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ORIGINAL ARTICLE

The Effect of Media Campaigns, Patient Characteristics, and Presenting Symptoms on Prehospital Delay in Myocardial Infarction Patients: A Prospective Cohort Study

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Background Delays in reperfusion therapy for myocardial infarction (MI) are associated with increased mortality and morbidity, and most of this delay is due to delay in patients initiating contact with emergency services. This study assesses the impact of the Australian National Heart Foundation media campaign and identifies patient characteristics and presenting symptoms that may contribute to delay.

Methods This prospective cohort study identified patients with a diagnosis of MI admitted to a single tertiary metropolitan hospital in Perth, Western Australia from July 2013 to January 2014. Patients were interviewed and responses were categorised to determine their reasons for delaying treatment and the impact of mass media campaigns. Delay times were analysed using multivariable linear regression models for the Whole Cohort (all patients admitted to the tertiary hospital, including patients from rural and peripheral hospitals) and the Direct Admission Cohort (patients admitted directly to the tertiary hospital).

Results Of 376 patients, 255 patients provided consent, and symptom onset-time was available for 175 patients. While almost two thirds of the cohort was aware of media campaigns, awareness was not associated with decreased prehospital delay. Median delay was 3.9 hours for the Whole Cohort and 3.5 hours for the Direct Admission Cohort. Delay was associated with being widowed, symptom onset on a weekday compared with weekend, past medical history of MI and coronary artery bypass graft, private compared with ambulance transport to hospital, and lack of symptoms of sweating and weakness. In addition, for the Direct Admission Cohort, age and income were also associated with delay.

Conclusions This study did not find an association between awareness of media campaigns and delay. This study identified important characteristics and presenting symptoms that are associated with delay, and possibly relevant to future media campaigns.

Keywords Myocardial infarction • Prehospital delay • Media campaigns • Symptom presentation • Ambulance transport

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Introduction

Cardiovascular disease is the leading cause of death in Australia [1] and worldwide [2]. In Australia (2012–13), over 54,000 patients were hospitalised with a myocardial infarction (MI) [3], and MI claimed an average of 23 lives each day [1] in 2015. Rapid reperfusion of an obstructed coronary artery is associated with improved survival [4,5], and since this intervention is time-critical, delays to treatment must be minimised.

Prehospital delay, the time from symptom onset to arrival in the emergency department (ED) has two components: transport delay and patient decision delay. Patient decision delay is the amount of time taken from symptom onset to calling for or seeking assistance. Reducing patient decision delay has been challenging. Median prehospital delay times among patients with MI are between 2 to 11 hours [6–8]. However, improved survival for patients with ST-segment elevation MI (STEMI) is greatest if myocardial reperfusion is in the first hour after symptom onset [9,10].

For people experiencing MI, correct identification of symptoms indicates need to seek care. Warning signs of MI include not only pain or discomfort in the chest but also less typical symptoms: light headedness; nausea or vomiting; jaw, neck or back pain; discomfort or pain in arm or shoulder; and shortness of breath [11]. The National Heart Foundation has recommended that if MI warning signs are experienced an ambulance should be called immediately [11]. This recommendation is based on the rationale that ambulance is usually the fastest mode of transport to hospital and paramedics can begin treatment en route.

National mass media education campaigns have been initiated worldwide to decrease prehospital delay time, but only two of seven studies showed reduced prehospital delay [12]. The National Heart Foundation of Australia has a long history of conducting mass media campaigns. Their most recent campaign was the 'warning signs of heart attack', which ran from September 2010 to December 2012 and focussed on reducing delay in responding to the symptoms of MI and the importance of calling an ambulance. The campaign used a multifaceted media strategy consisting of radio, newspaper, television, and an online digital strategy that included videos via online publishers, such as Ninemsn, Ad2One, and Facebook (personal communication Heart Foundation WA).

There are many international studies [6] that have investigated presenting symptoms of MI and patient characteristics associated with prehospital delay. However, in Australia only two studies have investigated both patient characteristics and symptoms of MI. One is from 1995 [13] and the other is a recent study that included patients who arrived by ambulance and extracted symptom data from the paramedic patient care record [8]. Therefore, the primary aims of this study were to: (1) assess the impact of the Australian National Heart Foundation media campaign on patient decision delay; (2) describe the delay time of all patients diagnosed with MI; and (3) identify patient characteristics and presenting symptoms of MI that contribute to delay.

Material and Methods

Setting and Participants

All patients admitted to a Perth metropolitan tertiary hospital with a diagnosis of MI between July 2013 and January 2014 were invited to participate in the study. The hospital has over 60,000 ED presentations annually [14] and admits patients from both rural and metropolitan Western Australia (WA).

Patients were included if they were aged 18 years or older, fluent in English, and had sufficient cognitive capacity to provide informed consent. Patients were excluded if their MI occurred in hospital, was perioperative, trauma related, or due to drug abuse. Ethical approval was granted, and informed consent was obtained when they were considered clinically stable in writing from hospitalised patients ($n = 218$) and in vocal recordings ($n = 37$) for discharged patients.

Study Design and Data Sources

This prospective cohort study focussed on the quantitative data analysis and complements the qualitative analysis that has been published [15]. The data sources used in this study were: Emergency Department Information System (EDIS) [16]; iSOFT Clinical Manager [17], a software program that allows access to the patient's electronic record, laboratory results, and hospital discharge summary report; patient interview using the Symptoms of Acute Coronary Syndromes Inventory (SACSI), which includes symptoms of MI, health history, risk factors, and demographics [18]; and medical chart review.

Patient ED arrival time and mode of transport were extracted from EDIS. Patients who bypassed the ED and went directly to the cardiac catheter laboratory were identified from iSoft. Diagnosis of MI was confirmed by medical record review and abnormal elevation of the cardiac biomarker troponin. The variable 'mode of transport' had the following categories: 'Royal Flying Doctor Service (RFDS) and transfer from rural WA to tertiary hospital'; 'private transport to small metropolitan hospital and transfer to tertiary hospital'; 'ambulance transport to small metropolitan hospital and transfer to tertiary hospital'; 'private transport to tertiary hospital'; and 'ambulance transport to tertiary hospital'.

Patients were interviewed by a research nurse and the SACSI was completed. The SACSI was based on an extensive literature review that supported face validity of the instrument. The SACSI has a computed content validity index of 0.94 ($p < 0.05$) and a reported Cronbach alpha of 0.81 for reliability [18]. Patient characteristics were also collected (Table 1). Annual income was adjusted to the Australian context (Table 1) and based on Australian Bureau of Statistics 2011 Census Data [19]. An additional question asked if the patient was familiar with any advertising campaigns related to heart attack, and if so, how did the campaign influence their decision to go to hospital.

Table 1 Sample Characteristics.

Variable		Whole Cohort n (%) 175 (100)	Direct Admission Cohort n (%) 98 (100)
Age	≥80 years	14 (8.0)	8 (8.2)
	70 to 79 years	42 (24.0)	26 (26.5)
	60 to 69 years	56 (32.0)	35 (35.7)
	<60 years	63 (36.0)	29 (29.6)
Sex	Female	44 (25.1)	23 (23.5)
	Male	131 (74.9)	75 (76.5)
Marital status	Never married	13 (7.4)	8 (8.2)
	Widowed	19 (10.8)	13 (13.3)
	Divorced	21 (12.0)	11 (11.2)
	Separated	10 (5.7)	5 (5.1)
	Defacto	8 (4.6)	6 (6.1)
	Married	104 (59.4)	55 (56.1)
Education	University	31 (17.7)	22 (22.4)
	Technical or some university	38 (21.7)	20 (20.4)
	Completed high school	31 (17.7)	16 (16.3)
	Some high school	75 (42.8)	40 (40.8)
Annual household income	>104,000	27 (15.4)	15 (15.3)
	78,000 – 103,999	15 (8.6)	9 (9.2)
	52,000 – 77,999	21 (12.0)	9 (9.2)
	20,800 – 51,999	23 (13.1)	16 (16.3)
	<20,799	7 (4.0)	4 (4.1)
	Pensioner	72 (41.1)	38 (38.8)
Risk Factors			
Diabetes	Yes	52 (29.7)	32 (32.7)
	No	122 (69.7)	65 (66.3)
Hypertension	Yes	100 (57.1)	55 (56.1)
	No	75 (42.8)	43 (43.9)
Dyslipidaemia	Yes	83 (47.4)	54 (55.1)
	No	92 (52.6)	44 (44.9)
Family history of MI	Yes	60 (34.3)	37 (37.8)
	No	115 (65.7)	61 (62.2)
Smoking (current)	Yes	43 (24.6)	24 (24.5)
	No	132 (75.4)	74 (75.5)
History of coronary heart disease	Yes	52 (29.7)	37 (37.8)
	No	123 (70.3)	61 (62.2)
Past Medical History			
Previous Angina	Yes	29 (16.6)	23 (23.5)
	No	146 (83.4)	75 (76.5)
Previous PCI	Yes	52 (29.7)	38 (38.8)
	No	123 (70.3)	60 (61.2)
Previous MI and previous CABG			
	Neither previous MI or previous CABG	137 (78.3)	74 (75.5)
	Both previous MI and previous CABG	15 (8.6)	8 (8.2)
	Had previous MI	22 (12.6)	16 (16.3)
Mode of transport to hospital and transfer status			
	RFDS transfer from rural WA to tertiary hospital	36 (20.6)	
	Private transport to small metro hospital & transfer to tertiary hospital	22 (12.6)	
	Ambulance to small metro hospital & transfer to tertiary hospital	18 (10.3)	

Table 1. (continued).

Variable		Whole Cohort n (%) 175 (100)	Direct Admission Cohort n (%) 98 (100)
	Private transport to tertiary hospital	37 (21.1)	37 (37.8)
	Ambulance to tertiary hospital	61 (34.8)	61 (62.2)
Type of MI	NSTEACS	110 (62.8)	65 (66.3)
	STEMI	63 (36.0)	32 (32.7)
Symptom onset	Weekday	124 (70.8)	68 (69.4)
	Weekend	51 (29.1)	30 (30.6)
Symptom onset (time of day)	08:00 to 17:00	83 (47.4)	49 (50)
	>17:00 to <08:00	92 (52.6)	49 (50)
Symptom characteristics			
	Had one time and went away	15 (8.6)	11 (11.2)
	Symptoms would come and go	41 (23.4)	20 (20.4)
	Symptoms constant	118 (67.4)	67 (68.4)
Self-treat symptoms	Yes	65 (37.1)	37 (37.8)
	No	110 (62.8)	61 (62.2)
Similar symptoms in the past	Yes	72 (41.1)	43 (43.9)
	No	103 (58.8)	55 (56.1)
Presenting symptoms reported			
Chest pain	Yes	147 (84.0)	82 (83.7)
	No	28 (16.0)	16 (16.3)
Sweating	Yes	88 (50.3)	48 (49.0)
	No	87 (49.7)	50 (51.0)
Heat sensation	Yes	49 (28.0)	25 (25.5)
	No	126 (72.0)	73 (74.5)
Left arm pain	Yes	69 (39.4)	40 (40.8)
	No	104 (59.4)	57 (58.2)
Right arm pain	Yes	41(23.4)	23 (23.5)
	No	133 (76.0)	75 (76.5)
Left shoulder pain	Yes	50 (28.6)	29 (29.6)
	No	124 (70.8)	69 (70.4)
Right shoulder pain	Yes	35 (20.0)	23 (23.5)
	No	139 (79.4)	75 (76.5)
Jaw, throat or neck pain	Yes	59 (33.7)	35 (35.7)
	No	115 (65.7)	63 (64.3)
Short of breath	Yes	88 (50.3)	46 (46.9)
	No	87 (49.7)	52 (53.1)
Breathing difficulty	Yes	70 (40.0)	37 (37.8)
	No	105 (60.0)	61 (62.2)
Hyperventilating	Yes	34 (19.4)	17 (17.3)
	No	141 (80.6)	81 (82.7)
Nausea	Yes	60 (34.3)	31 (31.6)
	No	115 (65.7)	67 (68.4)
Indigestion	Yes	33 (18.8)	22 (22.4)
	No	142 (81.1)	76 (77.6)
Dizziness	Yes	51 (29.1)	31 (31.6)
	No	124 (70.8)	67 (68.4)
Light headed	Yes	64 (36.6)	40 (40.8)
	No	111 (63.4)	58 (59.2)
Weakness	Yes	79 (45.1)	46 (46.9)
	No	96 (54.8)	52 (53.1)
Fatigue	Yes	88 (50.3)	53 (54.1)
	No	87 (49.7)	45 (45.9)

Table 1. (continued).

Variable		Whole Cohort n (%) 175 (100)	Direct Admission Cohort n (%) 98 (100)
Upper back pain	Yes	40 (22.8)	18 (18.4)
	No	134 (76.6)	80 (81.6)
Unusually scared	Yes	64 (36.6)	35 (35.7)
	No	111 (63.4)	63 (64.3)
Awareness of media campaigns and influence on decision to go to hospital			
	Unaware of media campaign	52 (29.7)	39 (39.8)
	Aware		
	- no influence on decision to go to hospital	63 (36.0)	29 (29.6)
	- no influence, symptoms were different	13 (7.4)	5 (5.1)
	- slight influence, made wrong decision	15 (8.6)	8 (8.2)
	- no influence, past experience influenced	16 (9.1)	8 (8.2)
	- influenced decision to go to hospital	16 (9.1)	9 (9.2)

Abbreviations: n, number; %, percentage; IQR, interquartile range; Exp(B), exponential beta coefficient; CI, confidence interval; MI, myocardial infarction; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft; RFDS, Royal Flying Doctor Service; WA, Western Australia.

From the medical chart review the following were extracted: patient diagnosis, age, sex, comorbid conditions, previous percutaneous coronary intervention (PCI), previous coronary artery bypass graft (CABG), type of MI (STEMI, Non-ST Elevation Acute Coronary Syndrome [NSTEACS]), and smoking status.

Statistical Analysis

Continuous data were described using means, standard deviations, medians and inter-quartile ranges, and discrete data were summarised using frequencies and percentages. Delay time was calculated by subtracting the ED arrival time at the tertiary hospital from the patient self-reported symptom onset-time. Patient responses regarding 'familiarity with media campaigns about heart attack and if the campaign influenced their decision to go to hospital' were transcribed and analysed using content analysis by two members of the research team (LC, JvS). To enhance credibility and auditability, data were categorised independently, categories were confirmed, and disagreements were resolved by discussion until consensus was reached.

Two separate models were developed to identify variables associated with prehospital delay and if awareness of the media campaign was associated with patient decision delay.

- The Whole Cohort included all patients who presented directly to the tertiary facility and those who were transferred from both rural WA and small metropolitan peripheral hospitals. The model of the data from this cohort was used to identify variables associated with prehospital delay.
- The Direct Admission Cohort only included the patients who presented directly to the tertiary facility, and the model of the data from this cohort was used to determine if awareness of the media campaign was associated with patient decision delay.

An assumption was made that ambulance times and interfacility transfers from rural WA and small metropolitan peripheral hospitals were unlikely to be influenced by the media campaign.

As delay times were skewed, they were log transformed for further analysis. The variables 'prior history of MI' and 'previous CABG' were correlated, so they were combined to form the following categories: 'neither prior history of MI and previous CABG'; 'both prior history of MI and previous CABG'; and 'prior history of MI only'. In addition to the adjustment variables, 'age (as a continuous variable)', and 'sex', all variables with $p < 0.20$ in initial tests for association with delay time in univariable linear regression models were included in the multivariable linear regression models. These multivariable models were simplified in a stepwise fashion by removing the variable with the least significant p-value and refitting the models until only variables with p-values <0.05 were retained, in addition to the adjustment variables. As a final check, all excluded variables were retested one at a time. Exponential beta coefficients [exp(B)] and 95% confidence intervals (CIs) were reported. These values correspond to changes in the ratio of the expected geometric means of the original delay time. Data were analysed using SPSS version 23 (IBM Corp., SPSS Statistics for Windows, Armonk, NY, USA) and significance was set at 0.05.

Results

Characteristics of the Whole and the Direct Admission Cohorts

During the study period (July 2013 to January 2014), data were collected on 255 of the 367 potential eligible patients. Symptom onset-time was available for 175 (68.3%) of the 255 patients (Figure 1). There were minimal differences in patient demographics and MI characteristics between the Whole Cohort and the Direct Admission Cohort. The majority of the patients were younger than 70 years, male, married, pensioners, and had completed some high school. Most patients had a final diagnosis of NSTEACS, symptom onset on a weekday, constant symptoms, and over 80% presented with chest pain. Other common symptoms included sweating, shortness of breath and fatigue (Table 1).

Awareness of Media Campaigns About Heart Attack

The majority of patients were aware of media campaigns about heart attack; however, for most the campaigns had no influence on their decision to go to hospital. About two thirds

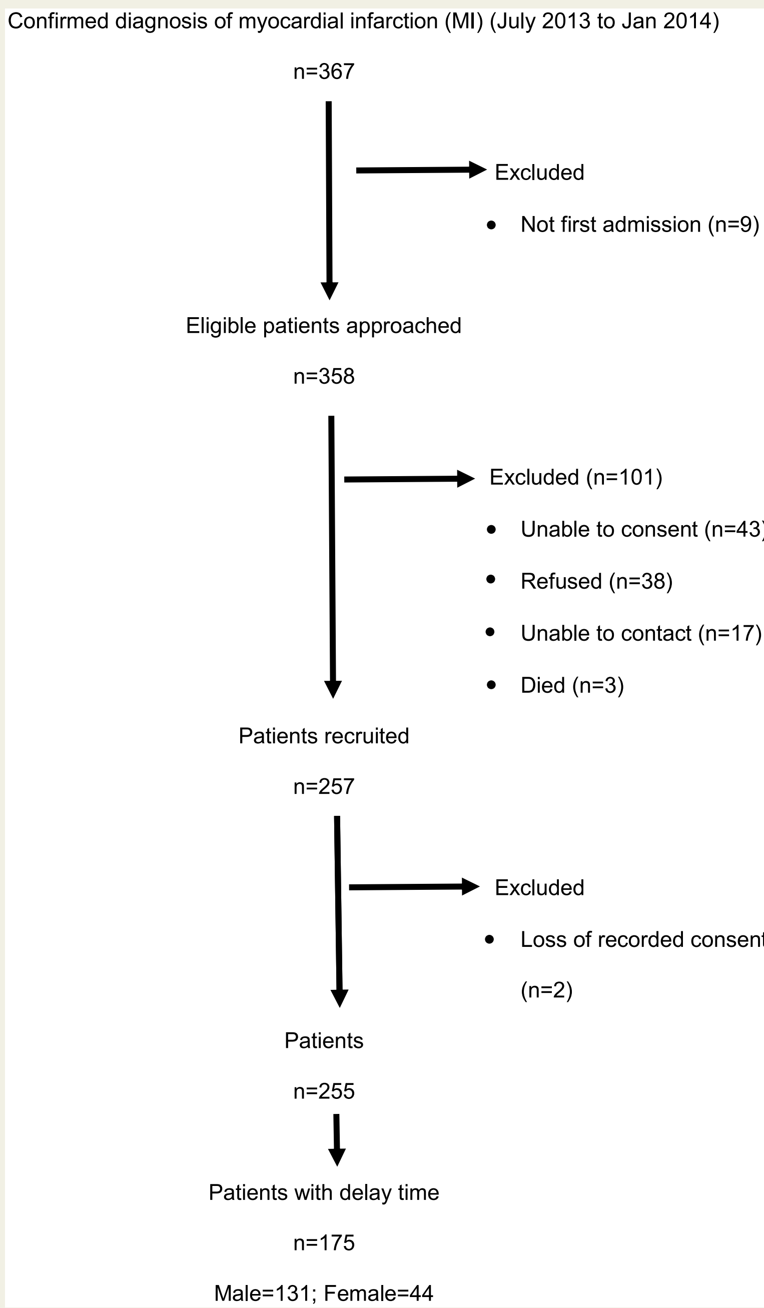

Figure 1 Study flow diagram.

Table 2 Prehospital Delay.

Whole cohort		Direct Admission Cohort	
Median (IQR)	**3.9 hours (1.8–12.2)**	**Median (IQR)**	**3.5 hours (2.0–16.4)**
Mean (SD)	**18.8 hours (40.7)**	**Mean (SD)**	**20.6 hours (42.3)**
	n (%)		n (%)
<1 hour	10 (3.9)	<1 hour	4 (3.0)
1–2 hours	37 (14.5)	1–2 hours	19 (14.3)
>2–6 hours	58 (22.7)	>2–6 hours	39 (29.3)
>6–24 hours	39 (15.3)	>6–24 hours	15 (11.3)
>1–3 days	17 (6.7)	>1–3 days	13 (9.8)
>3–7 days	9 (3.5)	>3–7 days	4 (3.0)
>1 week	6 (2.4)	>1 week	4 (3.0)
Missing	79 (31.0)	Missing	35 (26.3)

Abbreviations: n, number; %, percentage; IQR, interquartile range; SD, standard deviation.

of patients (Whole Cohort [n = 123, 70.3%] Direct Admission Cohort [n = 59, 60.2%]) were familiar with advertising campaigns about heart attack (Table 2); however, there were no differences in the Direct Admission Cohort in median delay times (aware 4.1 hours [IQR, 2.1–26.1], not aware 3.1 hours, [IQR, 1.8–7.5] p = 0.22 [results not reported in tables]). Some patients stated they ''remembered a man holding his chest'', one stated, ''I wish I had my heart attack again and if you think you are having a heart attack call 000'', and another remembered a flyer stating what to do in the event of heart attack on a village notice board.

Delay Time

The median delay time for the Whole Cohort (n = 175) was 3.9 hours (IQR, 1.8-12.2) and 3.9% (n = 10) of patients arrived in the ED within one hour of symptom onset. The peak arrival time (n = 58, 22.7%) in the ED was 2 to 6 hours after symptom onset. Whole Cohort patients missing a symptom onset-time were more likely to be female (41.3% vs. 26.8%, p = 0.02) and there were no differences in age (mean age 63.6 vs. 62.4 years, p = 0.50).

For Direct Admission Cohort patients (n = 98) the median delay was 3.5 hours (IQR, 2.0-16.4) and 3.0% (n = 4) of patients arrived in the ED within one hour of symptom onset. The peak arrival time (n = 39, 29.3%) in the ED was 2 to 6 hours after symptom onset (Table 2). There were no age or sex differences between patients who were missing a symptom onset-time (female 34.3% vs. male 23.5%, p = 0.21; mean age 67.6 vs. 64.8 years, p = 0.25).

Patient Characteristics and Presenting Symptoms Associated With Delay Time

In the Whole Cohort model, variables associated with longer median delay times in univariable analyses were: being widowed compared with being married; and using private transport compared with using an ambulance to travel to the ED. Shorter delay times were associated with: having household income between $52,000 and $77,999 compared with being a pensioner; presenting with STEMI compared with NSTEACS; and presenting with sweating compared with no sweating.

In the Direct Admission Cohort model, most variables associated with delay times in univariable analyses were similar. Exceptions were: type of MI (STEMI/NSTEACS) was not significant, and 'symptoms that would come and go' or 'had one time and went away' had longer delay times compared with constant symptoms (Table 3).

In the Whole Cohort model, variables associated with longer delay time in the multivariable analysis were: being widowed compared with being married; onset of symptoms on a weekday compared with a weekend; having had both a previous MI and previous CABG and having neither previous MI nor previous CABG compared with having a previous MI; using private transport or RFDS transferral from rural WA compared with using an ambulance to travel to ED; and presenting with the symptom of weakness. The variable associated with shorter delay time was presenting with the symptom of sweating.

In the Direct Admission Cohort model, variables associated with delay times in the multivariable analysis were similar. In addition, patients with annual income of $52,000 to $77,999 compared with a pensioner had shorter delay times, and for each one-year increase in age patients were 4% less likely to delay (Table 4).

Discussion

Previous research has shown that early (90 to 120 minutes) invasive management of patients with STEMI and very high risk NSTEACS is associated with improved survival [4,5,10], and current Australian guidelines recommend primary PCI within 90 to 120 minutes of first medical contact [10]. Reducing prehospital delay will reduce time to treatment and potentially save lives. Important findings from this study suggest patient awareness of media campaigns about heart attack was not associated with prehospital delay. It also recognises several features of delay times which are relevant to targeting future media campaigns. The median prehospital delay in this study was 3.5 for the Direct Admission cohort and 3.9 hours for the Whole Cohort. In multivariable analyses, this study found patient characteristics associated with prehospital delay were marital status, week-day symptom onset, past medical history of MI and CABG, and mode of transport to hospital. The symptoms associated with prehospital delay were sweating and weakness. In addition, for the Direct Admission Cohort, income and age were associated with delay.

Disappointingly, this study did not find an association between awareness of media campaigns and delay times. One Australian study [20] conducted in Melbourne showed awareness of the Australian National Heart Foundation

Table 3 Delay time and univariable linear regression.

Variable		Whole cohort				Direct Admission Cohort			
		Delay (hours)	Univariable linear regression			Delay (hours)	Univariable linear regression		
		Median, IQR	Exp(B)	95% CI	P-value	Median, IQR	Exp(B)	95% CI	P-value
Age					0.62				0.97
	≥80 years	4.0, 2.4–13.4	1.03	0.42–2.49	0.96	2.9, 2.4–8.5	0.77	0.24–2.51	0.67
	70 to 79 years	5.0, 2.7–12.6	1.23	0.67–2.26	0.50	3.9, 2.5–13.4	0.98	0.44–2.18	0.97
	60 to 69 years	3.4, 1.6–14.3	0.81	0.46–1.41	0.45	3.9, 1.6–19.3	0.88	0.42–1.86	0.74
	<60 years	3.2, 1.8–12.3	1			3.1, 2.0–32.1			
Sex	Female	6.9, 2.7–14.6	1.58	0.91–2.75	0.10	10.5, 3.3–30.3	2.50	1.27–4.93	0.008
	Male	3.2, 1.6–11.2	1			3.1, 1.8–6.7	1		
Marital status					0.01				0.009
	Never married	2.6, 1.6–4.3	0.65	0.28–1.48	0.30	2.5, 1.9–3.0	0.76	0.27–2.13	0.60
	Widowed	10.0, 3.3–12.5	4.14	1.82–9.42	0.001	11.8, 3.2–128	4.39	1.88–10.2	0.001
	Divorced	2.5, 1.9–7.2	0.90	0.44–1.83	0.77	3.0, 2.0–7.5	0.98	0.39–2.42	0.96
	Separated	5.3, 3.7–24.4	1.62	0.61–4.27	0.33	5.9, 4.4–71.3	3.14	0.87–11.3	0.08
	Defacto	6.2, 2.5–11.8	1.22	0.44–3.41	0.70	5.0, 1.8–16.4	1.13	0.35–3.69	0.84
	Married	3.5, 1.6–12.2	1			3.4, 1.6–12.3	1		
Education					0.79				0.75
	University	3.6, 1.8–7.5	0.84	0.44–1.60	0.59	3.5, 1.8–22.1	0.85	0.39–1.85	0.68
	Technical or some university	3.8, 2.1–10.1	0.79	0.44–1.44	0.44	3.6, 2.3–9.6	0.73	0.33–1.63	0.44
	Completed high school	3.6, 1.7–11.2	0.74	0.39–1.42	0.37	3.0, 1.8–21.1	0.64	0.27–1.53	0.32
	Some high school	4.1, .8–22.5	1			4.0, 2.0–25.7	1		
Annual household					0.02				0.01
income (A$)	>104,000	3.9, 2.0–34.0	0.94	0.49–1.78	0.84	3.6, 2.1–4.7	0.57	0.24–1.32	0.19
	78,000 – 103,999	3.8, 2.1–5.9	0.69	0.31–1.52	0.35	3.6, 2.2–13.4	0.70	0.25–1.97	0.50
	52,000 – 77,999	1.8, 1.1–3.0	0.28	0.14–0.56	<0.001	1.6, 0.4–2.5	0.13	0.05–0.37	<0.001
	20,800 – 51,999	4.1, 1.3–25.0	0.80	0.41–1.57	0.51	3.8, 1.3–23.5	0.68	0.30–1.57	0.37
	< 20,799	3.3, 2.0–8.8	0.67	0.22–2.04	0.48	3.4, 2.6–40.0	0.71	0.17–3.07	0.65
	Pensioner	5.9, 2.5–18.0	1			5.9, 2.9–38.2	1		
Risk Factors									
Diabetes	Yes	3.7, 2.0–21.1	1.42	0.86–2.33	0.17	3.1, 2.0–45.1	1.43	0.76–2.71	0.27
	No	3.9, 1.7–10.7	1			3.7, 2.0–12.0	1		
Hypertension	Yes	4.2, 2.0–15.0	1.28	0.81–2.04	0.29	3.9, 2.2–26.1	1.20	0.66–2.19	0.55
	No	3.2, 1.6–10.2	1			3.2, 1.8–10.5	1		
Dyslipidaemia	Yes	3.6, 2.0–15.1	1.07	0.67–1.69	0.78	3.4, 2.0–20.4	1.12	0.61–2.04	0.72
	No	3.9, 1.7–12.2	1			3.6, 1.8–11.9	1		

Table 3. (continued).

Variable		Whole cohort				Direct Admission Cohort			
		Delay (hours)	Univariable linear regression			Delay (hours)	Univariable linear regression		
		Median, IQR	Exp(B)	95% CI	P-value	Median, IQR	Exp(B)	95% CI	P-value
Family history of	Yes	3.0, 1.6–21.7	0.92	0.56–1.49	0.72	2.9, 1.8–17.5	0.84	0.45–1.55	0.57
MI	No	4.1, 1.9–10.5	1			3.9, 2.2–15.1	1		
Smoking (current)	Yes	3.3, 1.8–15.1	0.94	0.55–1.60	0.82	3.4, 2.0–31.0	1.37	0.69–2.73	0.37
	No	4.0, 1.8–12.2	1			3.6, 2.0–13.2	1		
History of coronary	Yes	3.4, 2.0–14.7	0.92	0.56–1.49	0.72	3.9, 2.1–20.9	1.10	0.59–2.03	0.77
heart disease	No	3.9, 1.8–12.2	1			3.5, 2.0–15.4	1		
Past Medical History									
Previous Angina	Yes	3.0, 1.8–6.9	0.84	0.45–1.55	0.57	3.1, 2.0–7.1	0.79	0.39–1.59	0.51
	No	3.9, 1.8–12.6	1			3.6, 2.0–18.5	1		
Previous PCI	Yes	3.5, 2.0–21.3	1.12	0.68–1.85	0.65	4.0, 2.2–26.3	1.17	0.64–2.16	0.61
	No	3.9, 1.8–12.0	1			3.5, 1.9–11.9	1		
Previous MI and previous CABG					0.25				0.13
Neither previous MI or previous CABG		3.9, 1.9–11.7	1.38	0.72–2.67	0.33	3.5, 2.1–13.2	1.42	0.64–3.14	0.39
Both previous MI and previous CABG		4.1, 2.0–27.0	2.25	0.86–5.85	0.10	15.5, 2.2–144	3.63	1.04–12.7	0.04
Had previous MI		2.8, 1.3–8.0	1			3.0, 1.4–10.5	1		
Awareness of media campaigns and influence on decision to go to hospital					0.45				0.63
Unaware of media campaign		3.6, 1.8–11.6	1.10	0.49–2.49	0.81	3.1, 1.8–7.5	0.48	0.15–1.57	0.22
Aware									
-no influence on decision to go to hospital		4.9, 1.7–18.5	1.27	0.57–2.80	0.56	4.9, 1.9–22.7	0.78	0.23–2.66	0.69
-no influence, symptoms were different		5.7, 3.0–10.5	1.56	0.54–4.52	0.41	4.7, 3.0–108	1.03	0.91–5.54	0.97
-slight influence, made wrong decision		10.0, 1.1–27.0	1.71	0.62–7.74	0.30	18.7, 2.0–83.6	0.84	0.17–4.17	0.83
-no influence, past experience influenced		2.9, 1.3–4.2	0.64	0.24–1.75	0.39	3.8, 2.8–6.4	0.52	0.18–2.28	0.38
-influenced decision to go to hospital.		2.4, 2.0–9.8	1			2.5, 2.1–32.3	1		
Mode of transport to hospital and transfer status					0.002				
RFDS transfer from rural WA to tertiary hospital		6.3, 1.4–16.4	1.64	0.92–2.93	0.09				
Private transport to small metro hospital & transfer to tertiary hospital		5.1, 1.7–10.1	1.32	0.66–2.61	0.43				
Ambulance to small metro hospital & transfer to tertiary hospital		2.3, 1.5–7.3	1.00	0.48–2.10	0.99				
Private transport to tertiary hospital		8.4, 3.3–50.6	3.10	1.74–5.50	<0.001	8.4, 3.3–50.6	3.10	1.75–5.50	<0.001
Ambulance to tertiary hospital		2.9, 1.8–4.4	1			2.9, 1.8–4.4	1		
Type of MI	NSTEACS	4.7, 2.1–22.1	1.84	1.15–2.94	0.01	3.9, 2.3–28.2	1.71	0.91–3.22	0.10
	STEMI	2.5, 1.4–6.2	1			2.5, 1.8–6.0			

Table 3. **(continued).**

Variable		Whole cohort				Direct Admission Cohort			
		Delay (hours)	Univariable linear regression			Delay (hours)	Univariable linear regression		
		Median, IQR	Exp(B)	95% CI	P-value	Median, IQR	Exp(B)	95% CI	P-value
Symptom onset	Weekday	4.4, 1.9–15.4	1.61	0.96–2.69	0.07	3.9, 2.0–24.4	0.61	0.32–1.16	0.13
	Weekend	2.8, 1.3–5.9	1			3.2, 1.5–6.2			
Symptom onset	08:00 to 17:00	3.2, 1.7–12.3	0.81	0.51–1.29	0.38	3.2, 1.8–15.4	0.81	0.45–1.47	0.49
(time of day)	>17:00 to <08:00	4.2, 2.1–12.2	1			3.9, 2.2–21.3			
Symptom characteristics					0.07				0.02
Had one time and went away		8.1, 3.3–30.9	1.92	0.81–4.60	0.14	6.7, 3.3–58.1	2.58	1.02–6.52	0.04
Symptoms would come and go		8.7, 3.4–23.7	1.74	1.02–2.99	0.04	5.4, 3.3–48.0	2.25	1.09–4.64	0.03
Symptoms constant		2.9, 1.7–7.5	1			2.9, 1.8–7.5	1		
Self-treat symptoms	Yes	4.0, 2.0–12.6	1.00	0.62–1.61	0.98	3.9, 2.4–26.1	1.38	0.75–2.55	0.30
	No	3.8, 1.8–12.3	1			3.5, 1.8–11.4	1		
Similar symptoms	Yes	3.3, 1.8–14.4	1.11	0.70–1.78	0.66	3.5, 2.1–27.0	1.2	0.66–2.18	0.55
in the past	No	3.9, 1.8–12.0	1			3.6, 1.9–8.4	1		
Presenting symptoms reported									
Chest pain	Yes	3.7, 1.8–12.0	0.86	0.46–1.60	0.62	3.5, 2.0–16.4	1.09	0.49–2.45	0.83
	No	5.7, 2.3–16.4	1			3.8, 1.6–22.1	1		
Sweating	Yes	2.8, 1.6–6.6	0.47	0.30–0.73	0.001	3.0, 2.0–6.0	0.49	0.27–0.87	0.02
	No	6.4, 2.5–23.2	1			4.6, 2.4–38.2	1		
Heat sensation	Yes	3.0, 1.8–13.4	0.92	0.55–1.54	0.75	3.9, 2.1–21.3	1.01	0.51–2.01	0.97
	No	4.0, 1.9–12.3	1			3.5, 1.8–15.4	1		
Left arm pain	Yes	3.6, 1.8–9.4	0.72	0.45–1.15	0.17	3.2, 1.7–7.4	0.63	0.35–1.13	0.12
	No	3.9, 1.8–15.4	1			3.6, 2.1–26.5	1		
Right arm pain	Yes	4.1, 2.1–6.9	0.77	0.45–1.32	0.34	3.5, 2.5–6.1	0.71	0.35–1.44	0.34
	No	3.9, 1.8–15.3	1			3.6, 2.0–19.3	1		
Left shoulder pain	Yes	3.2, 1.8–11.4	0.91	0.55–1.50	0.71	2.9, 1.9–13.4	0.80	0.42–1.54	0.51
	No	4.0, 1.9–12.3	1			3.9, 2.0–18.8	1		
Right shoulder pain	Yes	4.2, 2.5–10.2	1.17	0.66–2.07	0.58	3.5, 2.5–10.0	1.00	0.50–2.03	0.99
	No	3.9, 1.8–12.3	1			3.6, 1.9–18.5	1		
Jaw, throat or neck	Yes	3.8, 1.8–15.6	1.25	0.77–2.01	0.37	3.2, 2.0–22.0	1.14	0.61–2.12	0.68
pain	No	3.9, 1.8–11.8	1			3.6, 2.0–11.8	1		
Short of breath	Yes	3.6, 2.0–14.4	1.12	0.71–1.78	0.62	3.8, 2.2–26.3	1.32	0.73–2.39	0.36
	No	3.9, 1.8–12.2	1			3.4, 1.6–12.2	1		
Breathing difficulty	Yes	2.9, 1.8–10.0	1.01	0.63–1.62	0.97	3.1, 2.2–21.3	1.27	0.69–2.34	0.45
	No	4.2, 1.8–14.5	1			3.6, 1.7–15.4	1		
Hyperventilating	Yes	2.5, 4.6–10.3	0.82	0.48–1.48	0.82	2.2, 1.7–9.6	0.66	0.30–1.44	0.29

Table 3. (continued).

Variable		Whole cohort				Direct Admission Cohort			
		Delay (hours)	Univariable linear regression			Delay (hours)	Univariable linear regression		
		Median, IQR	Exp(B)	95% CI	P-value	Median, IQR	Exp(B)	95% CI	P-value
	No	4.1, 1.9–12.9	1			3.9, 2.0–18.9	1		
Nausea	Yes	2.8, 1.8–7.1	0.64	0.39–1.04	0.07	2.9, 1.8–7.1	0.68	0.36–1.28	0.23
	No	4.2, 2.0–18.5	1			3.9, 2.2–26.1	1		
Indigestion	Yes	5.5, 1.9–33.9	1.48	0.82–2.69	0.19	3.7, 2.0–44.5	1.39	0.68–2.85	0.37
	No	3.8, 1.8–11.8	1			3.5, 2.0–14.8	1		
Dizziness	Yes	3.9, 1.8–12.3	0.92	0.55–1.52	0.92	3.7, 2.1–22.0	0.90	0.47–1.71	0.75
	No	3.8, 1.8–12.2	1			3.5, 2.0–15.6	1		
Light headed	Yes	3.3, 1.4–16.5	0.91	0.56–1.46	0.69	3.9, 2.3–33.1	1.5	0.82–2.74	0.19
	No	4.1, 2.0–12.0	1			3.2, 1.9–7.7	1		
Weakness	Yes	3.6, 2.0–15.6	1.07	0.67–1.70	0.78	3.7, 2.2–20.6	1.14	0.63–2.08	0.66
	No	4.2, 1.8–12.1	1			3.4, 1.8–12.2	1		
Fatigue	Yes	3.7, 2.0–15.4	1.18	0.74–1.87	0.48	3.6, 2.2–21.3	1.20	0.66–2.18	0.56
	No	4.0, 1.8–11.2	1			3.5, 1.7–14.5	1		
Upper back pain	Yes	5.3, 2.5–11.8	1.17	0.67–2.03	0.58	6.0, 3.0–33.3	1.49	0.69–3.22	0.30
	No	3.5, 1.7–13.0	1			3.2, 1.9–14.8	1		
Unusually scared	Yes	4.2, 1.8–14.6	0.99	0.61–1.60	0.97	3.6, 2.1–12.3	0.87	0.47–1.62	0.66
	No	3.7, 1.8–12.2	1			3.5, 2.0–19.3	1		

Abbreviations: n, number; %, percentage; IQR, interquartile range; Exp(B), exponential beta coefficient; CI, confidence interval; MI, myocardial infarction; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft; RFDS, Royal Flying Doctor Service; WA, Western Australia; STEMI, ST Segment Elevated Myocardial Infarction; NSTEACS, non-ST Elevation Acute Coronary Syndrome.

Table 4 **Multivariable linear regression log delay time in hours.**

Variable		Whole Cohort			Direct Admission Cohort		
		Multivariable linear regression			Multivariable linear regression		
		Exp(B)	95% CI	P-value	Exp(B)	95% CI	P-value
Marital status				0.007			0.005
Never married		0.82	0.38–1.73	0.60	0.76	0.33–1.75	0.52
Widowed		3.53	1.82–6.88	<0.001	4.3	1.93–9.60	<0.001
Divorced		1.08	0.58–2.02	0.81	1.19	0.58–2.41	0.64
Separated		1.61	0.71–3.66	0.26	1.53	0.63–3.74	0.35
Defacto		0.92	0.37–2.32	0.87	0.66	0.28–1.55	0.34
Married		1			1		
Annual household income (A$)							0.003
>104,000					0.68	0.32–1.44	0.32
78,000 – 103,999					1.20	0.54–2.64	0.66
52,000 – 77,999					0.20	0.08–0.47	<0.001
20,800 – 51,999					0.83	0.44–1.45	0.47
< 20,799					1.36	0.47–3.97	0.57
Pensioner					1		
Previous MI and previous CABG				0.001			<0.001
Had neither previous MI or previous CABG		2.83	1.51–5.31	0.001	2.28	1.18–4.39	0.01
Had both previous MI and previous CABG		4.64	1.99–10.8	<0.001	6.63	2.62–16.8	<0.001
Had MI only		1			1		
Mode of transport to hospital and transfer status				<0.001			
RFDS and transfer to tertiary hospital		1.77	1.06–2.96	0.03			
Private transport to small metro hospital and transfer to tertiary hospital		1.45	0.77–2.73	0.25			
Ambulance transport to small metro hospital and transfer to tertiary hospital		1.01	0.52–1.96	0.98			
Private transport to tertiary hospital (no transfer)		4.14	2.44–7.03	<0.001	4.19	2.63–6.68	<0.001
Ambulance to tertiary hospital (no transfer)		1			1		
Symptom onset	Weekday	1.63	1.09–2.44	0.02	2.02	1.28–3.18	0.002
	Weekend	1			1		
Sweating	Yes	0.46	0.31–0.68	<0.001	0.34	0.22–0.53	<0.001
	No	1			1		
Weakness	Yes	1.58	1.06–2.34	0.02	1.85	1.19–2.86	0.006
	No	1			1		
Age (continuous)		1.00	0.98–1.01	0.62	0.96	0.94–0.98	0.001
Sex	Female	1.18	0.74–1.86	0.49	1.53	0.87–2.68	0.14
	Male	1			1		

Abbreviations: IQR, interquartile range; Exp(B), exponential beta coefficient; CI, confidence interval; MI, myocardial infarction; CABG, coronary artery bypass graft; RFDS, Royal Flying Doctor Service.

'heart attack warning signs' media campaign was associated with shorter delay times; however, another study conducted in Canberra [21] also did not find an association. Recently, a study in Brisbane [22] found no association between awareness of the media campaign and ambulance use in a cohort of patients with acute coronary syndrome. The major limitation of these studies is small sample size.

This study found that patients who were widowed had longer delay times. Other studies [23,24] have found being married is associated with shorter delay times; similarly, some studies [6,25,26] have suggested that being with a companion and not being alone is associated with shorter delay time. Interestingly, the thematic analysis [15] conducted alongside this study also suggested that the person who was the patient's first point of contact influenced the decision to go to hospital. This finding may be relevant to targeting future media campaigns.

In this study, similar to another study [27], symptom onset on the weekend was associated with delay. Our complementary thematic analysis [15] found many of the patients preferred to visit their General Practitioner (GP), so it is possible that symptom onset on the weekend is associated with shorter delay time as many GP surgeries are not open on the weekend. It is important that future campaigns stress the importance of prompt arrival at the ED.

Our finding that previous history of MI and CABG was associated with delay time is in contrast with other studies [25,26]. Even though not supported in the literature, patients with previous MI had shorter delay times than patients without previous MI or CABG, which does seem logical. However, a novel finding in this study, and one that is not evaluated in detail in previous studies, was that patients with previous MI and CABG compared with previous MI alone also had longer delay times. This may suggest patients thought they were less likely to have a second MI as they already had CABG surgery, and this is another finding that may be relevant to the design of future media campaigns.

Similar to this study, there is consensus in the literature that calling an ambulance decreases delay time [28,29]. This study found that less than half of the patients diagnosed with MI called an ambulance (n = 111, 44%) after symptom onset. In other Australian studies [20,21,30,31], 34% to 71% of patients called an ambulance. These percentages are disappointing, considering that calling an ambulance has been emphasised in previous media campaigns Australia wide, and obviously needs to be a focus of future campaigns.

As this study includes transfers from small peripheral metropolitan hospitals and rural WA, new knowledge has been gleaned about delay times. Formal reperfusion protocols [32] were utilised for rural, remote, and peripheral metropolitan locations during the study period. Our finding of similar delay times for 'ambulance to tertiary metropolitan hospitals' and delay times to 'small peripheral metropolitan hospitals transferred to tertiary hospital' is reassuring. Also, the median delay time of 6.3 hours from rural WA via RFDS to tertiary hospital is reassuring considering the size of the state. Of note, we found almost half of the rural patients used private transport to arrive at their local hospital. This may be because private transport is perceived to be quicker than an ambulance in rural WA or it may be because there was no ambulance available to respond.

The presenting symptom of sweating is often associated with decreased delay times [6,8]; however, we found no other published studies that showed the symptom of weakness was associated with increased delay. This finding warrants further investigation.

Strengths and Limitations

The strengths of this prospective cohort study include interviewing all patients with MI over a 7-month period and our ability to adjust analyses for patient characteristics (e.g. age, sex, comorbidity etc.) and presenting symptoms. However, several limitations need to be considered: sample size was limited and the study may have been underpowered to identify other characteristics associated with delay. This study may not be generalisable as the patients were from a single hospital; however, the patients were from both metropolitan and rural WA. There is no reason to suggest that patient characteristics, presenting symptoms, and familiarity with media campaigns would differ in other states of Australia. We also did not have access to ambulance data and could not calculate ambulance transport or inter-facility transfer times. Nevertheless, we did analyse two separate models as media campaigns are unlikely to influence ambulance and inter-facility transfer times. Also, this study was observational and relied on self-reported symptom onset-time to calculate prehospital delay, which may be inaccurate due to recall bias. Additionally, we did not ask patients if their health insurance status was related to reluctance to call an ambulance.

Implications for Future Research

Although minimising delay time after symptom onset improves survival, we found many patients had prolonged delays to hospital arrival. Media campaigns need to stress the importance of calling an ambulance as soon as possible after symptom onset, not contact a General Practitioner, and not arrive at the hospital by private transport. Future research studies of media campaigns should include large sample sizes and target family members and friends of the patient, and assess their awareness of media campaigns and if the campaigns influenced their decision to call an ambulance and seek immediate care. We also need to investigate whether reluctance to call an ambulance is related to cost and whether universal ambulance cover should be offered to all Australians.

Conclusion

This study did not find an association between patient awareness of media campaigns about heart attack and delay.

Variables associated with delay were widowed marital status, symptom onset on a weekday compared with weekend, past medical history of MI and CABG, private mode of transport to hospital, and lack of symptoms of sweating and weakness. In addition, age and income were associated with delay in the Direct Admission Cohort. These findings are relevant to the design of future media campaigns.

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Conflict of Interest

The authors have no conflict of interest to declare.

Ethical Approval

Ethical approval was given by the Sir Charles Gairdner Group Human Research Ethics Committee, Perth, Australia (2013-012).

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