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Effects of comorbidity and hospital care on 6-month mortality in patients with elevated cardiac troponin T

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Objective: To examine the effects of comorbidity and hospital care on mortality in patients with elevated cardiac troponin T.
Design: Observational study.
Setting: A large university hospital with on-site diagnostic cardiac catheter laboratory.
Patients: All hospitalised patients with elevated cardiac troponin T level (≥0.01 μg/l) over an 8-week period.
Main outcome measures: 6-month all-cause mortality.
Results: Among 313 patients with elevated cardiac troponin T, 195 had acute coronary syndrome and 118 had other conditions. Multivariate analysis showed that among patients with acute coronary syndrome, increasing comorbidity score (odds ratio (OR) 1.23 per point increase, 95% confidence interval (CI) 1.00 to 1.51; p = 0.048), age (OR 1.08 per year, 95% CI 1.04 to 1.13; p<0.001), raised troponin T level (OR 2.22 per 10-fold increase, 95% CI 1.27 to 3.89; p = 0.005), and ST depression (OR 3.12, 95% CI 1.38 to 7.03; p = 0.006) were independent adverse predictors, while cardiologist care (OR 0.22, 95% CI 0.09 to 0.51; p<0.001) was associated with a better survival. Increasing troponin T level (OR 3.33 per 10-fold increase, 95% CI 1.24 to 8.91; p = 0.017) was found to predict a worse prognosis among patients without acute coronary syndrome, and cardiologist care did not affect outcome in this group. Among hospital survivors with acute coronary syndrome, increasing comorbidity score, age and a lack of cardiologist care were independently associated with lesser use of effective medications.
Conclusions: Comorbidity was associated with a higher 6-month mortality in patients having acute coronary syndrome, and lesser use of effective medicines among hospital survivors. Cardiologist care was associated with better 6-month survival in patients with acute coronary syndrome, but not in those without acute coronary syndrome.

Prognostic indices including the original Charlson's comorbidity index[1] have shown that comorbidity was important in determining the short and long term outcome in patients with various medical conditions, including those with acute myocardial infarction.[2–5] Among patients admitted to hospital with suspected acute coronary syndrome, an abnormally raised cardiac troponin level can be found in patients with, and also without, acute coronary syndrome.[6 7] An increasing cardiac troponin level was associated with increasing mortality in patients with acute coronary syndrome,[8] and also those without acute coronary syndrome.[9] Despite the availability of international management guidelines, care provided for patients with acute coronary syndrome varied in hospitals with or without interventional facilities, and was affected by whether patients received cardiologist care.[10] We examine the effects of comorbid diseases, including a validated comorbidity index,[11] and hospital care on the 6-month outcome among patients with elevated cardiac troponin T, caused by acute coronary syndrome and other conditions.

METHODS

Consecutive patients admitted to a large university hospital over an 8-week period between 5 January and 29 February 2004 with elevated troponin T (≥0.01 μg/l) were included in the study. Study protocol was prospectively written and approved by the Sefton Local Research Ethics Committee. Troponin T blood test was requested by the admitting physicians when the patients were suspected of having acute coronary syndrome, and their decision for measuring troponin T was not influenced by this study. Serum troponin T was routinely measured at 12 h from symptom onset in accordance with a hospital wide policy. Patients with elevated troponin T were identified by reviewing the hospital admission register, and the troponin T blood results list. Data were abstracted from medical records and the primary diagnosis was determined from the medical records and independently from the level of troponin T elevation. Acute coronary syndrome comprised ST segment elevation myocardial infarction (STEMI), and non-ST segment elevation acute coronary syndrome (NSTEACS). The diagnosis of acute coronary syndrome was made in the presence of ischaemic cardiac symptoms and/or electrocardiographic changes indicative of acute ischaemia. The diagnosis of other conditions associated with elevated troponin T was confirmed by two independent reviews (SM, AR, AD), and required the absence of these acute coronary syndrome characteristics together with a clinical picture of an alternative diagnosis. Any disagreement with the primary diagnosis required a further review (PW).

Comorbidity data were collected according to Charlson's method[1] (see appendix). Charlson's comorbidity score was a weighted index which summed up the individual score according to the presence or absence of 19 pre-specified medical conditions. A higher score indicated a greater number and/or seriousness of medical conditions present, and was associated with a higher mortality. In our analysis of comorbidities, we grouped hemiplegia with cerebrovascular disease, diabetes mellitus with and without end organ disease,

Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; GRACE, Global Registry of Acute Coronary Events; MINAP, Myocardial Infarction National Audit Project; NSTEACS, non-ST segment elevation acute coronary syndrome; STEMI, ST segment elevation myocardial infarction; TIMI, Thrombolysis in Myocardial Infarction

mild and moderate with severe liver disease, and any tumour with leukaemia. Six-month hospital re-admissions and all-cause mortality data were complete in all patients.

The degree of cardiologist care was determined in all patients. Patients were regarded as receiving ''direct'' cardiologist care when their care was transferred to a cardiologist after admission through the accident and emergency department or the medical admissions unit. Those patients who were subsequently referred by other physicians to a cardiologist after admission received ''referred'' cardiologist care. The continuing care of these patients was either transferred to the cardiologist, or remained with the other physicians after cardiologist consultation. Patients who have never seen a cardiologist during their hospital admission were regarded as receiving ''no'' cardiologist care.

Statistical analysis using χ^2 test for comparing categorical variables, Student's t test for comparing group means, and Mann Whitney U test for comparing group medians were performed where appropriate. Spearman rank correlation was used to investigate the relationship between age and comorbidity score. The effects of troponin T and peak creatine kinase on clinical outcome were investigated by logarithmic transformation ($\log_{10}$) of their values. Logistic regression was performed in two steps to investigate prognostic factors affecting 6-month mortality. Step 1: univariate analysis of baseline comorbid diseases (angina, myocardial infarction, coronary revascularisation, congestive cardiac failure, hypertension, diabetes mellitus with or without end organ disease, cerebrovascular disease with or without hemiplegia, peripheral vascular disease, treated hyperlipidaemia, asthma or chronic obstructive pulmonary disease, current smoker, dementia, connective tissue disease, peptic ulcer disease, any liver disease, moderate or severe renal disease, any tumour or leukaemia, metastatic solid tumour), age, and sex among patients with and without acute coronary syndrome. Significant univariate variables and age were subjected to multivariate analysis (backward stepwise method). Step 2: using a weighted comorbidity score, age, and event related factors (ST elevation, ST depression, T wave inversion, bundle branch block, troponin T, peak creatine kinase, and cardiologist care), the prognostic effect of these univariate variables among patients with and without acute coronary syndrome were examined. Significant univariate variables and age were further analysed by multivariate analysis. The discriminative power of the multivariate models in predicting 6-month mortality was assessed by the area under the receiver operating characteristic curve (c statistic). Further multivariate analysis was used to investigate the effects of comorbidity score, age and cardiologist care in medication usage among hospital survivors with acute coronary syndrome. Statistical tests were carried out using SPSS for Windows computer software version 13.5.

RESULTS

During the study period, 313 patients were found to have elevated cardiac troponin T (≥0.01 μg/l), of which 195 had acute coronary syndrome and 118 had other conditions. Of these 313 patients, 70 (22%) had no comorbid disease (comorbidity score 0), 183 (58%) had score of 1–3, and 60 (19%) had score of ≥4. Six-month mortality for these groups were 20%, 32%, and 53% respectively ($p = 0.001$).

Baseline characteristics, comorbidity, hospital care and outcome in patients with, and without acute coronary syndrome (table 1)

Patients with and without acute coronary syndrome were of similar age (73 vs 75 years; p = NS). Patients with acute coronary syndrome were less likely to be women (42% vs 59%; $p = 0.005$), have a history of congestive cardiac failure (10% vs 25%; $p<0.001$), suffer from any tumour or leukaemia (6% vs 14%; $p = 0.008$), and more likely to have a lower comorbidity score (median 1 vs 2; $p = 0.006$) than those without acute coronary syndrome. Patients with acute coronary syndrome were more likely to have ST segment deviation on their electrocardiogram ($p<0.001$), and higher cardiac troponin T ($p<0.001$) and peak creatine kinase ($p<0.001$) than those without acute coronary syndrome. In-hospital (18% vs 36%; $p<0.001$) and 6-month mortality (29% vs 42%; $p = 0.020$) were lower among patients with acute coronary syndrome than those without acute coronary syndrome.

Among patients with acute coronary syndrome, 150 had NSTEACS and 45 had STEMI (ratio 3.3:1). In-hospital (21% vs 11%; p = NS) and 6-month mortality (33% vs 13%; $p = 0.009$) were higher in patients with NSTEACS than STEMI. Of these 195 patients, 103 (53%) received ''direct'' cardiologist care, and a further 37 (19%) received ''referred'' cardiologist care after being referred by other physicians. Forty-five patients were considered for invasive coronary management during their index admission. Selection criteria for the 37 patients with NSTEACS were based on their acute coronary syndrome risk score as calculated from the local risk stratification guidelines,[12] and 8 patients with STEMI had recurrent ischaemic events. Of the remaining 150 patients, 64 (43%) were documented to be unsuitable for such invasive coronary management (58 serious comorbid diseases, 3 patient refusal, 3 others). Cardiac catheterisation was performed in 44 patients (35 index admission), of which 20 received percutaneous coronary intervention (13 index admission), 13 coronary artery bypass grafting (3 index admission), and 1 implantable defibrillator (index admission). In-hospital (2% vs 23%; $p = 0.001$) and 6-month (2% vs 37%; $p<0.001$) mortality were lower among patients who were considered for invasive management than those managed conservatively.

Logistic regression in the prognostic factors affecting 6-month mortality and discriminative power of the multivariate models (table 2)

Multivariate analysis using baseline comorbid diseases and age showed that congestive cardiac failure (odds ratio (OR) 3.48, 95% confidence interval (CI) 1.22 to 9.92; $p = 0.020$), metastatic cancer (OR 7.39, 95% CI 1.33 to 41.2; $p = 0.022$), and older age (OR 1.08 per year, 95% CI 1.04 to 1.12; $p<0.001$) were associated with a higher 6-month mortality in patients with acute coronary syndrome. Among patients without acute coronary syndrome, those with pre-existing asthma or chronic obstructive pulmonary disease had a better survival (OR 0.25, 95% CI 0.08 to 0.79; $p = 0.018$).

Using a weighted comorbidity score, age, and event related variables, we found that higher comorbidity score (OR 1.23 per point increase; 95% CI 1.00 to 1.51; $p = 0.048$), older age (OR 1.08 per year, 95% CI 1.04 to 1.13; $p<0.001$), ST depression (OR 3.12, 95% CI 1.38 to 7.03; $p = 0.006$), and increasing troponin T level (OR 2.22 per 10-fold increase, 95% CI 1.27 to 3.89; $p = 0.005$) were independently associated with a higher 6-month mortality in patients with acute coronary syndrome. Conversely, cardiologist care (OR 0.22, 95% CI 0.09 to 0.51; $p<0.001$) was associated with a lower 6-month mortality. In patients without acute coronary syndrome, increasing troponin T level (OR 3.33 per 10-fold increase, 95% CI 1.24 to 8.91; $p = 0.017$) was associated with an adverse outcome.

The discriminative power of the multivariate models in predicting 6-month mortality (c statistic) using (a) age and comorbid diseases; (b) age, comorbidity score and event related risk indicators were: 0.75, 0.84 for patients with acute coronary syndrome; and 0.69, 0.64 for those without acute coronary syndrome, respectively.

Table 1 Baseline characteristics, comorbidity, hospital care and outcome in patients with and without acute coronary syndrome

	ACS (n = 195)	Non-ACS (n = 118)	p Value
Age, mean (SD) years	73 (13)	75 (12)	NS
Female	82 (42%)	69 (59%)	0.005
Charlson's comorbidity score: median (25; 75th centiles)	1 (1; 3)	2 (1; 3)	0.006
Charlson's comorbid diseases			
Myocardial infarction	66 (34%)	29 (25%)	NS
Congestive cardiac failure	19 (10%)	29 (25%)	<0.001
Cerebrovascular disease including hemiplegia	36 (19%)	25 (21%)	NS
Peripheral vascular disease	14 (7%)	5 (4%)	NS
Chronic obstructive airway disease	43 (22%)	25 (21%)	NS
Diabetes mellitus ± end organ disease	36 (19%)	28 (24%)	NS
Renal disease (moderate or severe)	10 (5%)	12 (10%)	NS
Peptic ulcer disease	7 (4%)	3 (3%)	NS
Connective tissue disease	2 (1%)	1 (1%)	NS
Liver disease (mild, moderate or severe)	5 (3%)	7 (6%)	NS
Dementia	13 (7%)	14 (12%)	NS
Any tumour or leukaemia	11(6%)	17 (14%)	0.008
Metastatic solid tumour	7 (4%)	5 (4%)	NS
ECG and cardiac markers*			
ST elevation	45 (23%)	2 (2%)	<0.001
ST depression	52 (27%)	6 (5%)	<0.001
Bundle branch block	19 (10%)	18 (15%)	NS
Troponin T (μg/l) 50th (25th; 75th centiles)	0.34 (0.09; 1.51)	0.05 (0.03; 0.08)	<0.001
Peak creatine kinase (iu/l) 50th (25th; 75th centiles)	284 (110; 787)	115 (62; 216)	<0.001
Hospital care			
Direct cardiologist care	103 (53%)	19 (16%)	<0.001
Direct or referred cardiologist care	140 (72%)	29 (25%)	<0.001
Considered for coronary angiography	45 (24%)	0 (0%)	<0.001
Mortality			
In-hospital	36 (18%)	43 (36%)	<0.001
6-month	56 (29%)	49 (42%)	0.020

ACS, acute coronary syndrome; NS, non-significant.
*ECG unavailable in 4 non-ACS patients.

Clinical characteristics and outcome of patients with acute coronary syndrome who received ''direct'', ''referred'' or ''no'' cardiologist care (table 3)

As cardiologist care was associated with a better outcome, we examined for any potential mechanisms that could explain the observed difference. Patients who received ''direct'' or ''referred'' cardiologist care were younger (71 vs 79 years; p<0.001), less likely to be women (36% vs 56%; p = 0.011), and had a lower comorbidity score (median 1 vs 3; p<0.001) than those who received ''no'' cardiologist care. These patients were less likely to have a history of cerebrovascular disease including hemiplegia (13% vs 33%; p = 0.001), diabetes with or without end organ damage (15% vs 27%; p = 0.047), tumour or leukaemia (1% vs 18%; p<0.001), metastatic cancer (1% vs 9%; p = 0.020), or congestive cardiac failure (7% vs 16%; p = 0.051). Furthermore, patients who received cardiologist care were more likely to have ST elevation (30% vs 5%; p<0.001), but more patients with ST depression did not receive cardiologist care (21% vs 40%; p = 0.008). A third of patients who received cardiologist care were considered for invasive coronary management during their index admission, compared with none of the patients who were managed solely by other physicians (32% vs 0%; p<0.001). Despite having a higher acute coronary syndrome risk as indicated by a higher troponin T level (median 0.53 vs 0.10 μg/l; p<0.001), patients who received cardiologist care had a lower in-hospital (11% vs 38%; p<0.001) and 6-month (18% vs 56%; p<0.001) mortality than those managed solely by other physicians.

Comparing patients who received ''referred'' and ''direct'' cardiologist care, those patients referred by other physicians to the cardiologist were older (75 vs 69 years; p = 0.019) and had a higher comorbidity score (2 vs 1; p = 0.001). The proportion of patients who were considered for invasive coronary management was similar in both groups (38% vs 30%; p = NS).

Table 2 Logistic regression in the prognostic factors affecting 6-month mortality and discriminative power of the multivariate models

ACS (n = 195)	OR (95% CI)	p Value	Non-ACS (n = 118)	OR (95% CI)	p Value
Age and comorbid diseases					
Age	1.08 (1.04 to 1.12)	<0.001	Age	1.02 (0.99 to 1.06)	NS
Congestive cardiac failure	3.48 (1.22 to 9.92)	0.020	Liver disease	8.16 (0.93 to 71.7)	0.058
Metastatic cancer	7.39 (1.33 to 41.2)	0.022	Asthma/COPD	0.25 (0.08 to 0.79)	0.018
c statistics	0.75			0.69	
Age, comorbidity score and event related risk indicators					
Age	1.08 (1.04 to 1.13)	<0.001	Age	1.02 (0.99 to 1.06)	NS
Comorbidity score	1.23 (1.00 to 1.51)	0.048	Comorbidity score	1.08 (0.89 to 1.31)	NS
Troponin T	2.22 (1.27 to 3.89)	0.005	Troponin T	3.33 (1.24 to 8.91)	0.017
ST depression	3.12 (1.38 to 7.03)	0.006			
Cardiologist care	0.22 (0.09 to 0.51)	<0.001			
c statistics	0.84			0.64	

ACS, acute coronary syndrome; CI, confidence interval; COPD, chronic obstructive pulmonary disease; OR, odds ratio.

Table 3 Clinical characteristics and outcome of patients with acute coronary syndrome who received ''direct'', ''referred'' or ''no'' cardiologist care

	Cardiologist care				
	Direct (D) (n = 103)	Referred (R) (n = 37)	D + R (n = 140)	None (n = 55)	p Value
Age, mean years (SD)	69 (13)	75 (11)	71 (13)	79 (9)	<0.001
Female	36 (35%)	15 (41%)	51 (36%)	31 (56%)	0.011
Charlson's comorbidity score median (25; 75th centiles)	1 (0; 2)	2 (1; 2.5)	1 (0; 2)	3 (1; 4)	<0.001
Comorbid diseases					
Myocardial infarction	35 (34%)	14 (38%)	49 (35%)	17 (31%)	NS
Congestive cardiac failure	6 (6%)	4 (11%)	10 (7%)	9 (16%)	0.051
CVA including hemiplegia	12 (12%)	6 (16%)	18 (13%)	18 (33%)	0.001
Peripheral vascular disease	5 (5%)	6 (16%)	11 (8%)	3 (5%)	NS
COPD	21 (20%)	10 (27%)	31 (22%)	12 (22%)	NS
Diabetes mellitus ± end organ disease	17 (17%)	4 (11%)	21 (15%)	15 (27%)	0.047
Renal disease (moderate or severe)	2 (2%)	4 (11%)	6 (4%)	4 (7%)	NS
Peptic ulcer disease	3 (3%)	2 (5%)	5 (4%)	2 (4%)	NS
Connective tissue disease	0 (0%)	1 (3%)	1 (1%)	1 (2%)	NS
Liver disease (any grade)	3 (3%)	0 (0%)	3 (2%)	2 (4%)	NS
Dementia	4 (4%)	4 (11%)	8 (6%)	5 (9%)	NS
Any tumour or leukaemia	0 (0%)	1 (3%)	1 (1%)	10 (18%)	<0.001
Metastatic solid tumour	1 (1%)	1 (3%)	2 (1%)	5 (9%)	0.020
Presenting ECG and cardiac markers					
ST elevation	36 (35%)	6 (16%)	42 (30%)	3 (5%)	<0.001
ST depression	24 (23%)	6 (16%)	30 (21%)	22 (40%)	0.008
Bundle branch block	7 (7%)	7 (19%)	14 (10%)	5 (9%)	NS
Troponin T (μg/l), median	0.73	0.29	0.53	0.10	<0.001
Peak CK (iu/l), median	380	228	356	142	<0.001
Considered for coronary angiography	31 (30%)	14 (38%)	45 (32%)	0 (0%)	<0.001
All-cause mortality					
In-hospital	10 (10%)	5 (14%)	15 (11%)	21 (38%)	<0.001
6-month	16 (16%)	9 (24%)	25 (18%)	31 (56%)	<0.001

CK, creatine kinase; COPD; chronic obstructive pulmonary disease; CVA, cerebrovascular accident; ECG, electrocardiogram; NS, non-significant;
All p values are expressed as direct and referred cardiologist care versus no cardiologist care.

Effects of comorbidity and cardiologist care in medication usage among hospital survivors with acute coronary syndrome (tables 4 and 5)

Increasing comorbidity score was associated with: older age (p<0.001); a lesser chance to receive cardiologist care (p<0.001); lower use of aspirin (p<0.001), any antithrombotic (p = 0.024), β-blocker (p<0.001), angiotensin-converting enzyme (ACE) inhibitor and/or angiotensin receptor blocker (ARB) (p<0.001), and lipid lowering medications (p<0.001); and increasing mortality after hospital discharge (p<0.001). Multivariate analysis showed increasing comorbidity score was associated with a lower usage of aspirin (OR 0.78, 95% CI 0.63 to 0.95; p = 0.016), β-blocker (OR 0.65, 95% CI 0.50 to 0.85; p = 0.001), ACE inhibitor and/or ARB (OR 0.72, 95% CI 0.57 to 0.90; p = 0.005), and lipid lowering (OR 0.81, 95% CI 0.65 to 1.01; p = 0.058) treatment, and were independent of age and cardiologist care. Conversely, cardiologist care was associated with a higher usage of β-blocker (OR 3.42, 95% CI 1.20 to 9.73; p = 0.021), ACE inhibitor and/or ARB (OR 2.60, 95% CI 1.03 to 6.52; p = 0.042), and lipid lowering (OR 3.85, 95% CI 1.54 to 9.63; p = 0.004) medications.

Table 4 Effect of age, comorbidity score and cardiologist care in the use of cardiac medications among hospital survivors with acute coronary syndrome (n = 159)

	Comorbidity score			
	0 (n = 43)	1–3 (n = 91)	⩾4 (n = 25)	p Value
Age, mean (SD) years	64 (14)	75 (12)	77 (9)	<0.001
Cardiologist care	41 (95%)	72 (79%)	11 (44%)	<0.001
Aspirin	37 (86%)	55 (60%)	10 (40%)	<0.001
Anti-thrombotic	40 (93%)	80 (88%)	17 (68%)	0.024
β-blocker	32 (74%)	48 (53%)	3 (12%)	<0.001
ACEI and/or ARB	34 (79%)	55 (60%)	7 (28%)	<0.001
Lipid lowering	38 (88%)	71 (78%)	9 (36%)	<0.001
6-month mortality	1 (2%)	9 (10%)	10 (40%)	<0.001

ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker.

DISCUSSION

Among our patients with acute coronary syndrome, a history of congestive cardiac failure or metastatic cancer, higher comorbidity score and older age were independent adverse baseline prognostic factors in predicting 6-month mortality. An increasing troponin T level and presence of ST depression, which represented higher level of risk and type of acute coronary syndrome, were significant adverse event related prognostic factors. Cardiologist care was associated with a better 6-month survival.

Comorbidity is an important confounder which affects management decision and clinical outcome. We investigated the effects of comorbidity by a validated comorbidity score,[11] as well as by individual comorbid diseases. An increasing comorbidity score, which indicated an escalating level of comorbidity, was associated with a higher 6-month mortality in patients with acute coronary syndrome, and a lower usage of aspirin, β-blocker and ACE inhibitor and/or ARB among hospital survivors. Moreover, individual comorbid diseases like congestive cardiac failure[13] and metastatic cancer[14] were associated with a worse 6-month outcome in patients with acute coronary syndrome. Using our logistic regression model in table 2, we estimated the expected number of deaths if all acute coronary syndrome patients had a comorbidity score of 0, and found 12 of the 56 deaths (21%) could be attributed to comorbidity. Since Charlson's original work, various adaptations of this and other indices using a broadened range of comorbid diseases have been shown to predict mortality among patients with different medical conditions.[2 3 5] Common to

Table 5 Multivariate logistic regression on the effect of age, comorbidity score, and cardiologist care in the use of medications among hospital survivors with acute coronary syndrome (n = 159)

	Aspirin		Anti-thrombotic		β-blocker		ACEI ± ARB		Lipid lowering	
	OR (95% CI)	p Value	OR (95% CI)	p Value	OR (95% CI)	p Value	OR (95% CI)	p Value	OR (95% CI)	p Value
Age	0.95 (0.92 to 0.99)	0.004	0.98 (0.94 to 1.02)	NS	0.97 (0.94 to 0.99)	0.028	0.96 (0.93 to 0.99)	0.026	0.93 (0.89 to 0.97)	0.002
Comorbidity score	0.78 (0.63 to 0.95)	0.016	0.83 (0.66 to 1.04)	NS	0.65 (0.50 to 0.85)	0.001	0.72 (0.57 to 0.90)	0.005	0.81 (0.65 to 1.01)	0.058
Cardiologist care	0.60 (0.24 to 1.49)	NS	1.45 (0.49 to 4.27)	NS	3.42 (1.20 to 9.73)	0.021	2.60 (1.03 to 6.52)	0.042	3.85 (1.54 to 9.63)	0.004

ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CI, confidence interval; OR, odds ratio.
Cardiologist care = "direct" or "referred" cardiologist care.

these prognostic indices, important event related risk factors were not included as part of the index. The TIMI (Thrombolysis in Myocardial Infarction) and GRACE (Global Registry of Acute Coronary Events) risk scores were important tools in determining management and prognosis of patients with acute coronary syndrome, but the components of these risk scores comprised mainly event related risk factors.[15–17]

A recent MINAP (Myocardial Infarction National Audit Project) study reported that patients with acute coronary syndrome who received cardiologist care was associated with a better survival, and were more likely to receive effective medicines and invasive coronary management.[10] The extent of cardiologist care received by patients, and the mechanisms to explain the observed differences, were not entirely clear. Our cohort represented all hospitalised cases of acute coronary syndrome with a raised cardiac troponin T level. Our hospital admission policy followed the specialty triage model,[18] whereby patients were assessed in the accident and emergency department and the medical admissions unit, and the most appropriate specialty beds for admissions were made according to the diagnosis and bed availability. Cardiologists shared the acute unselected medical take with other specialty physicians, and there were no age or comorbidity restrictions in admitting patients to cardiology beds. The degree of cardiologist involvement in our cohort could be determined as 53% of patients were transferred directly to a cardiologist, after admission through the accident and emergency department or medical admissions unit. A further 19% of patients received cardiologist care after being referred by other physicians. Patients who were managed solely by other physicians were much older, more likely to be women, and had a significantly higher comorbidity score with excess stroke, diabetes, malignancy, and congestive cardiac failure than those who received cardiologist care. Only patients who received cardiologist care were considered for invasive coronary management during their index admission, and this proportion was not different between those who received "direct" or "referred" cardiologist care. Our findings suggested that other physicians referred patients who were likely to benefit from further cardiologist care, despite older age and higher comorbidity score. In addition to invasive coronary management, our patients who received cardiologist care were significantly more likely to receive β-blocker, ACE inhibitor and/or ARB, and lipid lowering therapy after accounting for age and comorbidity score. Use of effective medicines and coronary intervention have been found to be effective in reducing mortality.[19–21] From our study, increasing level of comorbidity, age and ST depression were associated with a smaller troponin rise, lower likelihood of receiving cardiologist care or effective medicines, and not being considered for invasive coronary management, which translated into a higher 6-month mortality. Whether patients received cardiologist or other physician care, comorbidity remained independently associated with an adverse outcome.

Among patients without acute coronary syndrome, increasing troponin T level was an independent predictor for a higher in-hospital and 6-month mortality.[9] Patients without acute coronary syndrome represented a sizeable one-third of our cohort and their 6-month outcome was not affected by cardiologist care. More effective treatment strategy is needed to improve the outcome of these patients.

The National Service Framework for coronary heart disease recommends that all hospitals should have a hospital-wide policy for managing patients with acute myocardial infarction, including access to cardiologist care.[22] Our findings and others[10] suggest that patients with acute coronary syndrome should be ideally managed by cardiologists. This management approach requires a sufficient number of cardiologists in each acute

Main points

- Comorbidity independently predicts higher 6-month mortality among patients with acute coronary syndrome, and lesser use of effective medicines among these hospital survivors.
- Cardiologist care is associated with a better outcome in patients with acute coronary syndrome, but not in those with other conditions.
- Physicians should refer all suitable patients with acute coronary syndrome to the cardiologists for consideration of invasive management, and consider effective medicines in all patients.
- Invasive coronary management should be considered and preferably implemented during the index admission in patients with troponin positive non-ST segment elevation acute coronary syndrome.

hospital to look after an increasing number of patients with acute coronary syndrome in our ageing population. Furthermore, this poses a challenge to the ever increasing bed pressure within National Health Service hospitals, whereby admissions to cardiology or other specialty beds can be dominated by target waiting time and bed availability. In the current less than ideal world, other physicians should continue to refer suitable patients with acute coronary syndrome for cardiologist care, and to consider effective medicines in all these patients. Given the high 6-month mortality among patients with troponin positive NSTEACS,[23] invasive coronary management should be considered and preferably implemented during their index admission.

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APPENDIX

Charlson's comorbidity score

Assigned weights for diseases	Conditions
1	Myocardial infarct
	Congestive heart failure
	Peripheral vascular disease
	Cerebrovascular disease
	Dementia
	Chronic pulmonary disease
	Connective tissue disease
	Ulcer disease
	Mild liver disease
	Diabetes
2	Hemiplegia
	Moderate or severe renal disease
	Diabetes with end organ damage
	Any tumour
	Leukaemia
	Lymphoma
3	Moderate or severe liver disease
6	Metastatic solid tumour
	AIDS

Score = sum of assigned weights for each condition that a patient has. Adapted from Charlson *et al*.[1]