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ORIGINAL RESEARCH

Referral patterns of patients presenting with chest pain at two rural emergency departments in Western Australia

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ABSTRACT

Introduction: Coronary heart disease is the largest single cause of death in Australia. In Western Australia invasive diagnostics and therapies for acute coronary syndromes are only provided in the metropolitan hospitals of Perth. Patients in rural hospitals who need invasive cardiac care have to be transferred to Perth. The aim of our research was to determine which patient factors are associated with referral to advanced cardiac care at metropolitan level and how this compares to Australian guidelines for the management of acute coronary syndromes.

Method: Data was collected from patients presenting with chest pain to the rural emergency department, who were at least 18 years old and had given their consent. Exclusion criteria were chest pain accompanied or precipitated by significant co morbidity and prior enrolment in this study protocol. Socioeconomic and medical information of patients was collected from their medical records. Data was analysed using χ^2 tests, independent sample *t*-tests and multivariable logistic-regression models (stepwise backwards procedure).

Results: The study included 115 rural patients with chest pain with a mean age of 58 years: 66 (57%) men, 12 (10%) indigenous Australians and 38 (33%) transferred patients. Of all transferred patients 19 (50%) had a positive peak troponin-T, 13 (36%) a high peak creatine kinase (CK) and 12 (32%) persistent ST-elevation on their electrocardiogram, compared with 10 (14%), 12 (17%) and 11 (14%) respectively for non-transferred patients. Chi-square-tests showed significant differences between transfer groups in

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all three essential initial cardiac investigations and known dyslipidaemia. In multivariate analyses the positive peak troponin-T increased odds of transfer (OR6.40; 95% CI 2.55–16.08). This effect increased after adjustment for gender, serum creatinine and known dyslipidaemia (OR27.61; 95% CI 6.41–119.04). When adjusted for the peak troponin-T, neither ECG with persistent ST-elevation nor high peak CK remained significant. Known dyslipidaemia remained significant and serum creatinine became significant. Gender became significant when adjusted for troponin-T, known dyslipidaemia and serum creatinine.

Conclusions: Peak troponin-T is an independent determinant associated with the transfer to advanced care at metropolitan level, but ECG with persistent ST-elevation and peak CK (other essential initial cardiac investigations) are not. Further investigation of the available and provided cardiac care in rural Western Australia is required.

Key words: ACACIA, acute coronary syndromes, chest pain, emergency department, transfer, triage, troponin, Western Australia.

Introduction

Coronary heart disease is the largest single cause of death in Australia[1]. Cardiovascular diseases contribute 18% to the total burden in disability-adjusted life years (DALYs) and accounted for 47,637 deaths in 2004 in Australia[2,3] and 36% of deaths in Western Australia (WA)[4]. Overall Australian death rates rise with increasing remoteness, with circulatory diseases as the leading cause[5]. This is possibly due to worse socioeconomic factors (higher prevalence of smoking and obesity) and impaired access to health care.

In WA, invasive treatments for acute coronary syndromes (ACS) are only available in the metropolitan hospitals of Perth. Patients admitted to rural clinics have to be transferred if they need invasive cardiac care. For patients with suspected ACS every hour counts; medical guidelines[6] and scientific papers[7-11] emphasize the importance of (early) recognition of ACS, by both patient (community) and medical staff, in order to effectively implement proven therapies and optimize patient outcomes[12]. Early invasive therapy and in-hospital revascularization leads to better survival rates of patients with a suspected ST-elevation myocardial infarction (STEMI), but also for those with a non ST-elevation ACS[13,14].

The ability of rural medical staff to accurately determine which patient with chest pain is likely to have ACS and needs to be transferred for invasive treatment in a metropolitan hospital, is crucial in the medical process. This study explored chest pain management in rural WA hospitals to determine if it agrees with Australian guidelines for the management of ACS[15].

Methods

Background

There are just over 2,000,000 citizens in WA and they are spread over 2,550,000 square kilometres[16]. Approximately 1,550,000 people live in the metropolitan area of Perth. The capital contains hospitals with many specialists, whereas large rural hospitals only have specialized emergency departments.

Two large rural centres are stationed in Geraldton and Kalgoorlie. Together they provide health care for approximately 100 000 people in the Midwest and Goldfields Region (an area of more than 1 million km^2), including a relatively high Aboriginal population[16]. These centres also act as the intermediate centres for transfers from even smaller clinics to Perth. Acute patients are transferred on airplanes; depending on the urgency of needed care, patients' transfer times differ.

Patient population

The recently finalized Australian Acute Coronary Syndrome Prospective Audit (ACACIA)[7,17] registry gathered data of

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3402 ACS Australian patients. Chew et al. found that major preventable risk factors for cardiovascular disease[1] and in-hospital measurements were independent predictors of hospital mortality of acute coronary events[18]. A simplified version of this method[17,19] was used to gather retrospective data at the Geraldton Regional Hospital and the Kalgoorlie Hospital.

Consenting patients, 18 years or older, who presented to the emergency department (ED) from January to May of 2008, complaining of chest pain (CP) and who could either have left the hospital that same day or stayed as in-patient for longer were selected for the study. Patients were asked to participate either prior to discharge or when called after discharge.

Exclusion criteria were ACS accompanied or precipitated by significant co-morbidity (eg motor vehicle accidents, trauma, severe gastrointestinal bleeding or peri-procedural MI).

These selection criteria were translated by a medical researcher (BB) to major diagnostic categories (MDCs) and Australian Triage Scale scores (ATS).

- The MDCs are mutually exclusive groups based on principal diagnosis; MDC-5, diseases and disorders of the circulatory system, was included in the study.
- Triaging is a systematic assessment determining patient's priority at ED arrival. Patients with triage scores 1–3, conditions that require a response of assessment within 30 minutes or less, were included.

Recruitment modalities

Patients' medical record numbers (MRNs) were selected and medical records were checked if patients fitted the selection criteria.

Of all these patients data were *first* registered of those who, during their in-hospital stay:

- were transferred to Perth
- had had a proven myocardium infarction.

Overlapping occurred because some transferred patients had an MI during their in-hospital stay.

Then, expanding the control group, the study aimed for twice as many non-transferred as transferred patients at each study site. Over a nine-week period from March till May 2008, all patients fitting the profile were selected.

Data collected

The data for these patients are summarised in Table 1.

A cardiologist divided all electrocardiograms into four classes:

1. Class 1 – persistent ST-elevation > 1 mm in ≥2 contiguous leads, or new/presumed new left bundle branch block.
2. Class 2 – ST-depression > 0.5 mm, or T-wave inversion in >2 contiguous leads.
3. Class 3 – Q-waves or ST/T changes in ≥2 leads.
4. Class 4 – other, not necessarily normal ECG.

The outcome measure was a patient's transfer or not (discharge from the rural hospital), which shows the doctors' interpretation of patients' symptoms. If doctors intended to transfer a patient, but the patient requested not to be, the outcome was registered as 'transfer'.

Statistical analysis

The χ^2 test was used to compare the single factors. If tests were 'not done' only registered tests could be compared.

Independent sample *t*-tests were used to compare means.

Univariate and multivariate logistic-regression analyses (stepwise backwards procedure) were used to determine which binary factors were likely to influence the transfer-outcome. Analyses were conducted with SPSS15 (SPSS; www.spps.com).

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Table 1: Data for patients included in the study

Patient characteristics	Gender, age, Indigenous status
Social and FHx	Currently smoking, FHx of coronary artery disease
Medical history	Dialysis dependence, known diabetes, hypertension and dyslipidaemia, prior atrial fibrillation and stroke
Prior interventions	Percutaneous coronary intervention, coronary artery bypass grafting
Current vital measurements	Heart rate, systolic blood pressure, first electrocardiogram
Blood measurements	Peak troponin-T, peak creatine kinase, first serum creatinine, first blood sugar level, first white cell count, total cholesterol, HDL, LDL and triglycerine levels

FHx, family history.

Results

Over 50 consents were obtained at each site. Of the 115 enrolled patients (mean age of 58 years), 36 (31%) were transferred to Perth. Table 2 lists further characteristics.

The patients were separated in two groups: those who were meant to be transferred (transfer) and those who were not (no transfer). At each site one patient requested not to be transferred, despite doctor's advice; these two patients were included in the transfer group.

Initially χ^2 tests and independent sample *t*-tests were used to compare patient groups on relevant socio-demographic and medical characteristics. Tables 3 to 6 show these results (if blood tests were missing, percentages were calculated over the number of known test results: *n*–).

Neither the mean age nor the number of indigenous patients differed between transfer groups. More men than women presented with chest pain and were transferred, hence, there was no significant difference between genders.

Histories of cardiovascular diseases, high blood pressure, diabetes and smoking were not significant, nor was family history for coronary artery disease. Known history of dyslipaedemia was different between transfer groups (*p*-value was 0.028).

A positive peak troponin-T was measured in 19 (50%) transferred and 10 (14%) non-transferred patients. Of the transferred patients, 13 (36%) had high peak creatine kinase (CK) levels compared with 12 (17%) non-transferred patients. The ECGs of 12 (32%) transferred and 11 (14%) non-transferred patients were suspected for STEMI. All three determinants were significant in chi-squared tests.

Dialysis dependency, increased serum creatinine, high white cell count, high blood sugar level, high lipid profiles, high blood pressure and increased heart rate were not significant.

According to binary-logistics, patients with a positive peak troponin-T were more likely to be transferred (6.40; 95% CI, 2.55–16.08). In all multivariable models, troponin-T remained significant.

Peak troponin-T was a confounder for both ECG and peak CK; these variables lost significance when adjusted for peak troponin-T. A known history of dyslipidaemia remained significant and serum creatinine became significant.

The stepwise backwards procedure was used to search for all determinants that remain or become significant when adjusted for each other in a regression model.

Gender and serum creatinine, which were not significant predictors on their own, became significant when taken into account with troponin-T and known dyslipidaemia. All four factors had significant increased or decreased odds when adjusted for each other (Table 7).

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Table 2: Patient characteristics, by site

Variable	Geraldton		Kalgoorlie		Total	
Consents	*n* = 58 (%)		*n* = 57 (%)		*n* = 115 (%)	
Female	24	(41)	25	(44)	49	(43)
Mean age in years	61	(16)	56	(15)	58	(16)
Indigenous	6	(10)	6	(11)	12	(10)
ECG class 1	12	(21)	11	(19)	23	(20)
ECG class 2	17	(29)	13	(23)	30	(26)
ECG class 3	8	(14)	16	(28)	24	(21)
Intention to transfer	18	(31)	20	(35)	38	(33)
Transferred to Perth	17	(29)	19	(33)	36	(31)

Table 3: Demographic patient characteristics and *p*-values, by transfer status

Variable	No transfer		Transfer		Total		*P*-value
Consents	*n* = 77 (%)		*n* = 38 (%)		*n* = 115 (%)		
Not transferred on pt request (*n*,%)	0	0	2	(5)	2	(2)	
Female (*n*,%)	36	(47)	13	(34)	49	(43)	0.201
Male (*n*,%)	41	(53)	25	(66)	66	(57)	
Age (years (mean,SD))	58	(17)	59	(14)	58	(16)	0.697
Indigenous (*n*,%)	9	(12)	3	(8)	12	(10)	0.531

Table 4: Social-medical history determinants and *p*-values according to transfer status

Variable	No transfer		Transfer		Total		*P*-value
Consents	*n* = 77 (%)		*n* = 38 (%)		*n* = 115 (%)		
Known diabetes (*n*,%)	23	(30)	13	(34)	36	(31)	0.637
Known dyslipidaemia (*n*,%)	36	(47)	26	(68)	62	(54)	0.028
Known hypertension (*n*,%)	52	(68)	31	(82)	83	(72)	0.114
Known current smoking (*n*,%)	27	(35)	15	(39)	42	(37)	0.171
Known former smoker (*n*,%)	21	(27)	15	(39)	36	(31)	
Known FHx of CAD (*n*,%)	19	(25)	12	(32)	31	(27)	0.433
Prior MI (*n*,%)	16	(21)	9	(24)	25	(22)	0.722
Prior PCI (*n*,%)	11	(14)	7	(18)	18	(16)	0.566
Prior CABG (*n*,%)	5	(6)	3	(8)	8	(7)	0.781
Prior AF (*n*,%)	14	(18)	4	(11)	18	(16)	0.288
Prior stroke (*n*,%)	3	(4)	1	(3)	4	(4)	0.669

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Table 5: Cardiac biomarkers and first ECGs of patients with chest pain, *p*-values by transfer status

Variable	No transfer		Transfer		Total		*P*-value
Consents	*n* = 77 (%)		*n* = 38 (%)		*n* = 115 (%)		
Troponin-T not done (*n*,%)	3	(4)	0	(0)	3	(3)	
Peak troponin-T + (n^-,%) *	10	(14)	19	(50)	29	(19)	<0.001
CK not measured (*n*,%)	7	(9)	2	(5)	9	(8)	
Peak CK > 195 U/L (n^-,%) *	12	(17)	13	(36)	25	(24)	0.029
ECG class 1 (*n*,%)	11	(14)	12	(32)	23	(20)	
ECG class 2 (*n*,%)	19	(25)	11	(29)	30	(26)	0.035
ECG class 3 (*n*,%)	21	(27)	3	(8)	24	(21)	

n^- = original *n* – amount of tests not done or not filed in the medical records.

Table 6: In-hospital measurements and *p*-values according to transfer status

Variable	No transfer		Transfer		Total		*P*-value
Consents	*n* = 77 (%)		*n* = 38 (%)		*n* = 115 (%)		
Dialysis dependent (*n*,%)	1	(1)	1	(3)	2	(2)	
Initial serum creatinine not done (*n*,%)	6	(8)	1	(3)	7	(6)	
Initial serum creatinine >150mmol/L (n^-,%) *	10	(14)	1	(3)	11	(10)	0.063
Initial white cell count not done (*n*,%)	5	(6)	3	(8)	8	(7)	
Initial WCC > 11 × 10^9/L (n^-,%) *	15	(21)	12	(34)	27	(25)	0.133
Blood sugar level not measured (*n*,%)	9	(12)	0	(0)	9	(8)	
First measured BSL > 6 mmol/L (n^-,%) *	39	(57)	27	(71)	66	(63)	0.163
Lipid profile not measured (*n*,%)	33	(43)	15	(39)	48	(42)	
First total cholesterol > 6 mmol/L (n^-,%) *	3	(7)	3	(13)	6	(9)	0.397
First triglycerine > 1.9 mmol/L (n^-,%) *	13	(30)	10	(43)	23	(34)	0.254
First blood pressure > 140 sysmmHg (*n*,%)	30	(39)	17	(45)	47	(41)	0.553
First Heart Rate (bpm [mean,SD])	83	(26)	85	(17)	84	(24)	0.693

n^- = original *n* – amount of tests not done or not filed in the medical records.

Table 7: Multivariate regression model, all 4 determinants adjusted for the other 3

Variable	Amount	Percent	*P*-value	OR (95% CI)
Peak troponin-T positive	29/108	26.85	0.000	27.61 (6.41–119.04)
Male gender	59/108	54.63	0.050	2.92 (1.00–8.55)
Known dyslipidaemia	62/108	57.41	0.030	3.25 (1.12–9.44)
High serum creatinine	11/108	10.19	0.001	0.01 (0.00–0.15)

Patients with a positive peak troponin-T were 27.61 times more likely to be transferred and those with known dyslipidaemia 3.25 times more likely (95% CI, 6.41–199.04 resp.1.12–9.44). Men had a 2.92 times higher chance of being referred to a metropolitan hospital than women (95% CI, 1.00–8.55). High serum creatinine decreased odds of transfer (OR0.01; 95% CI, 00–0.15).

Discussion

Main findings

A positive peak troponin-T gives increased the chances of transfer, but ECG and CK do not when adjusted for peak troponin-T. Known dyslipidaemia increased and high serum

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creatinine decreased the chance of transfer. Men were more likely to be transferred than women.

Limitations of this study

The study represents patients who had given their consent. However not all patients who fitted the selection criteria were reached. Patients and patient information may have been missed because hospital visits had not been filed properly. Furthermore, a short time was available for this trial and only 115 patients were enrolled. Due to the small transfer groups, the 95% confidence intervals were large.

Comparison with other studies

The results of this study do not agree with the finding of Chew et al.[17] that patients with suspected STEMI are strongly associated with invasive management during their in-hospital stay. This service is not available rural WA. Might one assume that more patients would have been referred, if rural hospitals provided invasive cardiac care? Scott et al.[20], who observed routine care of ACS in Australia, state that admission to tertiary hospitals increases chance of referral to early coronary angiography.

Known dyslipidaemia appears to increase odds of transfer, probably because high cholesterol increases the risk of coronary heart disease[21].

Although the catchment area of Kalgoorlie has more men than women, the influence of gender cannot only be attributed to patient demographics. The treatment of men is approached more aggressively than of women; their chest pain is more often recognized, diagnosed and treated[22,23].

In the ACACIA registry results, distance to invasive services does not appear to negatively impact upon events for Australian ACS patients[24]. Rural patients with suspected ACS were only enrolled in their study if they were transferred to a study hospital less than 12 hours after initial presentation, whereas this trial detected many patients transferred after more than 12 hours or not transferred at all. This worsens the outcome for ACS patients in rural WA.

Transfer rates for both patients with *chronic* heart failure and those presenting with *acute* coronary syndromes appear to be lower in rural areas than in urban areas[25,26]. The prevalence of chronic heart diseases is higher among people living outside capital cities[27] and rural death rates are also higher[28].

How to proceed?

Changes in ECG, and troponin-T and CK levels are the main signs of a present acute coronary syndrome[15]. Although many electrocardiograms were faxed to and discussed with cardiologists in Perth, rural clinics have missed suspected STEMIs, indicating that skills in reading electrocardiograms could be improved. Many rural WA patients have cardiac risk factors that indicate a need to reduce preventable risk factors. This study was too small to make a definitive comment on the quality of care provided for patients with ACS in rural Western Australia. It has, however, raised significant questions that should be explored through larger studies.

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