Variations in the application of cardiac care in Australia

Results from a prospective audit of the treatment of patients presenting with chest pain

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ABSTRACT

Objective: To evaluate the use of clinical practice guidelines for the management of acute coronary syndromes published by the National Heart Foundation (NHF) of Australia and the Cardiac Society of Australia and New Zealand (CSANZ) in patients presenting with chest pain.

Design: Cross-sectional study of consecutive patients admitted with chest pain.

Setting: Prospective case note review was undertaken in 2380 patients admitted to 27 hospitals across five states in Australia between January 2003 and August 2005. Patients were divided into two groups: those who presented to centres with angiography and percutaneous intervention facilities ($n = 1260$) and those treated at centres without these facilities ($n = 1120$).

Main outcome measures: The proportion of patients whose care met quality of care standards for diagnostic and risk-stratification procedures and management according to NHF/CSANZ treatment guidelines.

Results: Significant delays were identified in performing electrocardiography, administering thrombolysis, transferring high-risk patients to tertiary centres, and performing revascularisation. Medical therapy was underused, especially glycoprotein IIb/IIIa antagonists in patients with high-risk acute coronary syndromes. Patients treated at centres without interventional facilities were less likely to receive guidelines-based medical therapy and referral for coronary angiography (20.11%) than patients treated at centres with interventional facilities (66.43%; $P < 0.001$).

Conclusion: There are deficits in the implementation and adherence to evidence-based guidelines for managing chest pain in hospitals across Australia, and significant differences between hospitals with and without interventional facilities.

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Clinical practice guidelines for the management of acute coronary syndromes, including myocardial infarction, have been published by the National Heart Foundation (NHF) of Australia and the Cardiac Society of Australia and New Zealand (CSANZ).[1] These recommendations expand on previous guidelines,[2] incorporate a systematic review of available evidence, and aim to assist health professionals with the best practice management of cardiac patients.

Adherence to guidelines-based care is associated with improved patient outcomes.[3-6] However, overseas audits suggest only a proportion of patients are being treated according to best practice.[4-7] In Australia, there is limited information on the measurement and publication of quality indicators.

The Heart Protection Partnership (HPP) project was created to audit adherence to evidence-based guidelines in acute care facilities across Australia. Its purpose was to provide a "snapshot" of the quality of care, as assessed by adherence to the NHF/CSANZ guidelines.[1] The program then aimed to provide feedback to health care providers across Australia about the level of care rendered to real-world patients, through evaluation of actual performance versus optimal care standards. Through identification of treatment gaps and baseline indicator feedback, the intention was that individual centres could then implement locally adapted interventions for improving compliance.

METHODS

The HPP Steering Committee (a multistate, multidisciplinary panel incorporating cardiologists, interventional cardiologists, general physicians and representatives of the NHF) developed audit criteria based on NHF/CSANZ guidelines and definitions.[1] Once a hospital had agreed to enrol patients in the audit, a Care Coordinator (research assistant) was assigned to facilitate the audit and follow-up. Box 1 lists the participating centres and principal investigators. At each centre, up to 100 consecutive patients admitted with chest pain to a monitored bed were asked to participate; their written consent was obtained before their enrolment. Patients were free to withdraw at any time.

Following enrolment, a chart review was conducted, and admissions, procedural, medication, and discharge data were collected in an electronic database. Data were captured for procedural and diagnostic performance, use of medication as indicated per guidelines, and discharge care. Race was self-reported by patients at admission. For tests such as troponin measurements, the reference range at the treating centre was used to determine abnormal results. Once secured and de-identified, the data were sent to an independent statistician for analysis.

Individual hospital data were analysed and returned to the hospitals. Based on this information, individual hospital HPP committees developed their own process improvement plans.

Hospitals could seek re-audit after implementation of their improvement plans. Evaluation of performance after implementation of improved protocols, to evaluate the efficacy of solutions, is ongoing.

Measures

Primary outcome measures were the proportion of patients whose care met quality of care standards for diagnostic and risk-stratification procedures and management according to the NHF/CSANZ guidelines.[1] Compliance with guidelines was assessed by the Care Coordinator according to whether an action, such as medication prescribing, was indicated, and adjusted for stated contraindication. This was determined in conjunction with the principal investigator at the centre, with clarification from the treating physician as required.

We compared treatment between hospitals with interventional facilities and those without. Hospitals were defined as interventional centres if they had facilities for both angiography and percutaneous coronary intervention (PCI). Hospitals without such facilities were defined as non-interventional centres.

Ethics approval

The principal investigator at each centre was responsible for obtaining ethics committee

1 Participating sites and investigators

New South Wales
Coffs Harbour Hospital: J Waites
Concord Hospital: D Brieger
Gosford Hospital: P Lewis
Lismore Base Hospital: M Tscalis
Nepean Hospital: D Fitzpatrick
Orange Base Hospital: D Amos
Port Macquarie Base Hospital: K Alford
St George Hospital: D Rees
Queensland
Atherton Hospital: M Brigden
Bundaberg Hospital: P Miach
Cairns Base Hospital: P Boyd, C Lim
Gladstone Hospital: S Anandaraja
Mackay Base Hospital: S De Silva, B Weich
Nambour Hospital: S Coverdale
Prince Charles Hospital: D Walters
Rockhampton Hospital: M Schoeman
Royal Brisbane Hospital: J Atherton
Townsville General Hospital: S David
Townsville Mater Hospital: W Thoreau
Tasmania
Royal Hobart Hospital: P Roberts-Thompson
Victoria
Box Hill Hospital: G New
Frankston Hospital: G Szto
Monash Medical Centre: J Boxall
Northern Hospital: D Eccleston
Royal Melbourne Hospital: D Eccleston
St John of God Ballarat: A Ambikapathy, J Van den Broak
Western Australia
Hollywood Private Hospital: G Cope ◆

approval at that centre. In some hospitals, a formal ethics committee submission was not required for a quality assurance audit of this type.

Recruitment criteria

Our aim was to assess usual practice, and this was reflected in the flexible recruitment criteria. These were not strictly limited to acute coronary syndrome patients; we included all, preferably sequential, patients presenting with chest pain that was reasonably suspected to be cardiogenic. This encompassed all patients admitted to a coronary care unit with chest pain or a step-down unit in a monitored bed.

Statistical analysis

An independent data analysis company, Statistical Revelations (Melbourne, Vic), conducted the analysis using SAS, version 9 (SAS Institute, Cary, NC, USA). In general, separate results are presented for interventional and non-interventional hospitals, as well as overall results and the difference between the two hospital types.

For proportions, exact 95% confidence limits based on the binomial distribution were used. For continuous variables and for differences between proportions, 95% confidence intervals were based on the *t* distribution. The median time to events (eg, electrocardiography [ECG], thrombolysis or angiography) and 95% confidence limits were determined using the Kaplan–Meier method. Hazard ratios were determined using a Cox proportional hazards regression analysis.

Logistic regression models were developed for the outcome variables referral for angiography and in-hospital death. Variables considered were age, sex, primary diagnosis, cardiovascular risk factors and comorbidity (renal impairment). Each factor was explored in a univariate logistic regression model. All factors that were significant at the 0.1 level were considered together, and four methods of model selection were pursued: forward selection, backward elimination, stepwise selection, and a best subsets approach (using a score criterion and Akaike's information criterion to select the best model). The results from these processes were consistent, and a final model was fitted.

RESULTS

Between January 2003 and August 2005, 2380 patients were recruited from 27 hospitals across five states in Australia. Thirteen hospitals had both angiographic and PCI facilities at the time of the audit. Patient data are summarised in Box 2. Interventional hospitals had more men (69% v 65%; $P = 0.057$), fewer Indigenous patients (4% v 13%; $P < 0.001$), more smokers (28% v 23%; $P = 0.058$), and more patients with hyperlipidaemia (50% v 41%, $P < 0.001$) or known ischaemic heart disease (25% v 17%; $P < 0.001$). A greater proportion of patients at interventional centres had myocardial infarction as the primary discharge diagnosis (52% v 38%); atypical chest pain was a more common finding at non-interventional centres (12% v 8%; $P < 0.006$). The total in-hospital major adverse cardiovascular event rate was 3.9%, with no significant difference between interventional (4.4%) and non-interventional centres (3.2%; $P = 0.12$).

Procedural and diagnostic performance

Triage to electrocardiography

The median time from triage to ECG was 9.0 min (95% CI, 9.0–10.0 min) at interventional centres, and 7.0 min (95% CI, 7.0–8.0 min; $P < 0.001$) at non-interventional centres (overall range, 1 to > 240 min). Triage to ECG times ⩽ 10 min were recorded for 55% of patients. A further 27% received ECG within 10–30 min. At interventional centres, 56.6% of patients received an ECG within 10 min, compared with 65.3% at non-interventional centres ($P < 0.001$). The hazard ratio (non-interventional/interventional) by time from triage to ECG (minutes) was 0.83 (95% CI, 0.76–0.92).

Triage to thrombolysis

For 83% of patients undergoing thrombolysis, it was performed within 2 h of triage, with no significant difference between hospital types (interventional: median, 0.68 h; non-interventional: median, 0.60 h; $P = 0.78$). The hazard ratio (non-interventional/interventional) was 1.04 (95% CI, 0.80–1.35).

Triage to troponin measurements

Initial and peak troponin testing were reported in 2232 (98%) and 2176 (92%) patients, respectively. The hazard ratio (non-interventional/interventional) for time from triage to troponin testing (hours) was 0.91 (95% CI, 0.83–1.00; $P = 0.045$).

Measurement of lipid levels

Across all centres, cholesterol levels (high-density lipoprotein, low-density lipoprotein, triglycerides) were measured for 68% of patients, with no difference in percentage tested at interventional (67%) and non-interventional (69%) centres ($P = 0.21$).

Triage to angiography

The mean time from triage to angiography for patients referred for invasive assessment was less at interventional centres (115 h; 95% CI, 42.2–187.5 h) than at non-interventional centres (584 h; 95% CI, 438.4–729.5 h) ($P < 0.001$). The hazard ratio (non-interventional/interventional) was 2.85 (95% CI, 2.30–3.53).

Referral for angiography and revascularisation

Of the total group, 1103 patients presenting with acute coronary syndromes were referred for coronary angiography. The referral rate was lower at non-interventional centres (20.11%; 95% CI, 17.75%–

2 Patient characteristics by hospital type

Variable	Total sample	Interventional centre ($n = 1260$)	Non-interventional centre ($n = 1120$)	Difference	P
Mean age (years)	64.21 (63.66, 64.76)	63.74 (62.99, 64.49)	64.73 (63.93, 65.53)	–0.99 (–2.09, 0.11)	0.08
Male (%)	67.35 (65.43, 69.24)	69.08 (66.44, 71.62)	65.41 (62.54, 68.20)	3.67 (–0.11, 7.45)	0.057
Race* (%)					
White	83	87	80		
Indigenous	8.36 (7.28, 9.55)	4.29 (3.24, 5.56)	12.95 (11.04, 15.05)	–8.66 (–10.9, –6.5)	< 0.001
Asian	3	2	2		
Risk factors (%)					
Smoker	25.84 (24.09, 27.65)	28.17 (25.70, 30.75)	23.21 (20.76, 25.80)	4.97 (1.44, 8.49)	0.058
Ex-smoker	31.90 (30.03, 33.82)	32.38 (29.80, 35.04)	31.36 (28.65, 34.18)	1.02 (–2.74, 4.78)	0.60
BMI > 30 kg/m^2	15.99 (14.54, 17.53)	16.27 (14.27, 18.43)	15.68 (13.60, 17.95)	0.59 (–2.37, 3.54)	0.70
Hyperlipidaemia	45.88 (43.86, 47.90)	49.92 (47.12, 52.72)	41.31 (38.40, 44.26)	8.61 (4.61, 12.62)	< 0.001
Hypertension	54.42 (52.39, 56.44)	55.40 (52.60, 58.17)	53.32 (50.34, 56.28)	2.08 (–1.93, 6.1)	0.31
Diabetes	21.76 (20.11, 23.47)	22.78 (20.49, 25.20)	20.61 (18.27, 23.10)	2.17 (–1.16, 5.49)	0.20
Family history	31.86 (29.99, 33.78)	32.30 (29.72, 34.96)	31.36 (28.65, 34.18)	0.94 (–2.82, 4.70)	0.62
Known IHD	21.38 (19.75, 23.08)	25.00 (22.63, 27.49)	17.29 (15.12, 19.64)	7.71 (4.41, 11.00)	< 0.001
Renal impairment	6.94 (5.95, 8.04)	7.14 (5.78, 8.71)	6.72 (5.32, 8.35)	0.42 (–1.63, 2.47)	0.69
Discharge diagnosis (%)					
STEMI	21.81 (20.16, 23.52)	26.75 (24.32, 29.28)	16.25 (14.14, 18.54)	10.50 (7.20, 13.80)	< 0.001
Non-STEMI	23.61 (21.92, 25.37)	25.32 (22.94, 27.81)	21.70 (19.31, 24.23)	3.62 (0.20, 7.04)	0.038
Unstable angina	19.08 (17.51, 20.71)	20.40 (18.20, 22.73)	17.59 (15.40, 19.95)	2.81 (–0.36, 5.97)	0.08
Angina	6.85 (5.87, 7.94)	5.00 (3.86, 6.35)	8.93 (7.32, 10.75)	–3.93 (–5.96, –1.9)	0.001
Atypical chest pain	9.83 (8.66, 11.10)	8.25 (6.79, 9.91)	11.61 (9.79, 13.63)	–3.35 (–5.8, –0.96)	0.006
Arrhythmia	2.90 (2.26, 3.65)	1.83 (1.16, 2.73)	4.11 (3.02, 5.44)	–2.28 (–3.6, –0.93)	0.001
Cardiac failure	1.39 (0.96, 1.94)	1.27 (0.73, 2.05)	1.52 (0.89, 2.42)	–0.25 (–1.19, 0.69)	0.61
Pericarditis	0.92 (0.58, 1.40)	0.48 (0.17, 1.03)	1.43 (0.82, 2.31)	–0.95 (–1.7, –0.18)	0.015
Aortic dissection	0.55 (0.29, 0.93)	0.32 (0.09, 0.81)	0.80 (0.37, 1.52)	–0.49 (–1.08, 0.11)	0.11
In-hospital major adverse cardiovascular events (%)					
Mortality	1.51 (1.06, 2.09)	1.27 (0.73, 2.05)	1.79 (1.09, 2.74)	–0.52 (–1.50, 0.47)	0.30
Recurrent MI	2.27 (1.71, 2.96)	3.10 (2.21, 4.21)	1.34 (0.75, 2.21)	1.75 (0.55, 2.95)	0.004
CVA	0.38 (0.17, 0.72)	0.32 (0.09, 0.81)	0.45 (0.15, 1.04)	–0.13 (–0.63, 0.36)	0.61
Total	3.87 (3.13, 4.73)	4.44 (3.37, 5.73)	3.23 (2.27, 4.44)	1.22 (–0.34, 2.77)	0.12

BMI = body mass index. CVA = cardiovascular attack. IHD = ischaemic heart disease. MI = myocardial infarction. STEMI = ST elevation myocardial infarction. Values in parentheses are 95% confidence limits. * For Indigenous versus non-Indigenous race. ◆

22.64%) than at interventional centres (66.43%; 95% CI, 63.74%–69.04%) ($P < 0.001$).

At interventional centres, the revascularisation rates were 24.4% (95% CI, 22.09%–26.92%) for PCI and coronary artery bypass graft surgery (CABG). In the group undergoing angiography, 31% was for single vessel disease, 52% for multivessel disease and 16% for no significant coronary disease. The median time from admission to PCI was 63.1 h, and the median time from admission to CABG was 9.1 days ($P < 0.001$). Box 3 shows cumulative probability curves by time from triage to PCI and CABG.

Box 4 shows results of a logistic regression model for referral for angiography.

Use of medication

Box 5 shows use of medications adjusted for stated contraindication, for all centres during hospital admission, including emergency department, coronary care unit and ward.

The use of clopidogrel, a glycoprotein IIb/IIIa (GPIIb/IIIa) inhibitor, or both across all centres is shown in Box 6.

Mortality

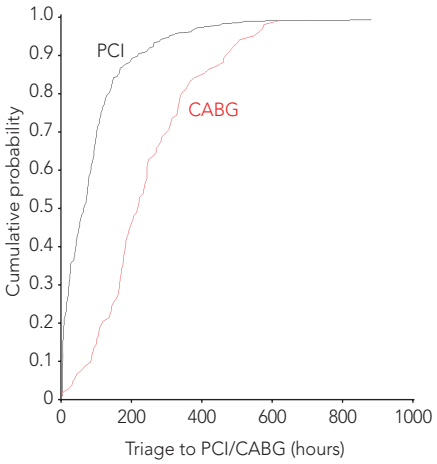
A logistic regression model for in-hospital mortality included patient age, sex, primary diagnosis, cardiovascular risk factors, renal impairment and interventional versus non-interventional centre. Age was the only predictor of death in hospital. Corrected for age, the odds of dying in hospital were not significantly different ($P = 0.78$) for patients at an interventional centre (odds ratio, 0.898; 95% CI, 0.423–1.906) compared with a non-interventional centre.

Discharge care

Discharge summary

A discharge summary was sent to a general practitioner for 73% of patients overall, with some variation across diagnoses; for example, 79% for patients with congestive cardiac failure or heart failure, and 62% for patients with aortic dissection. Patients at interventional centres were more likely to receive a GP letter (77.09%; 95% CI,

3 Time from triage to PCI and CABG across all hospitals



There are significantly longer delays for patients undergoing coronary artery bypass graft surgery (CABG) compared with percutaneous coronary intervention (PCI). ◆

4 Logistic regression model for referral for angiography

Factor	OR	95% CI
Age	0.972	0.964–0.980
Male sex	1.418	1.135–1.773
Hyperlipidaemia	1.349	1.098–1.657
Renal impairment	0.551	0.364–0.833
Diagnosis (reference = angina)		
STEMI	3.412	2.339–4.978
NSTEMI	2.856	1.945–4.192
Unstable angina	1.394	0.982–1.979
Atypical chest pain	0.379	0.225–0.639
Interventional centre (reference = non-interventional centre)	7.412	5.985–9.179

NSTEMI = non-ST elevation myocardial infarction. OR = odds ratio. STEMI = ST elevation myocardial infarction. ◆

74.67%–79.40%) than patients at non-interventional centres (68.34%; 95% CI, 65.17%–71.12%, $P < 0.001$).

Referral to phase II cardiac rehabilitation

Fewer than 11% of patients across all centres were referred to phase II cardiac rehabilitation at discharge. This figure ranged from no patients with aortic dissection, pericarditis or congestive cardiac failure or heart failure, to 13% of patients with ST elevation myocardial infarction (STEMI) or non-STEMI.

Medication drop-off rates

High drop-off rates on discharge were observed for several key medications. Drop-off rates in hospitals with and without interventional facilities, respectively, were: aspirin, 11% v 24%; lipid-lowering medications, 4% v 9%; β-blockers, 12% v 18%; clopidogrel, 16% v 24%; and angiotensin-converting enzyme (ACE) inhibitors, 8% v 17%.

DISCUSSION

Many national projects, such as those in the United States[3-5,7-11] and Europe[6,12,13] have emphasised the importance of systematically measuring performance and outcomes to improve total quality of care. Our study was the first of its type in Australia to prospectively audit the care of consecutive patients presenting with undifferentiated chest pain to monitored beds across the nation. It was conducted during 2003–2005, allowing a reasonable amount of time for dissemination and uptake of the NHF/CSANZ guidelines published in 2000.[2] The audit was timed to occur just before the update of the guidelines in 2006.

Our study showed wide variations in adherence to evidence-based guidelines in Australian acute care facilities for patients presenting with undifferentiated chest pain, about 71% of whom had a discharge diagnosis of an acute coronary syndrome. Substantial gaps in use of guidelines-based treatment paths and medications were evident at all centres. A similar audit of acute coronary syndrome patients,[14] conducted after ours, reaffirms our finding. However, we more particularly found adherence was significantly lower in non-interventional centres than in interventional centres.

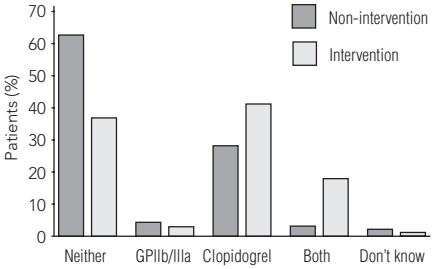
In our study, prescribing of medical therapy according to recommendations varied significantly. The rates of medication prescribing are similar to those reported in other Australian-based studies, as well as international audits such as GRACE. For example, the rate of aspirin prescribing in our study was 91%, compared with 90% in a Queensland study,[15] 92.9% in a similar audit,[14] and 93% in the GRACE study.[16] Similarly, the respective rates for ACE inhibitor prescribing were 58%, 56%, 48.5% and 73%. Notably, the largest discrepancies in medical therapy, both between settings and in terms of deviation from the guidelines, arose in the use of acute treatments, such as GPIIb/IIIa antagonists and early use of clopidogrel. The use of these agents was low, particularly in non-interventional centres. A study of the early use of GPIIb/IIIa antagonists in the US[8] found a similarly low rate of 25%, and other audits conducted in Australia found a rate of 5%.[15] It is not apparent why use of these agents is so low — possible explanations include access to these treatments, training and education in their use, and cost. This is an area where further investigation is suggested.

5 Medication use indicated by guidelines and adjusted for stated contraindication

	Total		Intervention		Non-intervention		
Medication	% (95% CI)	*n*	% (95% CI)	*n*	% (95% CI)	*n*	*P*
Aspirin	90.6 (89.3, 91.8)	2100	91.8 (90.1, 93.2)	1123	89.3 (87.3, 91.1)	977	0.04
BB-oral	75.1 (73.3, 76.8)	1740	77.9 (75.5, 80.2)	958	71.9 (69.1, 74.5)	782	< 0.001
ACE	58.1 (56.1, 60.1)	1374	65.2 (62.4, 67.8)	815	50.2 (47.2, 53.2)	559	< 0.001
AIIA	11.5 (10.3, 12.9)	274	11.4 (9.7, 13.2)	143	11.7 (9.9, 13.7)	131	0.79
Lipid	75.9 (74.2, 77.7)	1799	80.6 (78.3, 82.8)	1012	70.7 (67.9, 73.3)	787	< 0.001
LMWH	61.5 (59.5, 63.5)	1459	60.4 (57.6, 63.1)	758	62.8 (59.9, 65.6)	701	0.23
Heparin	28.1 (26.3, 29.9)	668	40.4 (37.7, 43.2)	508	14.3 (12.3, 16.5)	160	< 0.001
Clopidogrel	43.9 (41.9, 46.0)	1042	56.8 (54.0, 59.5)	712	29.5 (26.9, 32.3)	330	< 0.001
GPIIb/IIIa	14.6 (13.2, 16.1)	347	21.1 (18.9, 23.4)	265	7.3 (5.9, 9.0)	82	< 0.001
Thrombolysis	12.8 (11.4, 14.2)	303	13.0 (11.2, 15.0)	163	12.5 (10.6, 14.6)	140	0.73

ACE = angiotensin-converting enzyme inhibitor. AIIA = angiotensin II receptor antagonist. BB = β-blocker. GPIIb/IIIa = glycoprotein IIb/IIIa receptor antagonist. Lipid = lipid-lowering medication. LMWH = low molecular weight heparin. ◆

6 Use of clopidogrel and glycoprotein IIb/IIIa receptor antagonist



The data highlight a significantly higher use of both medications in interventional hospitals, compared with other hospitals ($P < 0.001$), where the medication was indicated by the guidelines and adjusted for stated contraindication.

GPIIb/IIIa = glycoprotein IIb/IIIa receptor antagonist. ◆

Interventional versus non-interventional centres

The demographics of patients presenting at interventional and non-interventional centres were significantly different, and may reflect a combination of the community population that is being serviced and patient referral patterns. High-risk acute coronary syndromes, such as myocardial infarction, are more likely to be managed at interventional centres.

We found significant differences in the quality of care between interventional centres and non-interventional centres. Variations were not limited to any single facet of care, and were evident both in procedural treatments and in use of medication, discharge referral and follow-up. These findings were apparent across all centres.

A previous study found little overall difference in quality of care, with regard to use of medical therapies, between hospital types in Queensland.[15] However, that study compared tertiary versus non-tertiary hospitals, and did not include some of the largest cardiac centres in Queensland. A further study did find a link between the quality of care and funding initiatives directed towards the implementation of "multiple systematic interventions".[17] In another study, variability in care of patients with acute coronary syndrome depended on whether they experienced STEMI, non-STEMI or unstable angina.[14] The CRUSADE initiative in the US demonstrated marked variation in the use of recommended medical therapies between leading (most adherent) and lagging (least adherent) hospitals.[5] This variation was most evident with therapies considered recent innovations or more aggressive. If our results are compared with results from these leading and lagging centres, based on acute medication use, it appears that Australian practice varies widely between that of leading and lagging centres in the US, depending on the treatment. For example, overall use of GPIIb/IIIa inhibitors in Australian centres is lower than in the most lagging US hospitals, whereas use of any heparin was similar to the most leading US hospitals.[9-11]

Not all our indicators favoured interventional centres. For some key indicators, interventional hospitals had lower adherence to guidelines. For example, a higher proportion of patients underwent ECG within the first 10 minutes at non-interventional facilities.

Angiography and revascularisation

Referral rates for angiography at centres with PCI capability were similar to rates described in GRACE and other registries.[18]

However, we found a significantly reduced rate of referral for investigation and further evaluation at non-interventional centres than at interventional centres. These findings have been noted in previous audits in Queensland and rural New South Wales. The Queensland study found lower rates of referral for coronary angiography for patients with acute coronary syndromes admitted to non-tertiary centres without interventional facilities (55% v 85%).[15] A study in NSW found patients admitted to metropolitan hospitals were more likely to be referred for angiography than patients managed in non-metropolitan hospitals.[19]

In New Zealand, one study showed a significantly reduced rate of referral for investigation and further evaluation at community hospitals compared with tertiary hospitals with interventional facilities.[20] Another New Zealand study showed reduced rates of adherence to medical therapy, referral for angiography and revascularisation in centres without cardiologists.[21] The New Zealand Audit Group concluded that patients admitted to hospitals without interventional facilities in general received fewer investigations and less revascularisation than patients admitted to interventional centres.[22]

The difference in referral rates we observed cannot be attributed to the difference in patient demographics alone. Logistic regression analysis showed that the odds of being referred for angiography are 7.4 times higher at an interventional centre than at a non-interventional centre when adjusted for age, sex, diagnosis and presence of risk factors. We also found men were more likely than women to be referred for angiography. Patients with unstable syndromes were more likely to be referred for angiography than those with simple angina. Patients with hyperlipidaemia were also more likely to be referred for angiography. There was a lower likelihood to refer patients with renal impairment for angiography. With increasing age, the odds of being referred for angiography also decreased. These factors are known to bias physicians in referring patients for angiography.[23-25]

Rates of referral for invasive assessment may have been influenced by the ascertainment of high-risk acute coronary syndromes at non-interventional centres. The reason for the different rates of referral requires further evaluation, but may include access block, significant delays in transfer of patients, reluctance of patients in rural areas to be transferred, or a lack of adherence to or awareness by local physicians of current guidelines. Regardless of the reasons, this represents an area in which the quality of care could be improved.

Another consistent finding was that significant delays are experienced for patients who require CABG compared with those undergoing PCI. The lengths of stay for patients undergoing CABG were higher, which has direct implications for the cost to the health service, and could increase bed access block, especially to high-dependency beds. There is also significant potential to impair outcomes for patients with high-risk syndromes if revascularisation does not occur early in the course of hospitalisation.

Limitations

The limitations of our study include the relatively small numbers of patients enrolled and the uneven distribution of patients across states. The total number of patients presenting to the emergency rooms of the individual centres and their outcomes was not recorded. Only patients admitted to monitored beds were studied. This may bias the study sample. Although data were captured in both tertiary and non-tertiary centres, there was no cohesive tracking of patients between the two systems, so transferred patients were not adequately followed. There is potential for significant referral bias between interventional and non-interventional centres. Our study was not powered to adjust for the multiple con-

founders, especially combined with the low event rate in a cohort that included patients with non-cardiac chest pain. This makes it difficult to draw firm conclusions from the multivariate logistic regression analysis in relation to a comparison of mortality between the two groups. We also acknowledge the limitation of drawing data from case notes and medical records.

ACKNOWLEDGEMENTS

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COMPETING INTERESTS

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