Multisite, quality-improvement collaboration to optimise cardiac care in Queensland public hospitals

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ABSTRACT

Objective: To evaluate changes in quality of in-hospital care of patients with either acute coronary syndromes (ACS) or congestive heart failure (CHF) admitted to hospitals participating in a multisite quality improvement collaboration.

Design: Before-and-after study of changes in quality indicators measured on representative patient samples between June 2001 and January 2003.

Setting: Nine public hospitals in Queensland.

Study populations: Consecutive or randomly selected patients admitted to study hospitals during the baseline period (June 2001 to January 2002; $n = 807$ for ACS, $n = 357$ for CHF) and post-intervention period (July 2002 to January 2003; $n = 717$ for ACS, $n = 220$ for CHF).

Intervention: Provision of comparative baseline feedback at a facilitative workshop combined with hospital-specific quality-improvement interventions supported by on-site quality officers and a central program management group.

Main outcome measure: Changes in process-of-care indicators between baseline and post-intervention periods.

Results: Compared with baseline, more patients with ACS in the post-intervention period received therapeutic heparin regimens (84% v 72%; $P < 0.001$), angiotensin-converting enzyme inhibitors (64% v 56%; $P = 0.02$), lipid-lowering agents (72% v 62%; $P < 0.001$), early use of coronary angiography (52% v 39%; $P < 0.001$), in-hospital cardiac counselling (65% v 43%; $P < 0.001$), and referral to cardiac rehabilitation (15% v 5%; $P < 0.001$). The numbers of patients with CHF receiving β-blockers also increased (52% v 34%; $P < 0.001$), with fewer patients receiving deleterious agents (13% v 23%; $P = 0.04$). Same-cause 30-day readmission rate decreased from 7.2% to 2.4% ($P = 0.02$) in patients with CHF.

Conclusion: Quality-improvement interventions conducted as multisite collaborations may improve in-hospital care of acute cardiac conditions within relatively short time frames.

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EVIDENCE–PRACTICE GAPS in the care of patients hospitalised with acute coronary syndromes (ACS) and congestive heart failure (CHF) have been identified in Australia[1,2] and overseas.[3] In the United States,[4-8] Canada[9] and the United Kingdom,[10] multihospital quality-improvement programs involving professional experts, hospital clinicians and government agencies have led to significant improvements in one or more processes of care.

We describe the methods and results of a collaboration of Queensland public hospitals involved in optimising care of patients hospitalised with either ACS or CHF.

METHODS

Collaborative development

In mid-2000, Queensland Health established the Collaborative for Healthcare Improvement (CHI) under its Quality Improvement and Enhancement Program to promote improvement of care of specific patient populations within Queensland public hospitals.[11] Under the CHI banner, a Cardiac Collaborative (CHI-CC) was formed which recruited hospitals to target patients admitted with either ACS or CHF.

The collaborative adopted and extended the use of clinical indicators and quality-improvement interventions which had undergone trials in three Brisbane teaching hospitals as part of the federally funded Brisbane Cardiac Consortium Clinical Support Systems Program (CSSP), under the auspices of the Royal Australasian College of Physicians.[12]

Study design and setting

The study was a prospective before-and-after study of the effects of quality-improvement interventions undertaken in nine public hospitals in Queensland.

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The study took place between 27 June 2001 and 28 January 2003.

Study hospitals

Study hospitals comprised three tertiary (Royal Brisbane, Princess Alexandra and Townsville) and six non-tertiary (Queen Elizabeth II, Nambour, Caboolture, Redcliffe, Ipswich and Ingham) institutions. Four of these hospitals had begun CSSP-initiated practice-improvement programs in the 3 months before recruitment into the CHI-CC. These programs targeted both ACS and CHF patients at three hospitals (Royal Brisbane, Princess Alexandra and Queen Elizabeth II) and ACS patients alone at the other hospital (Townsville). These four hospitals were classed as "high-intensity intervention" hospitals, and the others as "low-intensity intervention" hospitals. High-intensity intervention hospitals received, under contract, considerable extra funding to implement multiple interventions systematically over the study period.

Study patients

The target population comprised patients discharged with a clinical diagnosis of ACS or CHF. Quality indicators were measured in a subset of consecutive or randomly selected patients who

- were admitted between 27 June 2001 and 29 January 2002 (baseline period) or between 27 July 2002 and 28 January 2003 (post-intervention period);
- had a coded principal discharge diagnosis of either ACS (ICD-10-AM[13] codes I20.0 or I21.0–I21.9) or CHF (ICD-10-AM[13] codes I50.0–I50.9); and
- satisfied prespecified case definitions for either ACS (dynamic electrocardiograph changes or raised serum cardiac markers [creatine kinase level more than twice, or troponin level more than 1.5 times, normal upper reference range]) or CHF (documented presence of at least two cardinal signs — raised jugulovenous pressure, gallop rhythm, bilateral chest crackles to mid-zone, pedal oedema, or cardiomegaly or pulmonary oedema on chest x-ray).

Based on anticipated lowest rates of admission across all hospitals, each hospital was required to sample a minimum of 50 patients with ACS and 25 with CHF during each measurement period. To avoid oversampling from large tertiary hospitals, sample sizes were limited to 150 patients with ACS and 50 with CHF.

Quality indicators

Quality indicators were based on those developed by the CSSP.[1,2] Briefly, process-of-care indicators were the proportions of all patients, or of highly eligible patients (definite indication and no contraindication), who received specific clinical interventions. Detailed patient eligibility criteria are described elsewhere.[1,2,14] These indicators were derived from evidence-based guidelines released in 2000 and 2001,[15,16] and modified by consensus of an expert panel of cardiologists and general physicians. Outcome indicators were in-hospital mortality rate, mean length of hospital stay, and same-diagnosis readmission rate within 30 days of discharge.

Data collection and analysis

Data for calculating quality indicators were abstracted retrospectively by trained abstractors from hospital records. Variables recorded were patient characteristics, mode of clinical presentation, in-hospital interventions, complications, deaths, medications and investigation results to within 24 hours of discharge or death, and 30-day readmission status.

Data forms were mailed to a central facility and scanned into a database for analysis. Any outlier datasets identified by aggregate data checks were returned to the corresponding hospital for verification. Data quality was verified by reabstraction of randomly selected cases (10%) by independent physicians at each hospital (κ score,[17] >0.7 [good agreement] for all data items).

Quality-improvement interventions

Set-up phase

Late 2000: A lead clinician was appointed to oversee the development of methods of indicator measurement and quality improvement interventions and to recruit lead clinicians from candidate hospitals.

Early 2001: A central program management group was established to oversee data collection and management systems, produce feedback reports for participating hospitals, provide resources and liaise with hospital personnel.

Mid-2001: Quality officers were appointed at each hospital to abstract and submit datasets and facilitate practice innovation in liaison with local lead clinicians.

Program implementation phase

Baseline period: Quality indicators were measured for the period 27 June 2001 to 29 January 2002.

May 2002: A workshop was held in Brisbane on 3 May 2002, at which quality officers and lead clinicians from all hospitals received a personalised feedback packet of information. This comprised interhospital comparisons of quality indicators, sample clinical guidelines, sentinel articles about quality improvement interventions, and a toolkit of resources already in use in CSSP hospitals. Group discussion centred on feedback reports, clinical indicators, methods of data collection, applicability of various quality improvement interventions, and drafting of quality improvement plans for each hospital.

Intervention period: Each site then implemented, at its own discretion, one or more quality improvement interventions (Box 1), targeting its worst-performing indicators.

Post-intervention period: Quality indicators were remeasured for the period 27 July 2002 to 28 January 2003.

February 2003: A second workshop was held on 28 February 2003 to review progress reports, to showcase and discuss locally implemented interventions, and to update indicators.

Outcome measures

The primary measures of effect were changes between baseline and post-intervention periods in condition-specific process-of-care indicators for highly eligible patients and for all patients from all hospitals.

Secondary analyses included:

- differences in process-of-care indicators for all patients grouped according to referral status (tertiary versus non-tertiary) and intensity of quality improve-

1: Frequency of use of quality-improvement interventions by participating hospitals*

Intervention	Hospital type		
	All (*n*=9)	Tertiary (*n*=3)	High-intensity (*n*=4)
Clinical decision support			
Clinical guidelines	7 (78%)	3 (100%)	4 (100%)
Clinical pathways	6 (67%)	3 (100%)	4 (100%)
Checklists, reminders, prompts	7 (78%)	3 (100%)	4 (100%)
Flowcharts, algorithms	8 (89%)	3 (100%)	4 (100%)
Targeted clinician education			
Lectures, presentations	9 (100%)	3 (100%)	4 (100%)
Case-based group discussions	5 (56%)	3 (100%)	4 (100%)
Clinical pharmacist detailing	3 (34%)	2 (67%)	3 (75%)
Use of opinion leaders	7 (78%)	3 (100%)	4 (100%)
Baseline indicator feedback			
Passive dissemination	6 (67%)	3 (100%)	4 (100%)
Active discussion	7 (78%)	2 (67%)	3 (75%)
Patient-directed interventions			
Patient-held medication lists	4 (44%)	2 (67%)	3 (75%)
Individual patient education	4 (44%)	2 (67%)	3 (75%)
Patient self-care techniques	4 (44%)	2 (67%)	3 (75%)
Organisational change (change in work practices or design)	6 (67%)	3 (100%)	4 (100%)

* An intervention was counted if used for management of acute coronary syndromes or congestive heart failure or both.

2: Characteristics of patients sampled in the baseline and post-intervention periods

	Baseline	Post-intervention
Acute coronary syndromes		
Number of patients	807	717
Mean age in years (SD)	68.1 (14.2)	67.3 (13.8)
Sex (number of men)	505 (62.6%)	451 (62.9%)
Previous ACS	322 (39.9%)	316 (44.1%)
Past CHF	84 (10.4%)	70 (9.8%)
Hypertension	408 (50.6%)	382 (53.3%)
Hyperlipidaemia*	278 (34.4%)	307 (42.8%)
Current smoker	206 (25.5%)	171 (23.8%)
Diabetes	193 (23.9%)	177 (24.7%)
Peripheral vascular disease	67 (8.3%)	50 (7.0%)
Chronic atrial fibrillation	41 (5.1%)	53 (7.4%)
Infarction type		
NSTEMI	606 (75.1%)	539 (75.2%)
STEMI	201 (24.9%)	178 (24.8%)
Admission source		
Direct ED presentation	704 (87.2%)	606 (84.5%)
Transfer from other hospital	103 (12.8%)	111 (15.5%)
Congestive heart failure		
Number of patients	357	220
Mean age in years (SD)	76.6 (10.9)	76.9 (11.7)
Sex (number of men)	181 (50.7%)	104 (47.3%)
Previous hospitalisation with CHF*	152 (43.1%)	125 (56.8%)
Underlying cause for CHF†		
Hypertension	205 (57.4%)	122 (55.5%)
Coronary artery disease*	172 (48.2%)*	133 (60.5%)*
Chronic atrial fibrillation	135 (37.8%)	81 (36.8%)
Diabetes	93 (26.1%)	73 (33.2%)
Current smoker	29 (8.1%)	20 (9.1%)
Independent living*	48 (13.4%)*	53 (24.1%)*

ACS = acute coronary syndromes. CHF = congestive heart failure. STEMI = ST-segment elevation myocardial infarction. NSTEMI = non-STEMI. ED = emergency department.
* Statistically significant ($P < 0.05$) difference between baseline and post-intervention groups.
† More than one cause possible, and total more than 100%.

ment intervention (high versus low intensity) of admitting hospitals; and

- differences in outcome indicators (in-hospital death, 30-day same-cause readmissions, and mean length of stay) for all patients and the above subgroups.

Statistical analysis

Patient characteristics and outcome measures were compared using χ^2 test for proportions and t tests for means. For each of the condition-specific process-of-care analyses which involved multiple (≥ 10) comparisons of proportions, a step-down Bonferroni correction was used in adjusting raw P values to correct for type I errors.[18] No adjustment was considered necessary for comparing outcome indicators. A P level < 0.05 was considered significant.

Ethics approval

Study methods were approved by the Medical Quality Program Management Committee, a gazetted quality assurance committee of Queensland Health. Patient data were de-identified, and analysis and reporting used aggregate data.

RESULTS

Patient characteristics

A total of 1524 patients with ACS (baseline, 807; post-intervention, 717) and 577 patients with CHF (baseline, 357; post-intervention, 220) were studied. Patient characteristics for each condition (Box 2) showed no significant differences between periods, except that in the post-intervention period more patients with ACS were recorded as having hyperlipidaemia (43% v 34%; $P < 0.001$) and more with CHF as having prior hospitalisation for CHF (57% v 43%; $P < 0.001$) and being fully dependent on others for care (24% v 13%; $P = 0.001$).

Quality indicators

All hospitals

ACS: Significant increases were seen between the baseline and post-intervention periods in the proportions of highly eligible patients who received therapeutic heparin (89% v 70%; $P < 0.001$) and lipid-lowering agents (84% v 76%;

3: Comparison of process-of-care indicators at baseline and after intervention

Process indicator	Baseline	Post-intervention	*P* (adjusted*)
Acute coronary syndromes			
Thrombolysis			
Highly eligible patients	113/120 (94%)	122/142 (86%)	0.21
All patients	145/807 (18%)	130/717 (18%)	1.00
Time to thrombolysis < 30 minutes			
Patients receiving thrombolysis	42/113 (37%)	45/122 (37%)	1.00
Heparin			
Highly eligible patients	164/233 (70%)	178/201 (89%)	< 0.001
All patients	578/807 (72%)	599/717 (84%)	< 0.001
β-Blockers			
Highly eligible patients	367/462 (79%)	360/437 (82%)	1.00
All patients	572/807 (71%)	545/717 (76%)	0.16
Antiplatelet agents			
Highly eligible patients	655/700 (94%)	592/626 (95%)	1.00
All patients	706/807 (88%)	641/717 (89%)	1.00
ACE inhibitors			
Highly eligible patients	141/198 (71%)	144/179 (80%)	0.24
All patients	451/807 (56%)	457/717 (64%)	0.02
Lipid-lowering agents			
Highly eligible patients	330/436 (76%)	331/393 (84%)	0.03
All patients	496/807 (62%)	513/717 (72%)	< 0.001
In-hospital cardiac counselling			
All patients	347/807 (43%)	463/717 (65%)	<0.001
Outpatient cardiac rehabilitation			
All patients	43/807 (5%)	107/717 (15%)	< 0.001
Early coronary angiography			
Highly eligible patients	84/142 (59%)	124/173 (72%)	0.18
All patients	318/807 (39%)	375/717 (52%)	< 0.001
Non-invasive stress testing			
Highly eligible patients	89/186 (48%)	39/120 (33%)	0.09
All patients	147/807 (18%)	98/717 (14%)	0.20
Congestive heart failure			
Assessment of LV function			
All patients	218/357 (61%)	137/220 (62%)	1.00
ACE inhibitors			
Highly eligible patients	158/210 (75%)	126/168 (75%)	1.00
All patients	244/357 (68%)	151/220 (69%)	1.00
Second-line vasodilators			
Highly eligible patients	4/14 (29%)	12/20 (60%)	0.56
All patients	26/357 (7%)	35/220 (16%)	0.01
β-Blockers			
Highly eligible patients	84/203 (41%)	70/122 (57%)	0.04
All patients	121/357 (34%)	114/220 (52%)	< 0.001
Digoxin			
Highly eligible patients	71/113 (63%)	49/65 (75%)	0.63
All patients	121/357 (34%)	114/220 (52%)	< 0.001
Warfarin			
Highly eligible patients	39/94 (42%)	23/60 (38%)	1.00
All patients	72/357 (20%)	50/220 (23%)	1.00
Deleterious agents			
All patients	82/357 (23%)	29/220 (13%)	0.04

ACE = angiotensin-converting enzyme. LV = left ventricular.
* Adjusted by step-down Bonferroni method.[18] † During admission or within 30 days of discharge.

P = 0.03; Box 3). Significant changes were also seen in the proportions of all patients receiving these treatments as well as angiotensin-converting enzyme (ACE) inhibitors (64% v 56%; *P* = 0.02), early use (during admission or within 30 days of discharge) of coronary angiography (52% v 39%; *P* < 0.001), in-hospital cardiac counselling (65% v 43%; *P* < 0.001), and referral to outpatient cardiac rehabilitation (15% v 5%; *P* < 0.001). There was no change in rates of in-hospital death (4.8% v 4.5%) or 30-day same-cause readmission (5.2% v 4.2%), or in mean length of stay (6.7 days v 6.6 days).

CHF: Significant increases were observed in the proportion of highly eligible patients who received β-blockers (57% v 41%; *P* = 0.04), combined with a decrease in numbers of patients receiving deleterious agents, such as non-steroidal anti-inflammatory drugs or negatively inotropic calcium antagonists (13% v 23%; *P* = 0.04, Box 3). Significant increases were also seen in the proportions of all patients receiving second-line vasodilators (16% v 7%; *P* = 0.01) and digoxin (52% v 34%; *P* < 0.001). Rates of in-hospital death (6.8% v 6.7%) and mean length of stay (8.2 days for both periods) did not change, but 30-day same-cause readmission rates decreased significantly (2.4 % v 7.2%; *P* = 0.02).

Tertiary v non-tertiary hospitals

ACS: Indicators associated with significant all-patient increases across all hospitals also showed significant increases in both tertiary and non-tertiary hospitals, with the exception of ACE inhibitors, for which increases were restricted to non-tertiary hospitals. In the post-intervention period, a higher proportion of patients in tertiary than in non-tertiary hospitals were referred for cardiac rehabilitation (23% [78/337] v 8% [29/380]; *P* < 0.001), while the reverse was true for use of heparin (79% [265/337] v 88% [334/380]; *P* < 0.001).

CHF: Significant post-intervention increases were seen in both patient groups for the same indicators that displayed significant all-patient increases in the all-hospital analysis, with the exception of digoxin. In the

post-intervention period, more patients in tertiary than in non-tertiary hospitals underwent assessment of left ventricular (LV) function (85% [61/72] v 51% [76/148]; $P < 0.001$) and received digoxin (51% [37/72] v 36% [53/148]; $P = 0.01$).

High-intensity v low-intensity hospitals

ACS: The proportions of all patients receiving heparin, lipid-lowering agents, in-hospital cardiac counselling and coronary angiography increased significantly in both hospital groups, while the proportions of patients receiving ACE inhibitors and thrombolysis within 30 minutes increased significantly in low-intensity hospitals only. In the post-intervention period, more patients in high-intensity than in low-intensity intervention hospitals received cardiac counselling (69% [209/303] v 61% [254/414]; $P = 0.01$) and referral to cardiac rehabilitation (29% [87/303] v 5% [20/414]; $P < 0.001$), and fewer patients were readmitted with ACS at 30 days post-discharge (2.1% [6/285] v 5.8% [23/400]; $P = 0.01$).

CHF: In both groups, significant increases were seen in the numbers of patients receiving β-blockers and avoiding deleterious agents. There was a notable reduction in 30-day same-cause readmission rate in low-intensity hospitals, from 6.6% (16/242) to 2.1% (3/140; $P = 0.05$). High-intensity hospitals scored better than low-intensity hospitals with respect to patients receiving β-blockers (64% [46/72] v 46% [68/148]; $P = 0.02$) and undergoing assessment of LV function (86% [62/72] v 51% [75/148]; $P < 0.001$).

DISCUSSION

This study suggests that multihospital collaborations using performance feedback and multifaceted quality improvement interventions accelerate shifts in acute cardiac care towards best practice within relatively short time frames. Significant improvements were seen in nine of 19 process-of-care indicators over an interaudit interval of 6 months. Highest scores for most quality indicators were seen in tertiary hospitals and in those engaged in intensive quality-improvement programs.

However, potential for improvement persists, especially with regard to the timeliness of thrombolysis, provision of in-hospital cardiac counselling, referral to cardiac rehabilitation, and use of non-invasive stress testing to identify reversible ischaemia in patients with ACS, along with objective assessment of left ventricular function and more aggressive use of second-line vasodilators, β-blockers and warfarin in patients with CHF.

Study limitations: The absence of a control group was a limitation of the study. It is possible that improvements in care may reflect general trends rather than intervention effects. Various randomised trials of in-hospital quality improvement programs targeting acute cardiac care have shown similar improvements in both intervention and control patients.[19,20] However, other controlled studies demonstrate better care[4-6] and outcomes[21] for patients subjected to quality-improvement strategies.

We argue that general trends are unlikely to be the sole explanation for the changes in process-of-care indicators seen in this study. Since late 1999, the Global Registry of Acute Coronary Events (GRACE) has collected data about management of ACS from 95 hospitals in 14 countries, including six Australian hospitals located in Bathurst, Sydney, and Melbourne.[22,23] With the exception of heparin use, no process indicators have shown significant variation over time in the Australian hospitals compared with hospitals in other countries.

In the current study, the proportions of highly eligible patients receiving heparin, lipid-lowering agents and coronary angiography increased over 19 months by 19%, 8% and 13%, respectively, compared with no change, 4% and 3% increase in patients reported to GRACE over the 18-month period July 2000 to December 2001[23] (Box 4).

Although similar registry data over time are lacking for patients with CHF, a single large survey of European hospitals from 2001–2002[24] reported overall rates of use of medications similar to those in our baseline patients: second-line vasodilators, 5% v 7%; β-blockers, 37% v 34%; and digoxin, 36% v 34%.

We concede that current research evidence may invalidate eligibility criteria of some of our process-of-care indicators, but all accorded with evidence available in mid-2001. Legitimate but unrecorded reasons for withholding care were not ascertained, but their prevalence is unlikely to have changed markedly between audits.

The applicability of our results may be questioned, as only eight of the 25 major (≥ 200 beds) public hospitals in Queensland participated. However, study hospitals accounted for 40%

4: Percentages of highly eligible patients with acute coronary syndromes who received specific interventions compared between the current study and contemporary registry data

	Global Registry of Acute Coronary Events (GRACE)*				Current study		
Intervention†	Jul–Dec 00 (*n* = 1193)	Jan–Jul 01 (*n* = 1352)	Jul–Dec 01 (*n* = 1088)	% Change (Jul 00–Dec 01)	Jun 01–Jan 02 (*n* = 807)	Jul 02–Jan 03 (*n* = 717)	% Change (Jun 01–Jan 03)
Heparin (%)	72	66	72	0	70	89	19
ACE inhibitors (%)	56	60	64	8	71	80	9
Lipid-lowering agents (%)	53	53	57	4	76	84	8
Coronary angiography (%)	57	56	60	3	59	72	13

ACE = angiotensin-converting enzyme.
* As 75% of patients in our study had non-ST-segment elevation myocardial infarction (NSTEMI), data shown from the GRACE registry[22] are for patients with NSTEMI (percentages based on eligible patients for respective treatments as defined in appendix B, reference 23).
† As there were significant geographic variations in heparin use in the GRACE registry, data shown are for Australia/New Zealand/Canada sites; for all other indicators, there were no significant geographic variations.

(5451/13486) and 34% (1714/5068) of all admissions to Queensland hospitals with a principal discharge diagnosis of ACS or CHF, respectively, in the fiscal year 2000–2001 (Dr Michael Coory, Queensland Health Information Centre, personal communication).

Comparisons with other quality improvement studies: Our post-intervention results for patients with ACS compare well with those reported from other collaborations that used similar methods and included control groups. The proportions of highly eligible patients with ACS receiving ACE inhibitors and early coronary angiography in the post-intervention period were similar to those reported at the conclusion of the GAP (Guidelines Applied to Practice) program in the United States[6] (80% v 86% and 72% v 76%, respectively), while the proportion receiving lipid-lowering agents was higher (84% v 75%).

Implications for practice: This study and others[4-8] suggest that evidence–practice gaps in in-hospital care can be reduced by implementation of quality-improvement interventions. Our collaboration emphasised:

- developing best-practice standards and process-of-care indicators that were evidence-based, expert-endorsed, and agreed by all participants;[25]
- establishing systems for collecting and analysing standardised patient data across multiple sites and for regularly reporting comparative performance data;[26]
- implementing decision support at the point of care,[27] redesigning systems of care, using opinion leaders,[5] and directing resources to improving access to indicated clinical services;[28]
- forming and nurturing interdisciplinary groups that addressed inefficiencies at critical interfaces (eg, between emergency departments and coronary care units);[29] and
- networking of hospitals and sharing of experiences and resources across sites.

Quality of in-hospital care of patients with acute cardiac conditions may be enhanced if admitting hospitals engage in systematic quality-improvement programs which feature feedback of process-based quality indicators combined with decision-support interventions and organisational change. Economies of scale and more rapid change may be achieved if programs are conducted as multisite collaborations with support from government agencies. At the time of publication, another eight major hospitals in Queensland have joined the collaboration during the 12 months since January 2003.

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COMPETING INTERESTS

None identified.

REFERENCES

1. Scott I, Denaro C, Bennett C, et al. Quality of care of patients hospitalised with acute coronary syndromes. *Intern Med J* 2002; 32: 502-511.
2. Scott I, Denaro C, Flores J, et al. Quality of care of patients hospitalised with congestive heart failure. *Intern Med J* 2003; 33: 140-151.
3. Barron H, Michaels A, Maynard C, Every N, for the National Registry of Myocardial Infarction 2 Participants. Use of angiotensin-converting enzyme inhibitors at discharge in patients with acute myocardial infarction in the United States: Data from the NRMI 2. *J Am Coll Cardiol* 1998; 32: 360-367.
4. Marciniak T, Ellerbeck E, Radford J, et al. Improving the quality of care for Medicare patients with acute myocardial infarction: results from the Co-operative Cardiovascular Project. *JAMA* 1998; 279: 1351-1357.
5. Soumerai S, McLaughlin T, Gurwitz J, et al. Effect of local medical opinion leaders on quality of care for acute myocardial infarction: a randomised controlled trial. *JAMA* 1998; 279: 1358-1363.
6. Mehta R, Montoye C, Gallogly M, et al. Improving quality in the care of acute myocardial infarction: the Guidelines Applied to Practice (GAP) Initiative. *JAMA* 2002; 287: 1269-1276.
7. DeLong J, Allman R, Sherrill R, Schliesz N. A congestive heart failure project with measured improvements in care. *Eval Health Prof* 1998; 21: 472-486.
8. Caldwell G, Berg P, Pritchard C, Lewis J. Quality improvement in the diagnosis and treatment of heart failure by participating Indiana and Kentucky hospitals. *Eval Health Prof* 1998; 21: 461-471.
9. Montague T, Taylor L, Martin S, et al. Can practice patterns and outcomes be successfully altered? Examples from cardiovascular medicine. The Clinical Quality Improvement Network (CQIN) Investigators. *Can J Cardiol* 1995; 11: 487-492.
10. Birkhead J. Clinical audit in myocardial infarction: origin and development of the Myocardial Infarction National Audit Project. In: Norris R, editor. Measurement of clinical performance. Practical approaches in acute myocardial infarction. London: Royal College of Physicians, 2001: 71-79.
11. Ward M, Scott I, LaBrooy J, Harden H. An overview of the Collaborative for Healthcare Improvement. Brisbane: Queensland Health, 2002. Available at: www.qheps.health.qld.gov.au/chi/home.htm (accessed Dec 2003).
12. Brisbane Cardiac Consortium Clinical Leadership Group. Brisbane Cardiac Consortium Clinical Support Systems Program - Executive Summary. Brisbane, 2002. Available at: www.health.qld.gov.au/bcc (accessed Jan 2004).
13. National Centre for Classification of Health. The International Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification (ICD-10-AM). Sydney: University of Sydney, 2000.
14. Clinical indicators V6 for the CHI Cardiac Collaborative, 2001. Available at: www.qheps.health.qld.gov.au/chi/home.htm (accessed Dec 2003).
15. Aroney C, Boyden AN, Jelinek MV, et al on behalf of the Unstable Angina Working Group. Management of unstable angina guidelines – 2000. *Med J Aust* 2000; 173 (Suppl): S65-S88.
16. National Heart Foundation of Australia and Cardiac Society of Australia and New Zealand Chronic Heart Failure Clinical Practice Guidelines Writing Panel. Guidelines for management of patients with chronic heart failure in Australia. *Med J Aust* 2001; 174: 459-466.
17. Landis J, Koch G. The measurement of observer agreement for categorical data. *Biometrics* 1977; 33: 159-174.
18. Hochberg Y. A sharper Bonferroni procedure for multiple tests of significance. *Biometrika* 1988; 75: 800-802.
19. Heller R, D'Este C, Lim L, et al. Randomised controlled trial to change the hospital management of unstable angina. *Med J Aust* 2001; 174: 217-221.
20. Philbin E, Rocco T, Lindenmuth N, et al. The results of a randomized trial of a quality improvement intervention in the care of patients with heart failure. *Am J Med* 2000; 109: 443-449.
21. Scott I, Coory M, Harper C. The effects of quality improvement interventions on inhospital mortality after acute myocardial infarction. *Med J Aust* 2001; 175: 465-470.
22. The GRACE Investigators. Rationale and design of the GRACE (Global Registry of Acute Coronary Events) Project: a multinational registry of patients hospitalised with acute coronary syndromes. *Am Heart J* 2001; 141: 190-199.
23. Fox KAA, Goodman SG, Anderson FA, et al, on behalf of the GRACE Investigators. From guidelines to clinical practice: the impact of hospital and geographical characteristics on temporal trends in the management of acute coronary syndromes. *Eur Heart J* 2003; 24: 1414-1424.
24. The Study Group of Diagnosis of the Working Group on Heart Failure of the European Society of Cardiology. The EuroHeart Failure Survey programme – a survey on the quality of care among patients with heart failure in Europe. Part 2: treatment. *Eur Heart J* 2003; 24: 464-474.
25. Mant J, Hicks N. Detecting differences in quality of care: the sensitivity of measures of process and outcome in treating acute myocardial infarction. *BMJ* 1995; 311: 793-796.
26. Mannion R, Davies H. Reporting health care performance: learning from the past, prospects for the future. *J Eval Clin Practice* 2002; 8: 215-228.
27. Weingarten S. Translating practice guidelines into patient care. Guidelines at the bedside. *Chest* 2000; 118: 4S-7S.
28. Bradley E, Holmboe E, Mattera J, et al. The roles of senior management in quality improvement efforts: what are the key components? *J Healthc Manag* 2003; 48: 15-28; discussion 29.
29. McNicol M, Layton A, Morgan G. Team working: the key to implementing guidelines. *Qual Health Care* 1993; 2: 215-216.

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