemporary evidence into best practice [20,32]. Nevertheless, our research continues to support a notion of age-dependent inequality in ACS care and moreover, highlights gaps in key aspects of the management of elderly patients with ACS who benefit equally as much as their younger counterparts from an early invasive strategy [28,33,34].

This study provides evidence for opportunities for improvements in the quality of clinical care. For example, despite high frequencies of previous AMI in the very elderly, they had previously less often undergone revascularisation when advanced age alone must not be considered a contraindication to performing coronary angiography and PCI [34]. Overall rates of emergency reperfusion (primary PCI and thrombolysis) for STEMI in those <55 years of age were nearly a third higher than for those aged ≥ 85 years. For those with a final diagnosis of AMI, older patients were less likely to be discharged on aspirin, clopidogrel, β blockers, ACE inhibitors, and statins. In light of our evidence for increased risk of early mortality and greater lengths of hospital stay, the application of evidence-base ACS therapies to appropriate patients regardless of age may further reduce overall cost and improve early outcomes [2].

The causes for discrepancies in quality care for the elderly are multifactorial. In part, the shortfalls in treatment may be due to the lack of appropriate specialist care and inappropriate placement within the hospital [35]. Although the MINAP database includes data relating to the indication, contra-indication, refusal of treatments (all taken into account in the analyses), we were unable to evaluate the appropriateness of ACS management [36]. Reductions in risk of in-patient death may be related to improved primary [37] and secondary prevention [38], however we specifically considered in-hospital mortality (rather than longer-term survival) because this more clearly reflects acute care associated with the index admission. Nonetheless, improvements in mortality are associated with the application of evidence-based medicine [38], and it is likely that the implementation of strategic networks of care (such as the national primary PCI service in England and Wales [20]) has contributed to the greater application of ACS treatments and hence better outcomes [39].

Not withstanding age-dependent inequalities in care, the elderly are more likely to present differently and less likely to have the same diagnosis on discharge from hospital as that which they were given on admission. In our study, the risk of a change in diagnosis from that on admission to a different one on discharge in patients ≥85 years of age was over 10% greater than for patients <55 years of age: RR, 95% CI 1.12, 1.09-1.16. Multi-level adjustment made little difference to the risk of in-hospital mortality and suggests that the 'diagnosis' *per se* is a stronger predictor of outcome than the covariates modelled. As such, mechanisms to improve the early and accurate diagnosis of specific ACS subgroups in the elderly are needed so that timely risk-evaluated ACS interventions may be implemented. It is plausible that Physicians already know that the likelihood of an elderly patient presenting with STEMI is much lower than that of a younger patient, and that this influences their perception of a diagnosis of STEMI in an older patient. Finally, age-dependent inequalities in treatments may be the legacy of a risk–adverse strategy to ACS care [4] through lack of accurate estimation of ACS risk [40].

Limitations

MINAP does not collect data on all patients in England and Wales and it is possible that patients entered into the MINAP database differ from those not recorded. We noted that data missingness for age was 4.3 % and for final diagnosis 3.2%. Although this may introduce systematic bias, we have previously noted that whilst being statistically significant the inclusion of missing data does not alter regional standardised mortality ratios [41]. As with all observational data, the modelling of diagnosis, in-hospital mortality and effect of year considered hospital-level and patient-specific influences and the use of alternative covariates may change the effect sizes demonstrated. Finally, this research reveals important associations but cannot prove causation.

Conclusion

The elderly comprise a substantial proportion of ACS admissions. They have a different risk factor and ACS diagnosis profile to younger patients. Biases in elderly ACS care remain and the elderly have significantly longer hospital lengths of stay and higher in-hospital mortality rates. Despite this, improvements in the application of evidence-based ACS care were evident across all age groups from 2003 to 2010.

There were significant year-on-year reductions in in-hospital mortality equally across all age groups, both sexes and for STEMI and NSTEMI.

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Table 1. Baseline clinical characteristics MINAP patients (all ACS diagnoses combined) by age group

Age group (years)		**<55, % (n)**	**55-64, % (n)**	**65-74, % (n)**	**75-84, % (n)**	**≥85, % (n)**	**Totals, % (n)**
Men		**81310**	**86660**	**94668**	**85741**	**30464**	**395464**
Women		**21105**	**27816**	**48164**	**68391**	**42257**	**217513**
Diabetes	Men	10.1 (8224)	14.3 (12412)	19.9 (18878)	19.8 (16953)	15.7 (4771)	16.1 (63592)
	Women	13.6 (2867)	16.2 (4508)	20.7 (9962)	19.0 (12986)	13.6 (5742)	17.2 (37507)
Hypertension	Men	27.2 (22086)	37.3 (32315)	43.7 (41378)	45.9 (39394)	44.0 (13403)	38.9 (153969)
	Women	31.0 (6534)	42.2 (11751)	48.9 (23535)	52.3 (35768)	49.2 (20777)	46.9 (102094)
Current smoker	Men	52.6 (42791)	36.6 (31748)	20.9 (19762)	10.9 (9361)	6.2 (1880)	27.7 (109362)
	Women	47.4 (10009)	36.1 (10032)	21.5 (10349)	10.9 (7452)	3.6 (1534)	18.8 (40955)
Prior AMI	Men	15.2 (12324)	20.9 (18135)	28.1 (26591)	33.3 (28525)	35.0 (10668)	25.3 (100186)
	Women	11.9(2504)	15.5 (4307)	21.6 (10420)	26.4 (18078)	27.1 (11440)	22.3 (48541)
Angina	Men	15.4 (12498)	23.2 (20123)	32.2 (30460)	39.1 (33525)	42.2 (12860)	28.8 (113935)
	Women	17.0 (3592)	23.2 (6462)	30.3 (14594)	35.5 (24272)	35.9 (15150)	30.7 (66725)
Prior revascularization	Men	10.4 (8429)	14.1 (12246)	17.2 (16313)	14.5 (12390)	6.7 (2053)	13.5 (53520)
	Women	7.8 (1641)	10.0 (2786)	11.4 (5505)	8.2 (5642)	3.0 (1288)	8.0 (17506)
Chronic heart failure	Men	1.1 (890)	2.3 (1961)	4.8 (4543)	8.4 (7202)	12.1 (3686)	4.8 (19060)
	Women	1.3 (273)	2.4 (665)	5.0 (2418)	8.9 (6053)	12.4 (5237)	7.0 (15252)
Chronic renal failure	Men	1.1 (869)	1.7 (1514)	3.7 (3456)	6.8 (5795)	9.5 (2901)	3.8 (15216)
	Women	1.5 (325)	2.0 (544)	3.2 (1559)	4.8 (3307)	5.8 (2450)	3.9 (8558)

Table 2. Initial and final ACS diagnoses, method of presentation and provision of care by age group

Age group		**<55, % (n)**	**55-64, % (n)**	**65-74, % (n)**	**75-84, % (n)**	**≥85, % (n)**	**Missing age, % (n)**	**Totals, % (n)**
Men		**81310**	**86660**	**94668**	**85741**	**30464**	**16621**	**395464**
Women		**21105**	**27816**	**48164**	**68391**	**42257**	**9780**	**217513**
Initial diagnosis								
STEMI	Men	37.8 (30709)	35.6 (30841)	27.7 (26265)	20.1 (17250)	13.9 (4229)	19.1 (3182)	28.4 (112476)
	Women	25.7 (5433)	26.8 (7458)	23.9 (11494)	19.0 (13013)	15.0 (6324)	13.8 (1345)	20.7 (45067)
NSTEACS	Men	39.5 (32152)	42.8 (37123)	45.1 (42687)	44.8 (38403)	43.5 (13244)	40.5 (6734)	43.1 (170343)
	Women	41.5 (8767)	44.3 (12331)	43.8 (21082)	42.1 (28824)	38.6 (16318)	37.7 (3687)	41.8 (91009)
Final diagnosis								
STEMI	Men	45.9 (37313)	44.3 (38376)	36.4 (34449)	28.3 (24244)	21.8 (6633)	24.7 (4113)	36.7 (145128)
	Women	32.9 (6952)	34.7 (9663)	32.1 (15473)	27.9 (19106)	23.9 (10081)	20.0 (1955)	29.1 (63230)
NSTEACS	Men	37.7 (30690)	45.1 (39063)	52.7 (49886)	61.3 (52541)	68.7 (20926)	51.0 (8473)	51.0 (201579)
	Women	42.3 (8931)	49.3 (13706)	54.7 (26338)	60.7 (41541)	66.2 (27973)	53.5 (5231)	56.9 (123720)
Presentation and provision of care – all ACS								
Called emergency services	Men	50.7 (41228)	54.7 (47383)	59.7 (56475)	64.8 (55594)	68.6 (20899)	32.7 (5436)	57.4 (227015)
	Women	49.7 (10488)	54.5 (15150)	59.3 (28557)	64.8 (44317)	68.1 (28784)	34.6 (3381)	60.1 (130677)
Made own way to hospital	Men	25.7 (20913)	19.7 (17065)	13.3 (12621)	7.6 (6518)	4.1 (1239)	11.5 (1914)	15.2 (60270)
	Women	22.7 (4785)	17.6 (4897)	11.7 (5628)	6.2 (4268)	3.4 (1434)	7.9 (774)	10.0 (21786)
Already in hospital	Men	1.7 (1403)	2.5 (2184)	4.1 (3838)	6.0 (5104)	7.1 (2175)	12.6 (2096)	4.2 (16800)
	Women	2.9 (615)	3.4 (952)	4.9 (2368)	6.6 (4544)	7.7 (3244)	16.1(1571)	6.1 (13294)
First ward - Cardiac Care Unit	Men	66.1 (53780)	63.1 (54709)	57.2 (54318)	49.0 (42054)	38.9 (11858)	43.3 (7203)	56.6 (223922)
	Women	59.1 (12471)	56.8 (15793)	52.8 (25423)	45.1 (30816)	35.1 (14823)	36.9 (3610)	47.3 (102936)
First ward: Cardiology	Men	4.8 (3901)	5.5 (4779)	5.8 (5472)	5.8 (4958)	5.8 (1781)	4.7 (784)	5.5 (21675)
	Women	5.0 (1056)	5.7 (1579)	5.8 (2780)	5.5 (3771)	5.2 (2193)	3.9 (375)	5.4 (11754)
Admitting Consultant: Cardiologist	Men	50.1 (40729)	48.0 (41627)	44.0 (41637)	36.8 (31561)	28.5 (8689)	38.3 (6365)	43.1 (170608)
	Women	47.1 (9950)	44.5 (12372)	42.0 (20229)	34.0 (23285)	25.1 (10609)	33.1 (3238)	36.6 (79683)

Table 3. Management and outcome by age group and ACS subgroups

Age group		**<55, % (n)**	**55-64, % (n)**	**65-74, % (n)**	**75-84, % (n)**	**≥85, % (n)**	**Missing age, % (n)**	**Totals**
Men		**81310**	**86660**	**94668**	**85741**	**30464**	**16621**	**395464**
Women		**21105**	**27816**	**48164**	**68391**	**42257**	**9780**	**217513**
All ACS								
Median length of hospital stay (IQR)	Men	4 (5)	5 (5)	6 (7)	7 (8)	7 (10)	5 (5)	5 (6)
	Women	4 (5)	5 (5)	6 (6)	7 (9)	8 (11)	6 (8)	6 (8)
In-hospital mortality	Men	1.3 (1070)	2.5 (2161)	5.6 (5296)	11.8 (10141)	19.7 (6004)	7.4 (1224)	6.6 (25996)
	Women	1.7 (360)	3.2 (888)	6.5 (3151)	12.7 (8660)	20.3 (8570)	10.8 (1053)	10.4 (22682)
Patients with an initial diagnosis is STEMI								
Primary PCI	Men	24.3 (7470)	21.1 (6509)	19.5 (5123)	17.3 (2992)	15.1 (640)	8.8 (280)	20.5 (23014)
	Women	23.7 (1287)	20.6 (1534)	19.3 (2223)	16.7 (2174)	13.4 (849)	6.5 (88)	18.1 (8155)
Pre-hospital thrombolysis	Men	11.8 (3644)	12.9 (3973)	11.7 (3072)	7.1 (1221)	2.4 (102)	1.6 (50)	10.7 (12062)
	Women	9.5 (516)	11.3 (840)	9.6 (1102)	5.6 (734)	1.7 (106)	1.3 (17)	7.4 (3315)
In hospital thrombolysis	Men	52.6 (16175)	53.8 (16607)	54.3 (14253)	54.7 (9442)	52.8 (2233)	49.6 (1580)	53.6 (60290)
	Women	53.7 (2920)	55.1 (4112)	54.4 (6256)	54.5 (7091)	50.2 (3172)	44.8 (603)	53.6(24154)
Median length of hospital stay (IQR)	Men	4 (3)	5 (4)	5 (5)	6 (7)	6 (9)	5 (5)	5 (5)
	Women	5 (4)	5 (4)	6 (5)	6 (7)	7 (10)	6 (6)	6 (7)
In-hospital mortality	Men	1.5 (467)	2.6 (815)	6.2 (1625)	14.0 (2423)	24.5 (1035)	5.5 (174)	5.8 (6539)
	Women	2.3 (126)	4.2 (313)	8.2 (944)	17.2 (2232)	28.9 (1827)	14.1 (189)	12.5 (5631)
Patients with a final diagnosis is AMI (NSTEMI + STEMI)								
Aspirin on discharge	Men	79.1(48675)	77.9 (55083)	74.6 (57505)	70.2 (50171)	66.5 (17508)	73.5 (8210)	74.5 (237152)
	Women	77.0 (10690)	77.2 (16011)	74.0 (27850)	69.6 (38934)	65.5 (23562)	68.3 (4373)	77.0(214905)
Clopidogrel on discharge	Men	36.7 (22566)	35.7 (25230)	32.5 (25031)	29.9 (21343)	28.5 (7509)	22.9 (2557)	32.7 (104236)
	Women	36.0 (4992)	35.3 (7331)	32.0 (12048)	29.4 (16463)	25.7 (9255)	19.4 (1241)	30.1 (51330)
B blocker on discharge	Men	71.9 (44265)	68.3 (48266)	61.3 (47285)	53.6 (38327)	46.0 (12108)	60.1 (6709)	61.9(196960)

	Women	64.3 (8925)	63.1 (13084)	58.3(21917)	53.3 (29843)	46.3 (16642)	50.7 (3249)	54.9 (93660)
ACE inhibitor on discharge	Men	70.1 (43168)	69.6 (49228)	66.2 (51016)	59.4 (42504)	49.4 (13021)	61.7 (6886)	64.7 (205823)
	Women	63.4 (8792)	65.4 (13565)	63.7 (23979)	58.5 (32743)	48.1 (17286)	53.4 (3421)	58.5 (99786)
Statin on discharge	Men	78.4 (48261)	78.0 (55116)	75.5 (58154)	70.4 (50344)	61.3 (16131)	72.3 (8072)	74.2 (236078)
	Women	76.0 (10545)	77.1 (15986)	74.9 (28181)	69.6 (38920)	56.2 (20224)	63.9 (4093)	69.2 (117949)
Coronary angiography	Men	56.7 (34883)	51.1 (36119)	43.6 (33577)	27.5 (19654)	12.1 (3196)	34.3 (3831)	41.2 (131260)
	Women	53.9 (7485)	47.5 (9850)	38.7 (14567)	22.5 (12592)	8.8 (3153)	24.0 (1535)	28.8 (49182)
Echocardiography	Men	48.7 (29987)	48.9 (34557)	49.6 (38257)	48.6 (34781)	41.3 (10872)	46.4 (5182)	48.3 (153636)
	Women	49.2 (6823)	48.4 (10036)	49.5 (18642)	48.2 (26941)	38.2 (13728)	42.9 (2745)	46.3 (78915)
Median length of hospital stay (IQR)	Men	5 (4)	5 (5)	6 (6)	7 (8)	7 (9)	6 (5)	6 (6)
	Women	5 (4)	5 (5)	6 (7)	7 (9)	8 (11)	7 (8)	7 (8)
In-hospital mortality	Men	1.3 (824)	2.6 (1872)	5.6 (4506)	12.0 (8894)	19.7 (5329)	8.0 (940)	6.8 (22365)
	Women	1.9 (276)	3.5 (747)	6.9 (2704)	13.2 (7674)	20.6 (7700)	12.8 (861)	11.3 (19962)

Table 4. Association of age with risk of in-hospital all-cause mortality for STEMI and NSTEMI, by sex.

Risk of in-hospital mortality	**Male**		**Female**	
	Odds ratio* (95% CI)	**Odds ratio** (95% CI)**	**Odds ratio* (95% CI)**	**Odds ratio** (95% CI)**
STEMI				
<55 years	1.00	1.00	1.00	1.00
55-64 years	1.95 (1.76-2.15)	1.97 (1.75-2.23)	1.79 (1.51-2.14)	1.89 (1.54-2.33)
65-74 years	4.55 (4.14-4.99)	4.41 (3.94-4.94)	3.75 (3.21-4.40)	3.80 (3.14-4.59)
75-84 years	11.50 (10.51-12.59)	10.62 (9.51-11.86)	8.19 (7.03-9.54)	8.29 (6.91-9.95)
≥85 years	23.30 (21.09- 25.74)	20.31 (17.97-22.95)	15.28 (13.10-17.83)	14.98 (12.44-18.03)
NSTEMI				
<55 years	1.00	1.00	1.00	1.00
55-64 years	2.00 (1.77-2.19)	2.27 (1.99-2.59)	1.78 (1.49-2.12)	1.82 (1.48-2.23)
65-74 years	4.17 (3.79- 4.59)	4.94 (4.38-5.56)	3.81 (3.26-4.46)	4.10 (3.42-4.92)
75-84 years	8.94 (8.14-9.81)	10.46 (9.31-11.75)	7.53 (6.47-8.77)	8.08 (6.77-9.64)
≥85 years	15.71 (14.27-17.28)	18.10 (16.05-20.41)	12.66 (10.88-14.74)	13.47 (11.27-16.08)

* Unadjusted odds ratio for age, with hospital random intercept effects.

** Adjusted odds ratio for age, diabetes, hypertension, previous AMI, angina, previous revascularization, chronic heart failure, reperfusion (primary PCI or thrombolysis) during admission, admitting ward, admitting consultant, with hospital random intercept effects.

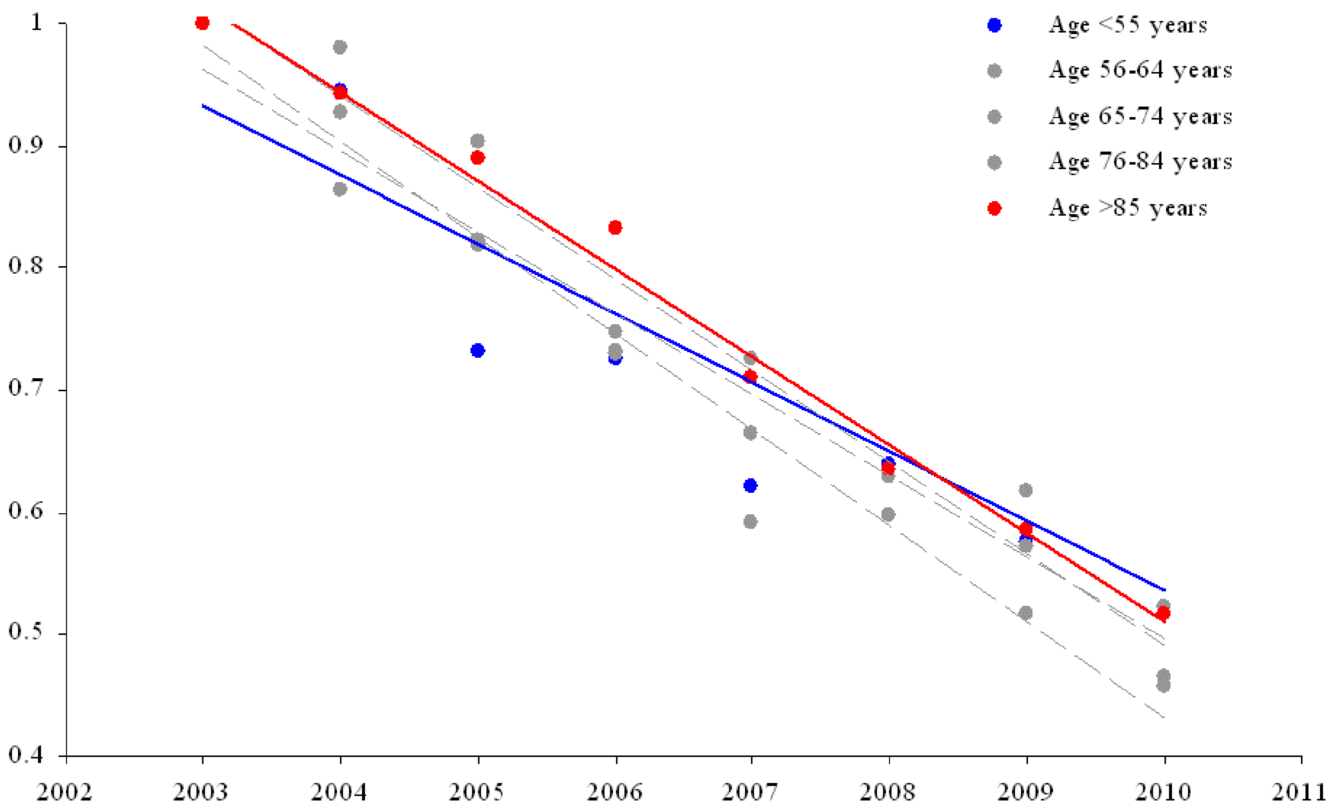
Table 5. ACS provision of care and in-hospital mortality by year of admission

	Age group	Years		Relative risk (95%CI)
Provision of care				
		2003-2004	**2009-2010**	
Primary PCI for STEMI	<55 years	3.3%	52.1%	31.57 (28.22-35.33)
	>85 years	0.5%	32.2%	82.52 (55.28-128.55)
Aspirin on admission for AMI	<55 years	86.5%	90.2%	1.43 (1.33-1.53)
	>85 years	76.6%	86.6%	1.97 (1.85-2.11)
GP IIbIIIa for AMI	<55 years	10.2 %	15.2%	1.59 (1.47-1.73)
	>85 years	2.0%	2.6%	1.31 (1.08-1.59)
Aspirin on discharge for AMI	<55 years	95.8%	82.5%	0.20 (0.19-0.22)
	>85 years	81.1%	71.6%	0.59 (0.55-0.63)
ACE inhibitor on discharge for AMI	<55 years	81.4%	76.5%	1.35 (1.27-1.42)
	>85 years	57.4%	55.9%	1.06 (1.01-1.12)
B blocker on discharge for AMI	<55 years	85.5%	75.3%	0.52 (0.49-0.55)
	>85 years	49.1%	56.7%	1.35 (1.29-1.43)
Clopidogrel on discharge for AMI	<55 years	56.1%	97.3%	28.48 (20.64-39.69)
	>85 years	28.1%	89.1%	81.31 (59.06-112.26)
Statin on discharge for AMI	<55 years	94.2%	82.4%	0.29 (0.26-0.31)
	>85 years	61.3%	68.6%	1.38 (1.31-1.46)
In-hospital mortality*				
		2003	**2010**	
STEMI	<55 years	2.0%	1.5%	0.72 (0.39-1.25)
	>85 years	30.1%	19.4%	0.54 (0.38-0.75)
NSTEMI	<55 years	1.9%	0.9%	0.89 (0.48-1.34)
	>85 years	31.5%	20.4%	0.56 (0.42-0.73)

*unadjusted rates

Figure 1. Odds ratios by year for in-hospital all-cause mortality, stratified by age category*

Odds ratio



Year

*2003 = base, adjustment for final diagnosis and hospital-level random effects.

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