Guideline-discordant care in acute myocardial infarction: predictors and outcomes

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ABSTRACT

Objectives: To determine (i) factors which predict whether patients hospitalised with acute myocardial infarction (AMI) receive care discordant with recommendations of clinical practice guidelines; and (ii) whether such discordant care results in worse outcomes compared with receiving guideline-concordant care.

Design: Retrospective cohort study.

Setting: Two community general hospitals.

Participants: 607 consecutive patients admitted with AMI between July 1997 and December 2000.

Main outcome measures: Clinical predictors of discordant care; crude and risk-adjusted rates of inhospital mortality and reinfarction, and mean length of hospital stay.

Results: At least one treatment recommendation for AMI was applicable for 602 of the 607 patients. Of these patients, 411(68%) received concordant care, and 191 (32%) discordant care. Positive predictors at presentation of discordant care were age > 65 years (odds ratio [OR], 2.5; 95% CI, 1.7–3.6), silent infarction (OR, 2.7; 95% CI, 1.6–4.6), anterior infarction (OR, 2.5; 95% CI, 1.7–3.8), a history of heart failure (OR, 6.3; 95% CI, 3.7–10.7), chronic atrial fibrillation (OR, 3.2; 95% CI, 1.5–6.4); and heart rate ⩾ 100 beats/min (OR, 2.1; 95% CI, 1.4–3.1). Death occurred in 12.0% (23/191) of discordant-care patients versus 4.6% (19/411) of concordant-care patients (adjusted OR, 2.42; 95% CI, 1.22–4.82). Mortality was inversely related to the level of guideline concordance ($P = 0.03$). Reinfarction rates also tended to be higher in the discordant-care group (4.2% v 1.7%; adjusted OR, 2.5; 95% CI, 0.90–7.1).

Conclusions: Certain clinical features at presentation predict a higher likelihood of guideline-discordant care in patients presenting with AMI. Such care appears to increase the risk of inhospital death.

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IMPLEMENTATION of evidence-based clinical practice guidelines is advocated to ensure eligible patients receive care of proven benefit.[1] While use of guidelines improves processes of care in randomised trials, relatively few studies have assessed their effects on patient outcomes;[1] it remains unclear whether patients who receive care discordant with guidelines (guideline-discordant care) have worse outcomes than those whose care concords with guidelines (guideline-concordant care). The few available studies suggest outcomes are worse in the group having guideline-discordant care.[2,3] This has important implications given that patients with acute coronary disease, on the basis of age or other characteristics, do not always receive care that concords with clinical practice guidelines.[4,5]

Acute myocardial infarction (AMI) is a well defined, common condition associated with a significant inhospital mortality rate (up to 14%).[6] Evidence-based clinical practice guidelines provide recommendations regarding the use of thrombolysis, β-blockers, aspirin, angiotensin-converting enzyme (ACE) inhibitors, and calcium antagonists.[7,8] The objectives of our study were to determine (i) clinical factors at presentation which identify patients with AMI who are more likely to receive guideline-discordant care; and (ii) whether such discordant care is associated with worse outcomes than guideline-concordant care.

METHODS

Study population and setting

Potential subjects were consecutive patients with a principal discharge diagnosis of AMI (*International classification of diseases*, 9th revision, clinical modification[9] [ICD-9-CM] code 414) who had been admitted to two community hospitals (a 300-bed public hospital and a 120-bed private hospital) in Ipswich, south-east Queensland, during the period 1 July 1997 to 31 December 2000. Neither institution had on-site cardiologist services or invasive coronary facilities; consultant staff comprised emergency and general physicians.

Subjects were excluded if they had been transferred to a study hospital from another site during the acute episode, or failed to satisfy two of three diagnostic criteria for AMI:

- acute chest pain lasting for 20 minutes or more;
- a rise in serial cardiac enzyme levels to more than twice the upper normal reference range; or
- diagnostic electrocardiographic (ECG) changes of infarction.

If patients had recurrent hospitalisations for AMI during the study period, the first admission only was studied.

During the study period, clinicians within both hospitals were made aware

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of locally developed, evidence-based clinical practice guidelines relating to inhospital AMI care. These guidelines were adapted from those issued in 1996 by the American College of Cardiology (ACC) and the American Heart Association (AHA).[8] Guideline dissemination was coupled with a six-monthly performance feedback, based on clinical audits comparing routine care with guideline recommendations.[10]

Ethical approval

Study methods were approved by the Ipswich Hospital Research Ethics Committee.

Data collection

Nurses who were trained abstractors and were blind to the study objectives abstracted demographic data, clinical presentation, investigation results, treatment processes and outcomes from hospital records of all confirmed cases of AMI within four weeks of discharge. Inter-rater reliability based on reabstraction audits was excellent (κ, 0.85).

Determination of guideline-concordant care

Recommendations from the 1996 ACC/AHA guidelines[8] were used in determining patient eligibility criteria for specific treatments. We chose six key treatment recommendations associated with strong evidence from randomised controlled trials of effects on short-term mortality and recurrent coronary events (Box 1). One recommendation was "negative" in that it stipulated avoidance of a drug class (calcium antagonists) in patients with left ventricular systolic dysfunction.

For each patient, a recommendation concordance score was calculated as shown in Box 1.[2] Applying pre-specified thresholds, patients with a concordance score of ≥ 0.75 were assigned to the guideline-concordant care group and those with a score of < 0.75 to the guideline-discordant care group.

Outcome measures

Study end-points were to

- identify clinical predictors at presentation of discordant care;
- distinguish recommendations associated with low and high discordance frequencies; and
- compare concordant- and discordant-care groups in relation to three outcome variables: rates of inhospital death (primary outcome) and reinfarction, and length of hospital stay.

Statistical methods

Using multivariate regression methods applied to the total cohort, clinical characteristics at presentation were identified as being independent predictors of discordant care, death, reinfarction and extended length of stay. These predictors were then used in calculating adjusted rates for each outcome variable in comparing the discordant- and concordant-care groups. Odds ratios (OR) and 95% CIs were used to determine the statistical significance of χ^2 comparisons of categorical variables, and *t* tests and Mann–Whitney *U* tests were used for comparisons of continuous variables. Correlation of outcome rates with concordance scores was tested using linear methods.

1: Treatment recommendations,[8] eligibility criteria and method for calculating concordance scores for each patient

Treatment recommendations and eligibility criteria (as per 1996 guidelines)[8]

1. Thrombolysis is recommended in:

All patients who present with chest pain lasting more than 20 minutes *and* ECG changes of ST-segment elevation in two or more contiguous chest leads *or* new left bundle branch block.

And who do not have:

Late presentation (>12 hours after symptom onset), recent stroke, recent trauma or cardiopulmonary resuscitation, uncontrolled hypertension, coagulopathy or concurrent warfarin therapy, active peptic ulcer disease, proliferative retinopathy, or patient refusal.

2. Commencement of thrombolysis is recommended within one hour of presentation to hospital

3. β-Blockers are recommended in:

All patients who do not have cardiogenic shock, past or current heart failure, asthma or chronic obstructive lung disease, or clinically significant bradyarrhythmia.

4. Aspirin is recommended in:

All patients who do not have active gastrointestinal bleeding or concurrent warfarin therapy.

5. Angiotensin-converting enzyme (ACE) inhibitors are recommended in:

All patients with past history or current clinical features of congestive heart failure *or* echocardiographic evidence of moderate to severe left ventricular systolic dysfunction.

6. Calcium antagonists should be avoided in:

All patients with past history or current features of congestive heart failure *or* echocardiographic evidence of moderate to severe left ventricular systolic dysfunction.

Method for calculating concordance scores for each patient

Column 1			Column 2		
Does guideline recommendation apply?			***Was recommended treatment given?***		
1. Lysis	Yes	No	If yes, was lysis given?	Yes	No
2. Lysis administration	Yes	No	If yes, was lysis given within one hour?	Yes	No
3. β-Blockers	Yes	No	If yes, were β-blockers given?	Yes	No
4. Aspirin	Yes	No	If yes, was aspirin given?	Yes	No
5. ACE inhibitor	Yes	No	If yes, was ACE inhibitor given?	Yes	No
6. Avoidance of calcium antagonists	Yes	No	If yes, were calcium antagonists NOT given	Yes	No
Number YES: Total (1):____			*Number YES: Total (2):____*		

Calculate concordance score by dividing Total (2) by Total (1)

Concordance score ⩾ 0.75 = Guideline-concordant care

Concordance score < 0.75 = Guideline-discordant care

2: Frequency distribution of applicable treatment recommendations

A. Patients to whom treatment recommendations applied

Number of treatment recommendations applicable	Number (%) of patients (n = 607)	Number (%) of deaths (n = 42)
0	5 (1%)	0 (0)
1	58 (10%)	9 (21%)
2	230 (38%)	10 (24%)
3	165 (27%)	15 (36%)
4	104 (17%)	5 (12%)
5	44 (7%)	3 (7%)
6	1 (< 1%)	0 (0)

B. Treatment recommendations and discordance frequency

Recommendation	Number of eligible patients (% of all patients)	Number of patients having discordant care (% of eligible patients)	Number of deaths (% of patients having discordant care)
Thrombolysis*			
–administration to eligible patients	167 (28%)	1 (< 1%)	0 (0)
–timely administration	167 (28%)	60 (36%)	4 (7%)
β-Blockers	412 (68%)	75 (18%)	7 (9%)
Aspirin	580 (96%)	56 (10%)	8 (14%)
ACE inhibitors	234 (39%)	78 (33%)	13 (17%)
Calcium antagonists (avoidance of)	96 (16%)	30 (31%)	5 (17%)

*Two recommendations were applicable: choice of patients to receive thrombolysis and administration of thrombolysis < 1 hour after hospital presentation.

RESULTS

Recommendation frequency and concordance scores

Of 790 patient records screened, 607 (77%) were found to satisfy the selection criteria. At least one treatment recommendation was applicable in 602 of the 607 patients (99%); the mean number of applicable recommendations per patient was 2.7 (Box 2A). The treatment recommendation which applied most frequently was administration of aspirin, while the least frequent was avoidance of calcium antagonists (Box 2B). The proportion of patients for whom an applicable treatment recommendation was not followed (discordance frequency) was low for thrombolysis administration to eligible patients (1%) and higher for timely administration of thrombolysis (36%), prescribing of ACE inhibitors (33%) and avoidance of calcium antagonists (31%) (Box 2B).

Mortality rates were inversely related to concordance scores grouped as quartiles (correlation coefficient [r] = – 0.969; P = 0.03) and were highest in those subjects with lowest concordance scores (score, < 0.25; 23%), intermediate in near-concordant-care patients (score, > 0.5– < 0.75; 9%), and lowest in those receiving concordant care (score, ⩾ 0.75; 5%) (Box 3). A similar but non-significant trend was noted for reinfarction.

Prevalence and predictors of discordant care

Of the 602 patients to whom recommendations did apply, 411 (68%) were assigned to the concordant-care group, and 191 (32%) to the discordant-care group. Patient characteristics of the two groups are compared in Box 4. Those which positively predicted discordant care at presentation were age > 65 years, silent infarction, anterior infarction, history of heart failure, chronic atrial fibrillation, tachycardia (heart rate, ⩾ 100 beats/min), and previous AMI. Negative predictors included current smoking status, ST-segment-elevation infarction, and previous coronary revascularisation. After fitting regression models, age ⩾ 65 years (OR, 1.7; 95% CI, 1.1–2.6; P = 0.02), anterior infarction (OR, 2.2; 95% CI, 1.4–3.4; P < 0.001), and history of heart failure (OR, 4.1; 95% CI, 2.2–7.6; P < 0.001) remained as independent positive predictors of discordant care.

Comparing group outcomes

There were 42 deaths (6.9%) among the total cohort of 607 patients; none occurred in the five patients to whom no treatment recommendation applied. Of the 602 patients to whom recommendations did apply, crude inhospital mortality rates were 12.0% (23/191) for discordant-care patients versus 4.6% (19/411) for concordant-care patients (OR, 2.8; 95% CI, 1.5–5.3; P = 0.001). There was also a trend towards higher rates of reinfarction in the discordant-care group (4.2% v 1.7%; OR, 2.5; 95% CI, 0.90–7.1; P = 0.07), but no differences in median length of hospital stay (6.0 days for both groups, excluding inhospital deaths).

3: Distribution of scores for concordance with guideline recommendations and relationship to inhospital mortality and reinfarction

	Discordant care			Concordant care	
Group assignment	⩽ 0.25	> 0.25– ⩽ 0.5	> 0.5– < 0.75	⩾ 0.75	Total
Number of patients (% of all patients)	22 (4%)	78 (13%)	91 (15%)	411 (68%)	602 patients
Number of deaths (% of patients in concordance group)	5 (23%)	10 (13%)	8 (9%)	19 (5%)	42 deaths
Number of patients with reinfarction (% of patients in concordance group)	0 (0)	5 (6%)	3 (3%)	7 (2%)	15 reinfarctions

4: Comparison of baseline characteristics of concordant-care and discordant-care patient groups

Characteristic	Concordant care ($n = 411$)	Discordant care ($n = 191$)	Odds ratio* (95% CI)	*P*
Age (mean [SD] years)	64 (13)	72 (13)	2.5 (1.7–3.6) †	<0.001
No. (%) female	105 (26%)	61 (32%)	1.4 (0.94–2.0)	0.11
No. (%) with silent infarction	32 (11%)	36 (25%)	2.7 (1.6–4.6)	<0.001
No. (%) with previous acute myocardial infarction	115 (28%)	69 (36%)	1.5 (1.1–2.1)	0.04
No. (%) with previous revascularisation	52 (13%)	13 (7%)	0.50 (0.27–0.95)	0.03
No. (%) with history of congestive cardiac failure	22 (5%)	50 (26%)	6.3 (3.7–10.7)	<0.001
No. (%) with chronic atrial fibrillation	14 (3%)	19 (10%)	3.2 (1.5–6.4)	0.001
No. (%) current smokers	145 (35%)	36 (19%)	0.43 (0.28–0.65)	<0.001
No. (%) with hypertension	194 (47%)	94 (49%)	1.1 (0.8–1.5)	0.6
No. (%) with hyperlipidaemia	121 (30%)	45 (24%)	0.74 (0.50–1.10)	0.14
No. (%) with diabetes	83 (20%)	50 (26%)	1.4 (0.94–2.1)	0.10
No. of hours from symptom onset to presentation (median, interquartile range)	2.5 (1.4–5.7)	2.8 (1.4–6.7)	na	
Admission pulse rate (mean [SD] beats/min)	83 (26)	89 (25)	2.1 (1.4–3.1)‡	<0.001
Admission systolic blood pressure (mean [SD] mmHg)	144 (38)	149 (80)	1.2 (0.8–1.6)¶	0.4
Admission diastolic blood pressure (mean [SD] mmHg)	83 (19)	81 (21)		
No. (%) with anterior infarct site	94 (23%)	67 (36%)	2.5 (1.7–3.8)	<0.001
No. (%) with ST-segment elevation infarct	172 (42%)	62 (33%)	0.67 (0.47–0.96)	0.03

na = not applicable.
* Odds ratios calculated comparing discordant-care v concordant-care patients.
† Odds ratio calculated using dichotomised variable: <65 and ≥65 years.
‡ Odds ratio calculated using dichotomised variable: <100 and ≥100 beats/min.
¶ Odds ratio calculated using dichotomised variable: <135/70 and ≥135/70 mmHg.

Patient characteristics at presentation which predicted risk of inhospital death were age > 70 years, female sex, silent infarction, previous AMI, history of heart failure, chronic atrial fibrillation, tachycardia, and blood pressure < 130/70 mmHg (positive predictors), and current smoker (negative predictor). After fitting logistic regression models, blood pressure < 130/70 mmHg (OR, 3.2; 95% CI, 1.5–6.7; $P = 0.002$), tachycardia (OR, 2.4; 95% CI, 1.2–4.9; $P = 0.02$) and female sex (OR, 2.2; 95% CI, 1.0–4.8; $P = 0.04$) remained as independent positive risk predictors, with age ≥ 70 years just failing to reach statistical significance (OR, 2.3; 95% CI, 1.0–5.3; $P = 0.06$). After risk adjustment, the odds for inhospital mortality for discordant- versus concordant-care groups remained statistically significant (OR, 2.42; 95% CI, 1.22–4.82; $P = 0.01$). No independent risk predictors were identified for re-infarction.

DISCUSSION

In patients receiving guideline-discordant care, the risk-adjusted rates of death and reinfarction were 2.5 times greater than in those receiving guideline-concordant care. Mortality rates were inversely related to the level of guideline concordance. Outcomes were risk-adjusted using predictors identified from regression analysis applied to all patients. These predictors have been validated in other cohort studies[11,12] and mortality audits.[13]

Predictors of discordant care

Older age predicted discordant care, as also noted in other studies assessing use of thrombolysis,[5,14] β-blockers[4] and ACE inhibitors[15] in eligible elderly patients. Pre-existing heart failure, which is prevalent in older patients (many of whom are female) and in those with previous AMI, and which signifies significant myocardial damage, may engender more conservative management.[16] Equivocal ECG findings or the absence of chest pain as a presenting symptom may temper a more aggressive approach due to diagnostic uncertainty.[17] Chronic atrial fibrillation and tachycardia at presentation often co-exist in older patients with advanced coronary disease.[18] An explanation for the association of anterior infarction with discordant care remains elusive.

Treatments associated with discordant care

In this cohort, only 1% of patients eligible to receive thrombolysis did not receive this treatment, which contrasts with other studies showing a much lower rate of use of thrombolysis, particularly in elderly subjects, women, and patients with silent infarction.[5,19] However, the high discordance frequency for its timely administration may account for a significant fraction of preventable mortality.[20]

The low discordance frequency of 10% for aspirin may reflect its ease of administration and low toxicity. Higher discordance frequencies of 18% and 33% noted with β-blockers and ACE inhibitors, respectively, mirror the underuse of these drugs in unselected populations reported by others.[21,22] Such discordance may reflect clinician uncertainty as to clear indications, as well as concern about possible drug-related adverse events immediately after the acute event.[22] Such concerns appear to be more pronounced in older patients. In contrast, recent research confirms that patients with comorbidities traditionally regarded as contraindications to specific treatments (such as

obstructive lung disease in the case of β-blockers) exhibit higher death rates than those without such comorbidities,[23] and gain greater reductions in absolute risk of death if, in fact, they receive these treatments.[23]

The discordance seen for avoidance of calcium antagonists invites scrutiny given the increased mortality associated with inappropriate use of these drugs in patients with impaired left ventricular systolic function.[24] If left ventricular function is preserved, these drugs can prevent reinfarction in patients with non-ST-segment-elevation infarction,[25] and are frequently used in patients with poorly controlled atrial fibrillation and postinfarction angina, which in our study accounted for 60% of all instances of calcium antagonist administration in patients with left ventricular dysfunction. While trials published since 1996 show new-generation dihydropyridine agents such as amlodipine and felodipine do not worsen prognosis in patients with left ventricular dysfunction,[26,27] this is not the case with first-generation agents such as verapamil and diltiazem,[24] which were used in 25% of patients (and in three of the five who died) receiving calcium antagonists. This emphasises the importance of formulating unambiguous recommendations for high-risk patient groups.

More deaths occurred among patients receiving calcium antagonists (5 of 30, 17%) and among eligible patients who did not receive aspirin (8 of 56, 14%) or ACE inhibitors (13 of 78, 17%) than in those who did not receive timely lysis (4 of 60, 7%) or β-blockers (7 of 75, 9%) (Box 2B). Of the estimated 10% absolute-risk reduction in 30-day mortality after AMI achieved over the past 20 years, a recent analysis concluded that aspirin use accounted for 34% of the decrease, followed by thrombolysis (17%), β-blockers (7%), and ACE inhibitors (3%).[28] In our cohort, all eligible patients received thrombolysis (although delayed in many), and most eligible patients received aspirin (90%), β-blockers (82%) and ACE inhibitors (67%). Nevertheless, the omission of one or more of these therapies appears to significantly increase the risk of early death.

Study limitations

The uncontrolled study design and risk-adjustment methods may not adequately account for unknown or unmeasured confounding factors responsible for the observed differences in outcome between the two patient-care groups. However, for the primary outcome measure of early death, a recent analysis of 2153 patients with confirmed AMI (in whom 250 demographic, clinical and treatment variables were measured) showed three admission characteristics alone (age, heart rate and systolic blood pressure) predicted 30-day mortality with a high level of accuracy (area under the receiver operating characteristics curve of 0.78).[13] These same factors, as well as others, were included in our risk-adjustment models.

Specific treatment recommendations (eg, for β-blockers, ACE inhibitors and specific calcium antagonists) are, on current evidence, restrictive in terms of patient eligibility, but were considered the standard of care during the study period. β-Blockers have been shown to reduce mortality in patients with heart failure,[29] and the use of ACE inhibitors could now be justified in all patients with AMI, not just those with left ventricular dysfunction.[30] We aimed to define those patients in whom the benefit–risk ratio was highest, based on evidence available in 1996.

We did not attempt to ascertain all legitimate clinical reasons as to why guideline recommendations were not followed in seemingly eligible patients, and which may themselves predict a poorer prognosis. However, we adjusted outcome results at the individual patient level for age and various comorbidities likely to be associated with justifiable clinician disinclination to prescribe selected therapies. This contrasts with other studies comparing concordant with discordant care which have not subjected their outcome results to any form of risk adjustment,[2] or have reported outcomes in patients simply stratified according to baseline risk (low, medium and high).[3]

The method for deriving concordance scores, and the choice of 0.75 as the discordant–concordant cut-point, have not been validated as accurate predictors of suboptimal care. Further, the equal weighting of scores (1 or 0) for each recommendation implies equivalent treatment effects on each outcome, which, as discussed above, is not the case.[28] However, the method has face validity, has been used by others,[2] and serves as a starting point for further refinement.

CONCLUSIONS

Failure to provide unselected AMI patients with acute-phase treatments recommended in evidence-based clinical practice guidelines increases the risk of inhospital death and reinfarction. Delays in administration of lysis, underuse of ACE inhibitors, and inappropriate use of calcium antagonists contributed to excess mortality in the patients receiving guideline-discordant care.

Our results strengthen the case for renewed efforts to better understand the barriers to clinician acceptance and adoption of guideline recommendations. In the case of AMI, quality improvement interventions should focus clinician attention on those patient groups identified here as being more likely to receive guideline-discordant care.

COMPETING INTERESTS

None declared.

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book review

Power to the old and arthritic

Live stronger live longer: An exercise and lifestyle program for over 40s. Mark Awerbuch. Sydney: McGraw-Hill, 2001 ($29.95, xviii + 230 pp). ISBN 0 074 71087 7.

THIS IS A TIMELY BOOK on progressive strength training for older people which is made doubly useful because the program can be modified for people with arthritic conditions.

The book is divided into two sections. The first provides a foundation for understanding changes to the body caused by ageing and arthritis. It discusses the impact of these changes on physical and psychological health, and presents the evidence supporting the benefits of strength and cardiovascular fitness training programs. Issues of nutrition and the importance of ensuring an appropriate diet are also discussed. Information is provided in an easy-to-read style, a user-friendly manner, and it is suitable for either health professionals or the interested layperson. A particularly useful chapter focuses on the barriers and motivators to starting and sustaining ongoing participation in exercise programs.

The second section provides a step-by-step framework for conducting a strength and/or cardiovascular fitness training program — the book argues that these programs are complementary. Exercises are simply described, with many photographs. One criticism is that all of the photographs show only two participants, who appear quite fit. To older people, or people with mild to moderate arthritis, the photos may make them think the program is not suitable for them. (The book argues strongly that the program is appropriate for these groups as long as the framework is followed.)

There is a very useful list of contact details on where to find further information (such as Fitness Australia-accredited gymnasiums), and a comprehensive bibliography of recent research in the area of exercise training for older people and people with arthritis.

Overall, the book is a useful text for health practitioners, older people generally, and those with mild arthritic problems. People with more severe arthritis should discuss the issues with their medical practitioner, specialist or physiotherapist before beginning this type of program, as there is a need in this group to closely monitor initial response to exercise to avoid aggravation of joint pain.

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