Variations in indicated care of patients with acute coronary syndromes in Queensland hospitals

Ian A Scott, Andy B Duke, Irene C Darwin, Kathy H Harvey and Mark A Jones for the CHI Cardiac Collaborative*

ABSTRACT

Objective: To identify variation in the rates of use of key evidence-based therapies and in clinical outcomes among patients hospitalised with acute coronary syndromes (ACS).

Design: Retrospective analysis of data on care processes and clinical outcomes of representative patient samples recorded by the Queensland Health Cardiac Collaborative registry.

Setting: 18 public hospitals (3 tertiary, 15 non-tertiary) in Queensland, August 2001 to December 2003.

Study population: 2156 patients who died or were discharged after troponin-positive ACS.

Main outcome measures: Comparison of proportions of highly eligible patients receiving indicated care and in-hospital mortality between subgroups categorised by age, sex, comorbidities (diabetes, renal failure, chronic obstructive pulmonary disease and mental disorder), type of admitting hospital (tertiary or non-tertiary), and cardiologist involvement (transfer or non-transfer to cardiology unit).

Results: Patients aged ⩾ 65 years were less likely than younger patients to receive heparin (79% v 87%), β-blockers (79% v 87%), lipid-lowering agents (78% v 87%), coronary angiography (51% v 66%), and referral to cardiac rehabilitation (17% v 33%). Patients with diabetes were less likely than others to receive coronary angiography (50% v 63%), while those with moderate to severe renal failure were less likely to receive thrombolysis (52% v 84%), heparin (71% v 83%), β-blockers (69% v 84%), lipid-lowering agents (61% v 84%), in-hospital cardiac counselling (46% v 64%) and referral to cardiac rehabilitation (9% v 25%). Patients admitted to tertiary hospitals were more likely than those admitted to non-tertiary hospitals to receive coronary angiography (85% v 55%) and referral to cardiac rehabilitation (36% v 21%). Risk-adjusted mortality was highest in patients with moderate to severe renal failure (15% v 3%) and older patients (6% v 2%).

Conclusions: Variations exist in the provision of indicated care to patients with ACS according to age, diabetic status, renal function and type of admitting hospital. Excess mortality in elderly patients and in those with advanced renal disease may be partially attributable to failure to use key therapies.

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Acute coronary syndromes (ACS), encompassing acute myocardial infarction and unstable angina, are prevalent causes of death, hospitalisation and illness burden.[1] For these conditions there are highly effective therapies such as thrombolysis, β-blockers, angiotensin-converting enzyme (ACE) inhibitors, antithrombotic drugs, and percutaneous coronary interventions which, in combination, have significantly decreased mortality rates in patients with ACS.[2-4]

Between 1980 and 2000, the in-hospital mortality rate for patients with acute myocardial infarction has almost halved, from 22% to 12%, combined with modest declines in mortality rates over the longer term.[2] Much of this improved survival reflects a real effect of evidence-based, guideline-recommended interventions.[5]

Studies suggest certain patient populations, such as older people,[6] women,[7] those with diabetes,[8] renal failure,[9] or mental health disorders,[10] and those admitted to non-tertiary hospitals[11] or whose care is not provided directly by cardiologists,[12] receive indicated care less often than others. This deficiency in care is amplified by the fact that many of these populations have an increased absolute risk of coronary death, and thus stand to derive greater absolute benefit from effective therapies.[13]

Most studies evaluating variations in management of ACS suffer from one or more flaws: only one or a few process-of-care measures were studied; explicit eligibility criteria for specific care processes were not defined or measured, with less precise casemix-based risk-adjustment models being used; studies were confined to North American hospitals, limiting generalisability to Australia; and data are not current (before 2000).

We have analysed the rates of use of specific clinical interventions in different subgroups of patients admitted with troponin-positive ACS to 18 public hospitals in Queensland. We aimed to:

- identify patient populations with significantly lower rates of indicated care;
- test associations between variations in care and differences in clinical outcomes; and
- evaluate changes in care over a contemporary 2.5-year period (2001–2003).

METHODS

Patients

Eligible patients were those for whom complete data on baseline characteristics and received care were obtainable from a registry maintained by the Queensland Health Cardiac Collaborative, an ongoing multisite quality improvement collaboration.[14] In brief, data were collected on samples of randomly selected or consecutive patients who died or were discharged from 18 public hospitals (3 tertiary; 15 non-tertiary) in Queensland

*MEMBERS OF THE CHI CARDIAC COLLABORATIVE ARE LISTED IN THE ACKNOWLEDGEMENTS.

Princess Alexandra Hospital, Brisbane, QLD.
Ian A Scott, FRACP, MHA, MEd, Director of Internal Medicine, and Associate Professor of Medicine, University of Queensland, Brisbane, QLD; Mark A Jones, BSc(Hons), Biostatistician, Clinical Services Evaluation Unit.
Collaborative for Healthcare Improvement, Royal Brisbane Hospital, Brisbane, QLD.
Andy B Duke, Senior Analyst; Irene C Darwin, BSpThy, GradCertManagement, Program Manager; Kathy H Harvey, GradCertManagement, Project Manager.
Reprints will not be available from the authors. Correspondence: Associate Professor Ian A Scott, Internal Medicine, Princess Alexandra Hospital, Ipswich Road, Brisbane, QLD 4102.
ian_scott@health.qld.gov.au

1 Eligibility criteria for clinical interventions

Eligibility assessed at presentation

Thrombolysis
Inclusions: Patients presenting directly to emergency department (ie, not transferred from another hospital) with ST segment elevation or new left bundle branch block
Exclusions: Recent trauma or surgery, cardiopulmonary resuscitation, past cerebrovascular accident, uncontrolled hypertension (> 180/100 mmHg), coagulopathy, active gastrointestinal bleeding, late (> 12 hours) presentation, intention to perform/refer primary angioplasty, patient refusal

Glycoprotein IIb/IIIa inhibitors
Inclusions: Non-ST elevation acute coronary syndrome (ACS) or recurrent ischaemia after ST elevation ACS
Exclusions: Adverse reactions, patient refusal

Heparin*
Inclusions: Non-ST elevation ACS or recurrent ischaemia
Exclusions: Adverse reactions to heparin or warfarin, patient refusal

Eligibility assessed at discharge†

β-blocker
Inclusions: All patients
Exclusions: Asthma, severe chronic obstructive pulmonary disease (forced expiratory volume in 1 second < 50% predicted or "severe chronic obstructive pulmonary disease" recorded in medical record), pulse rate at discharge ⩽ 60 bpm, systolic blood pressure at discharge < 100 mmHg, adverse drug reaction, patient refusal

ACE inhibitors
Inclusions: Past history or in-hospital onset of congestive heart failure, left ventricular ejection fraction < 40% or impaired left ventricular systolic function on echocardiography
Exclusions: Serum potassium level at discharge > 5.5 mmol/L, serum creatinine level at discharge > 0.3 mmol/L, systolic blood pressure at discharge < 100 mmHg, severe aortic stenosis (defined as aortic valve area < 0.9 cm^2), adverse drug reaction, patient refusal

Aspirin
Inclusions: All patients
Exclusions: Active peptic ulcer or any gastrointestinal bleeding, concurrent warfarin therapy, any other major or recent bleeding, adverse drug reaction, patient refusal

Lipid-lowering agents
Inclusions: Random serum cholesterol > 4.0 mmol/L
Exclusions: Adverse drug reaction, patient refusal

Early coronary angiography‡
Inclusions: Non-ST elevation ACS, recurrent ischaemia, inducible ischaemia on non-invasive testing
Exclusions: Primary or rescue angioplasty, age > 75 years, major comorbidity,§ patient refusal

Non-invasive risk stratification¶
Inclusions: All patients
Exclusions: Primary or rescue angioplasty, coronary angiography (performed or scheduled), age > 75 years, major comorbidity,§ patient refusal

In-patient cardiac counselling**
Inclusions: All patients
Exclusions: Nil

Referral to outpatient cardiac rehabilitation
Inclusions: All patients
Exclusions: Terminal illness, cognitive impairment, living in residential care, patient refusal

* Unfractionated or low molecular weight.
† Among patients discharged or transferred alive.
‡ During index admission or scheduled within 30 days of discharge.
§ Severe chronic obstructive pulmonary disease, incapacitating stroke or neuromuscular disease, renal failure (serum creatinine ⩾ 0.2 mmol/L), advanced liver disease, advanced cancer, alcohol/drug dependence, patients living in residential care.
¶ By stress testing during index admission or scheduled within 30 days of discharge.
** Counselling about smoking cessation, dietary change and exercise.
ACE = angiotensin-converting enzyme.

between 1 August 2001 and 31 December 2003 with a coded separation diagnosis of ACS. The diagnosis was validated by a retrospective audit of hospital records against a prespecified case definition.[14]

Patients were categorised by:

- age and sex;
- presence of a comorbid condition — diabetes, moderate to severe renal failure (serum creatinine level > 0.15 mmol/L), moderate to severe chronic obstructive pulmonary disease (COPD; forced expiratory volume [FEV_1] < 50% predicted), or mental disorder (documented anxiety or depression requiring treatment);
- type of admitting hospital (tertiary or non-tertiary); and
- for those admitted to non-tertiary hospitals with no resident cardiology service, whether they were transferred to a cardiology unit during the index admission.

Process-of-care measures

The proportions of highly eligible patients in total and in each subgroup who received specific clinical interventions during admission or at discharge were determined at the level of individual patients using intervention-specific eligibility criteria (Box 1). These criteria were derived from evidence-based clinical practice guidelines by consensus of expert panels.[15]

Outcome measures

The primary outcome measures were differences between subgroups in the proportions of highly eligible patients who received specific interventions during the entire study period. Secondary outcome measures were differences between subgroups in risk-adjusted in-hospital mortality, 30-day same-cause readmission rates and mean length of hospital stay, as well as changes in subgroup process-of-care measures between consecutive yearly samples.

Statistical analysis

Proportions were compared using χ^2 methods with significance defined as $P < 0.05$. Crude mortality was risk-adjusted using a logistic regression model derived and validated within the whole patient population and having a c-statistic value[16] of 0.78. Correction methods were applied to adjust raw P values for multiple comparisons,[17] such that only raw P values less than or equal to 0.001 remained significant after adjustment.

Ethical approval

Study methods were approved by the Medical Processes Quality Assurance Committee, a gazetted committee of Queensland Health. Patient data were de-identified for analysis and reported as aggregate data.

RESULTS

Patient characteristics

A total of 2156 patients met the case definition and had complete evaluable data. This represented 15% of all patients with a coded principal discharge diagnosis of acute myocardial infarction admitted to study hospitals during the study period (Vanessa Cull, Queensland Health, personal communication). The baseline characteristics of the 2156 patients are

shown in Box 2. Mean age was 66.6 years (median, 68; range, 20–100); 65% were men, and 21% were admitted to tertiary hospitals.

Process-of-care comparisons

Differences between subgroups in use of interventions are shown in Box 3. The proportions of highly eligible patients receiving indicated care differed between subgroups as follows:

Age: Patients ⩾ 65 years of age were less likely than those < 65 years to receive glycoprotein IIb/IIIa inhibitors (3% v 8%) heparin (79% v 87%), β-blockers (79% v 87%), lipid-lowering agents (78% v 87%), early coronary angiography (51% v 66%), in-hospital cardiac counselling (57% v 70%), and referral to cardiac rehabilitation (17% v 33%; $P = 0.03$ for all comparisons). There was also a trend towards lower rates of non-invasive risk stratification (42% v 58%; $P = 0.06$).

Sex: Women were less likely than men to receive lipid-lowering agents (77% v 86%) or in-hospital cardiac counselling (56% v 65%; $P = 0.03$ for both comparisons).

Diabetes: Patients with diabetes were more likely than those without diabetes to receive ACE inhibitors (73% v 64%; $P = 0.03$), but less likely to receive early coronary angiography (50% v 63%; $P = 0.06$) and non-invasive risk stratification (34% v 57%; $P = 0.03$).

Renal disease: Patients with moderate to severe renal failure were less likely than those with no or mild renal failure to receive thrombolysis (52% v 84%), heparin (71% v 83%), β-blockers (69% v 84%), lipid-lowering agents (61% v 84%), in-hospital cardiac counselling (46% v 64%) and referral to cardiac rehabilitation (9% v 25%; $P = 0.03$ for all comparisons).

Chronic obstructive pulmonary disease: Patients with moderate to severe disease were less likely than those with mild or no disease to receive lipid-lowering agents (61% v 84%; $P = 0.03$).

Mental disorder: There were no significant differences in indicated care between patients with and without mental disorders.

Type of admitting hospital: Patients admitted to tertiary hospitals were more likely than those admitted to non-tertiary hospitals to receive early coronary angiography (85% v 55%) and referral to cardiac rehabilitation (36% v 21%; $P = 0.03$ for both comparisons).

Transfer status: Among patients initially admitted to a non-tertiary hospital with no resident cardiology service, those transferred to cardiology units were more likely than those not transferred to receive glycoprotein IIb/IIIa inhibitors (14% v 1%), heparin (92% v 77%) and early coronary angiography (92% v 35%; $P = 0.03$ for all comparisons), but were less likely to receive non-invasive risk stratification (4% v 55%) and in-hospital cardiac counselling (54% v 66%; $P = 0.03$ for both comparisons).

Outcome comparisons

Differences between subgroups in outcomes are shown in Box 3. Risk-adjusted in-hospital mortality was significantly higher in patients with moderate to severe renal failure (15% v 3%; $P < 0.001$), in older patients (6% v 2%; $P = 0.04$), and in those admitted to tertiary hospitals (7% v 3%; $P = 0.02$), and showed a trend towards higher values in women (5% v 3%; $P = 0.06$) and in those with moderate to severe COPD (7% v 4%; $P = 0.13$). Same-cause readmissions at 30 days were higher in older patients (6% v 3%; $P = 0.02$). Mean length of stay was higher in older patients (6.5 v 5.2 days; $P < 0.001$), in women (6.4 v 5.7 days; $P = 0.005$), patients with moderate to severe renal failure (6.9 v 5.8 days; $P = 0.001$), those with moderate to severe COPD (7.9 v 5.9 days; $P < 0.001$), those admitted to tertiary hospitals (7.7 v 5.5 days; $P < 0.001$) and those not transferred to cardiology units (5.9 v 4.5 days; $P < 0.001$).

Temporal comparisons

Comparisons between subgroups in process-of-care measures yielded statistically similar results from year to year except for:

- *Use of glycoprotein IIb/IIIa inhibitors:* In 2003, more younger patients (13% v 7%) and patients transferred to cardiology units (24% v 2%) received these agents compared with 2001 (6% v 4% and 10% v 2%, respectively); and
- *Use of heparin:* In 2003, more patients admitted to tertiary hospitals received this treatment (95% v 87%) compared with 2001 (70% v 72%).

2 Patient characteristics ($n = 2156$)

Variable	Number (%)*
Age (years) (mean [SD])	66.6 (14.4)
Elderly (age ⩾ 65 years)	1253 (58%)
Female	749 (35%)
Diabetes	495 (23%)
Renal disease†	225 (11%)
Chronic obstructive pulmonary disease‡	88 (4%)
Mental health problems	163 (8%)
Tertiary admitting hospital	453 (21%)
Transfer to cardiology unit	556 (26%)
Previous ACS	879 (41%)
Previous revascularisation	258 (12%)
Past heart failure	199 (9%)
Chronic atrial fibrillation	119 (6%)
Current smoker	559 (26%)
Hypertension	1087 (50%)
Hyperlipidaemia	808 (37%)
Pulse rate (bpm) on admission (mean [SD])	83 (24)
Blood pressure (mmHg) on admission (mean [SD])	143 (30)/ 78 (28)

* Unless otherwise indicated.
† Serum creatinine level > 0.15 mmol/L.
‡ Forced expiratory volume (FEV_1) < 50% predicted value.
ACS = acute coronary syndrome.

DISCUSSION

This study suggests that there are variations in indicated care of representative samples of patients with ACS admitted to public hospitals in Queensland. In particular, older patients, women, patients with diabetes, moderate to severe renal failure or COPD receive several indicated therapies significantly less often than those who are younger and have no or mild comorbidity. Early coronary angiography is the intervention most often withheld among the various patient subgroups studied. The higher risk-adjusted mortality observed in patients with moderate to severe renal failure, older people and women may be partly accounted for by observed differences in indicated care.

The strengths of this study included the prospective enrolment of patients satisfying a pre-specified case definition, which ensured validity of diagnosis compared with coded discharge diagnoses, which can be inaccurate in up to 15% of cases.[18] Further strengths were the accurate assessment of eligibility of individual patients for specific types of indicated care, evaluation of multiple treatments, and use of a contemporary cohort spanning 2.5 years to identify temporal trends.

The limitations of our study included the potential for overinclusion of patients in the highly eligible group if clinical reasons for withholding specific treatments had not been recorded, the inability to ascertain physician and system-of-care reasons why seemingly indicated care was withheld in individual patients, the small sample sizes for some indicators, and the reliance on serum creatinine level as the measure of renal function rather than more accurate, formal estimations of creatinine clearance. While not an aim of this study, the extent to which differences between

3 Proportions of highly eligible patients receiving indicated care and outcomes compared between subgroups

		Age (years)			Sex			Diabetes			Moderate–severe renal failure†		
	Total	< 65	⩾ 65	P*	Male	Female	P*	No	Yes	P*	No	Yes	P*
Interventions‡													
Thrombolysis	307/381 (81%)	181/211 (86%)	126/170 (74%)	0.2	223/270 (83%)	84/111 (76%)	0.9	257/313 (82%)	50/68 (74%)	0.9	290/347 (84%)	13/25 (52%)	0.03
Glycoprotein IIb/IIIa inhibitor	82/1726 (5%)	52/693 (8%)	30/1033 (3%)	0.03	62/1121 (6%)	20/605 (3%)	0.9	70/1322 (5%)	12/404 (3%)	0.9	76/1523 (5%)	4/177 (2%)	0.9
Heparin	1412/1725 (82%)	601/693 (87%)	811/1032 (79%)	0.03	941/1120 (84%)	471/605 (78%)	0.1	1090/1321 (83%)	322/404 (80%)	0.9	1268/1522 (83%)	126/177 (71%)	0.03
β-blocker	901/1087 (83%)	450/515 (87%)	451/572 (79%)	0.03	606/727 (83%)	295/360 (82%)	0.9	688/823 (84%)	213/264 (81%)	0.9	840/1003 (84%)	49/71 (69%)	0.03
ACE inhibitor	1193/1810 (66%)	496/799 (62%)	697/1011 (69%)	0.1	796/1207 (66%)	397/603 (66%)	0.9	892/1399 (64%)	301/411 (73%)	0.03	1099/1667 (66%)	83/123 (68%)	0.9
Aspirin	1712/1894 (90%)	776/847 (92%)	936/1047 (89%)	0.9	1151/1265 (91%)	561/629 (89%)	0.9	1335/1467 (91%)	377/427 (88%)	0.9	1566/1720 (91%)	130/153 (85%)	0.6
Lipid-lowering agent	1016/1229 (83%)	551/631 (87%)	465/598 (78%)	0.03	701/820 (86%)	315/409 (77%)	0.03	814/988 (82%)	202/241 (84%)	0.9	969/1155 (84%)	37/61 (61%)	0.03
Coronary angiography	494/826 (60%)	324/495 (66%)	170/331 (51%)	0.03	362/592 (61%)	132/234 (56%)	0.9	397/631 (63%)	97/195 (50%)	0.06	485/797 (61%)	2/7 (32%)	0.2
Non-invasive risk stratification	221/432 (51%)	142/244 (58%)	79/188 (42%)	0.06	171/309 (55%)	50/123 (41%)	0.3	182/318 (57%)	39/114 (34%)	0.03	nr	nr	-
In-hospital counselling	1283/2061 (62%)	621/894 (70%)	662/1167 (57%)	0.03	889/1363 (65%)	394/698 (56%)	0.03	997/1588 (63%)	286/473 (61%)	0.9	1187/1859 (64%)	82/180 (46%)	0.03
Cardiac rehabilitation§	344/1433 (24%)	215/650 (33%)	129/783 (17%)	0.03	252/968 (26%)	92/465 (20%)	0.5	276/1099 (25%)	68/334 (20%)	0.9	327/1303 (25%)	10/114 (9%)	0.03
Outcomes													
Deaths (risk-adjusted mortality rate)	88/2156 (4%)	6/903 (2%)	82/1253 (6%)	0.04	38/1407 (3%)	50/749 (5%)	0.06	66/1661 (4%)	22/495 (3%)	0.9	43/1905 (3%)	45/225 (15%)	< 0.001
Same-cause readmission¶	95/2061 (5%)	27/894 (3%)	68/1167 (6%)	0.02	59/1363 (4%)	36/698 (5%)	0.9	70/1588 (4%)	25/473 (5%)	0.9	85/1859 (5%)	10/180 (6%)	0.9
Mean length of stay (days)	5.9	5.2	6.5	< 0.001	5.7	6.4	0.005	5.8	6.2	0.12	5.8	6.9	0.001

* *P* values are those obtained after adjusting raw *P* values for multiple comparisons (ie, adjusted *P* values).[17]
† Moderate to severe renal failure, defined as serum creatinine level > 0.15 mmol/L. ‡ Patients who died in hospital were not included in denominators for calculating rates of use of interventions where eligibility was assessed at discharge (Box 1). § Referral for cardiac rehabilitation. ¶ 30-day same-cause readmission.

subgroups in risk-adjusted mortality disappear after adjustment for differences in treatment frequency would be of interest in determining the impact of suboptimal care on outcome.

Previous reports have shown that older age reliably predicts less than optimal care in patients with ACS.[6,19] Our findings concur with those of others regarding suboptimal use of β-blockers,[6,20] heparin,[19] lipid-lowering agents,[21] cardiac rehabilitation,[22] and early coronary angiography.[23]

While studies before 1995 suggested that women are less likely to receive both pharmacological and procedural treatments of ACS,[7] more recent studies, particularly those using risk-adjusted or indication-based process-of-care measures, suggest otherwise.[24,25] Our study showed that, with the exception of lipid-lowering agents and rehabilitation, quality of care was comparable between the sexes.

Our results for patients with diabetes differ from those reported from a 1995 Australian study of care of acute myocardial infarction. That study compared 268 patients with diabetes and 1714 without diabetes. After controlling for age, sex, coronary history, smoking status, educational level and disease severity, patients with diabetes were significantly less likely to receive thrombolytic therapy, aspirin, and β-blockers, but more likely to receive ACE inhibitors and calcium-channel blockers.[26] In contrast, we saw no differences between the groups in use of thrombolysis, aspirin, or β-blockers, but did find a greater use of ACE inhibitors.

In patients with moderate to severe renal failure, we found lower rates of use of thrombolysis, heparin, β-blockers, lipid-lowering agents, in-hospital cardiac counselling and cardiac rehabilitation. Analyses of patients in US registries[9] and in international randomised trials[27] have likewise found that those with significant renal impairment are less likely to receive thrombolysis,[9] β-blockers,[9,27] aspirin,[27] lipid-lowering agents[27] and angiography[27] during hospitalisation.

In our study, patients with moderate to severe COPD received lipid-lowering agents significantly less often than patients with milder or no COPD. As far as we are aware, no other study has evaluated quality of ACS care in patients with COPD, despite the high

3 ***continued***

	Moderate–severe COPD			Mental disorder			Tertiary admitting hospital			Transfer to cardiology unit		
	No	Yes	*P**	No	Yes	*P**	No	Yes	*P**	No	Yes	*P**
Interventions[‡]												
Thrombolysis	299/368 (81%)	8/13 (62%)	0.9	290/360 (81%)	17/21 (81%)	0.9	266/327 (81%)	41/54 (76%)	0.9	162/206 (79%)	103/116 (89%)	0.9
Glycoprotein IIb/IIIa inhibitor	78/1653 (5%)	4/73 (6%)	0.9	74/1588 (5%)	8/138 (6%)	0.9	65/1370 (5%)	17/356 (5%)	0.9	7/943 (1%)	56/416 (14%)	0.03
Heparin	1357/1652 (82%)	55/73 (75%)	0.9	1304/1587 (82%)	108/138 (78%)	0.9	1111/1369 (81%)	301/356 (85%)	0.9	721/942 (77%)	383/416 (92%)	0.03
β-blocker	na	na		846/1015 (83%)	55/72 (76%)	0.9	699/855 (82%)	202/232 (87%)	0.9	459/575 (80%)	240/280 (86%)	0.9
ACE inhibitor	1140/1743 (65%)	53/67 (79%)	0.9	1108/1681 (66%)	85/129 (66%)	0.9	952/1439 (66%)	241/371 (65%)	0.9	677/990 (68%)	275/449 (61%)	0.3
Aspirin	1660/1830 (91%)	52/64 (81%)	0.6	1591/1762 (90%)	121/132 (92%)	0.9	1349/1507 (90%)	363/387 (94%)	0.5	911/1023 (89%)	438/484 (90%)	0.9
Lipid-lowering agent	990/1186 (84%)	26/43 (61%)	0.03	957/1147 (83%)	59/82 (72%)	0.4	789/963 (82%)	227/266 (85%)	0.9	512/640 (80%)	277/323 (86%)	0.9
Coronary angiography	na	na		463/770 (60%)	31/56 (55%)	0.9	386/699 (55%)	108/127 (85%)	0.03	156/447 (35%)	230/250 (92%)	0.03
Non-invasive risk stratification	na	na		209/402 (52%)	12/30 (40%)	0.9	211/405 (52%)	10/27 (37%)	0.9	210/382 (55%)	1/23 (4%)	0.03
In-hospital counselling	1244/1980 (63%)	39/81 (48%)	0.4	1195/1909 (63%)	88/152 (58%)	0.9	1015/1635 (62%)	268/426 (63%)	0.9	737/1123 (66%)	278/512 (54%)	0.03
Cardiac rehabilitation[§]	334/1385 (24%)	10/48 (21%)	0.9	322/1334 (24%)	22/99 (22%)	0.9	237/1135 (21%)	107/298 (36%)	0.03	167/802 (21%)	70/333 (21%)	1.0
Outcomes												
Deaths (risk-adjusted mortality)	81/2068 (4%)	7/88 (7%)	0.1	78/1993 (4%)	10/163 (5%)	0.5	61/1703 (3%)	27/453 (7%)	0.02	na	na	
Same-cause readmission[¶]	89/1980 (5%)	6/81 (7%)	0.9	86/1909 (5%)	9/152 (6%)	0.9	78/1635 (5%)	17/426 (4%)	0.9	74/1123 (7%)	15/512 (3%)	0.8
Mean length of stay (days)	5.9	7.9	< 0.001	5.9	6.2	0.47	5.5	7.7	< 0.001	5.9	4.5	< 0.001

COPD = chronic obstructive pulmonary disease; moderate-severe COPD was defined as forced expiratory volume (FEV_1) < 50% of predicted value.
na = not assessed; denominator of eligible patients for that specific intervention, as defined by eligibility criteria, excluded one or both patient types being compared.
ACE = angiotensin-converting enzyme. nr = not reported.

prevalence and mortality risk of this condition in patients with ACS.[28]

We found that patients with documented anxiety or depression received treatment equal to that received by patients with no mental disorder. Other studies have suggested a bias towards withholding adjunctive therapies, percutaneous coronary interventions and rehabilitation from patients with schizophrenia or major affective disorders.[10]

We found no differences in quality of care between hospital types, apart from higher rates of coronary angiography and referral to cardiac rehabilitation in tertiary compared with non-tertiary hospitals. These differences may well relate to reduced access to such services in non-metropolitan sites, as opposed to the absence of clinical intention.[29] This contrasts with US studies, which have found that tertiary hospitals had significantly higher rates of use in eligible patients of aspirin,[11,30] β-blockers,[11] and lipid-lowering agents[30] compared with non-tertiary hospitals.

The higher risk-adjusted mortality of patients admitted to tertiary hospitals seen in this study may reflect higher rates of use of invasive cardiac procedures compared with non-tertiary sites. Recent data from a multinational registry, while showing no difference in in-hospital mortality, did show a 14% increase in risk-adjusted mortality at 6 months in patients admitted to tertiary sites compared with those admitted to non-tertiary sites.[31]

In a systematic review of studies published between 1980 and 1997, patients with ACS were more likely to receive indicated therapies if they were treated directly by cardiologists.[12] Among patients in our study initially admitted to non-tertiary hospitals with no resident cardiology service, those who were transferred to cardiology units were more likely than those not transferred to receive heparin, glycoprotein IIb/IIIa inhibitors and early coronary angiography. However, these differences are probably explained by selection bias, as cardiology units will preferentially accept higher-risk patients with fewer comorbidities in anticipation of angiography and percutaneous coronary interventions.[32] These patients will therefore be more likely to receive intensive antithrombotic treatment beforehand.

These results have implications for practice. The reasons that guideline-recommended

therapies are more likely to be withheld in certain patient populations are difficult to elicit.[33] Clinician concern about potential for treatment-induced harm is most probably a key consideration. Perceived bleeding risk may deter administration of antithrombotic agents to older patients and those with renal disease with its associated platelet dysfunction. Statins may be regarded as more likely to cause myositis or rhabdomyolysis in patients with reduced creatinine clearance. However, in many of these patients, including older people, the absolute risk reduction in death and recurrent coronary events as a result of closely monitored treatment will outweigh the small risk of serious side effects.[13,34]

Moreover, treatment risk does not readily account for the differences in rates of specific treatments between the sexes or between patients admitted to different types of hospital. Differences in access to rehabilitation programs, stress testing technology or angiography may well be a factor.

In conclusion, variation exists in the delivery of indicated care to patients with ACS. Older patients and those with comorbidities appear to be at risk of receiving suboptimal care. These patient populations also have higher risk-adjusted mortality, suggesting potentially avoidable excess deaths,[34] with implications for clinical practice. The generalisability of our results to other Australasian settings needs to be tested, as does the impact of quality improvement programs and improved access to invasive interventions in eliminating or reducing existing variations in care of patients with ACS.

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COMPETING INTERESTS

None identified.

REFERENCES

1 Commonwealth Department of Health and Aged Care, Australian Institute of Health and Welfare. National Health Priority Areas report: Cardiovascular health 1998. Canberra: The Department and AIHW. (AIHW Catalogue. No. PHE 9.)
2 Law M, Watt H, Wald N. The underlying risk of death after myocardial infarction in the absence of treatment. *Arch Intern Med* 2002; 162: 2405-2410.
3 Montague T, Montague P, Barnes M, et al. Acute myocardial infarction in Canada: new epidemiologic insights on incidence, therapy and risk. *J Thromb Thrombolysis* 1996; 3: 101-105.
4 Heidenreich P, McClellan M. Trends in treatment and outcomes for acute myocardial infarction: 1975-1995. *Am J Med* 2001; 110: 165-174.
5 Scott IA, Harper CM. Guideline-discordant care in acute myocardial infarction: predictors and outcomes. *Med J Aust* 2002; 177: 26-31.
6 Rathore S, Mehta R, Wang Y, et al. Effects of age on the quality of care provided to older patients with acute myocardial infarction. *Am J Med* 2003; 114: 307-315.
7 Chandra N, Ziegelstein R, Rogers W, et al. Observations of the treatment of women in the United States with myocardial infarction: a report from the National Registry of Myocardial Infarction-I. *Arch Intern Med* 1998; 158: 981-988.
8 Mehta R, Ruane T, McCarger P, et al. The treatment of elderly diabetic patients with acute myocardial infarction: insight from Michigan's Cooperative Cardiovascular Project. *Arch Intern Med* 2000; 160: 1301-1306.
9 Shlipak M, Heidenreich P, Noguchi H, et al. Association of renal insufficiency with treatment and outcomes after myocardial infarction in elderly patients. *Ann Intern Med* 2002; 137: 555-562.
10 Druss B, Bradford D, Rosenheck R, et al. Quality of medical care and excess mortality in older patients with mental disorders. *Arch Gen Psychiatry* 2001; 58: 565-572.
11 Chen J, Radford M, Wang Y, et al. Do "America's Best Hospitals" perform better for acute myocardial infarction? *N Engl J Med* 1999; 340: 286-292.
12 Go A, Rao R, Dauterman K, Massie B. A systematic review of the effects of physician specialty on the treatment of coronary disease and heart failure in the United States. *Am J Med* 2000; 108: 216-226.
13 Gottlieb S, McCarter R, Vogel R. Effect of beta-blockade on mortality among high-risk and low-risk patients after myocardial infarction. *N Engl J Med* 1998; 339: 489-497.
14 Scott IA, Darwin IC, Harvey KH, et al. Multisite, quality-improvement collaboration to optimise cardiac care in Queensland public hospitals. *Med J Aust* 2004; 180: 392-397.
15 Hickey A, Scott IA, Denaro CD, et al. Using clinical indicators in a quality improvement programme targeting cardiac care. *Int J Qual Health Care* 2004; 16 Suppl 1: i11-i25.
16 Centor RM, Schwartz JS. An evaluation of methods for estimating the area under the receiver operator characteristic (ROC) curve. *Med Decis Making* 1985; 5: 149-156.
17 Hochberg Y. A sharper Bonferroni procedure for multiple tests of significance. *Biometrika* 1988; 75: 800-802.
18 Boyle CA, Dobson AJ. The accuracy of hospital records and death certificates for acute myocardial infarction. *Aust N Z J Med* 1995; 25: 316-23.
19 Shahi C, Rathore S, Wang Y, et al. Quality of care among elderly patients hospitalised with unstable angina. *Am Heart J* 2001; 142: 263-270.
20 Krumholz H, Radford M, Wang Y, et al. Early beta-blocker therapy for acute myocardial infarction in elderly patients. *Ann Intern Med* 1999; 131: 648-654.
21 Fonarow G, French W, Parsons L, et al. Use of lipid-lowering medications at discharge in patients with acute myocardial infarction: data from the National Registry of Myocardial Infarction 3. *Circulation* 2001; 103: 38-44.
22 Ades P, Waldmann M, McCann W, et al. Predictors of cardiac rehabilitation participation in older coronary patients. *Arch Intern Med* 1992; 152: 1033-1035.
23 Paul SD, O'Gara PT, Mahjoub ZA, et al. Geriatric patients with acute myocardial infarction: cardiac risk factor profiles, presentation, thrombolysis, coronary interventions, and prognosis. *Am Heart J* 1996; 131: 710-715.
24 Raine R, Black N, Bowker T, Wood D. Gender differences in the management and outcome of patients with acute coronary artery disease. *J Epidemiol Community Health* 2002; 56: 791-797.
25 Rathore S, Wang Y, Radford M, et al. Sex differences in cardiac catheterisation after acute myocardial infarction: the role of procedure appropriateness. *Ann Intern Med* 2002; 137: 487-493.
26 Lim L, Tesfay G, Heller R. Management of patients with diabetes after heart attack: a population-based study of 1982 patients from a heart disease register. *Aust N Z J Med* 1998; 28: 334-342.
27 Anavekar NS, McMurray JJ, Velezquez EJ, et al. Relation between renal dysfunction and cardiovascular outcomes after myocardial infarction. *N Engl J Med* 2004; 351: 1285-1295.
28 Behar S, Panosh A, Reicher-Reiss H, et al. Prevalence and prognosis of chronic obstructive pulmonary disease among 5839 consecutive patients with acute myocardial infarction. *Am J Med* 1992; 93: 637-641.
29 Hadfield CD. Multisite, quality-improvement collaboration to optimise cardiac care in Queensland public hospitals [letter]. *Med J Aust* 2004; 181: 175.
30 Llevadot J, Guigliano R, Antman E, et al. Availability of on-site catheterisation and clinical outcomes in patients receiving fibrinolysis for ST-elevation myocardial infarction. *Eur Heart J* 2001; 22: 2049-2051.
31 Van de Werf F, Gore JM, Avezum A, et al for the GRACE Investigators. Access to catheterization facilities in patients admitted with acute coronary syndrome: multinational registry study. *BMJ* 2005: 330: 441-446.
32 Chen J, Radford M, Wang Y, Krumholz H. Care and outcomes of elderly patients with acute myocardial infarction by physician specialty: the effects of comorbidity and functional limitations. *Am J Med* 2000; 108: 460-469.
33 Cabana M, Rand C, Powe N, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *JAMA* 1999; 282: 1458-1465.
34 Alter DA, Manuel DG, Gunraj N, et al. Age, risk-benefit trade-offs, and the projected effects of evidence-based therapies. *Am J Med* 2004; 116: 540-545.

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