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Factors affecting time to arrival in hospital among patients with acute myocardial infarction (MI)

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Abstract

Time is crucial in the treatment of acute myocardial infarction but patients still come late to the hospital. This study aims to determine the factors which delay such patients coming to the ICCU. 100 patients (74 men & 26 women) of acute MI were interviewed. The mean time from symptom onset to ICCU arrival was 28 hrs. 55 min. (+ 96hrs 45min). 51 patients came within 6 hours – 13, 20 and 18 within 1,3 and 6 hours. Using the dependent variable of time as a binomial variable, univariate analysis showed that a perception that the chest pain could be cardiac in origin was more common among the early arrivers (<6 hrs) while, visiting a doctor in the clinic instead of going to an ICU directly, was more common among the late arrivers. Logistic regression analysis showed these two as significant factors with a weak to moderate relation (coefficient of determination r^2= 0.22 only). Analyzing the data using time as a continuous variable, which is the more appropriate statistical method, the statistical significance of the above two factors reduced to a trend, while another factor emerged – presence of a (para)medical person in the family hastened arrival to the ICCU. Multiple regression analysis did not reveal a statistically significant correlation (r^2 = 0.089). Gender, age, literacy, mode of transport and past history of MI were not significant factors. To conclude, patients with acute MI still arrive late to the ICCU with two important reasons being the decision making of the patient based on a perception that the pain could be cardiac, and, going to an ICCU directly rather than to a doctor's clinic or hospital without such facility.

Keywords: Myocardial Infarction, Time to arrival, Prehospital delay.

Introduction

Acute myocardial infarction (AMI) is a medical emergency. The advent of intravenous thrombolytic treatment and primary angioplasty into the therapeutics of this disease has greatly improved the outcome. The benefits in terms of survival as well as left ventricular function have been shown in multiple trials for both intravenous thrombolysis[1-4] as well as primary angioplasty. However, these treatments should be given as early as possible - a review of nine trials of fibrinolytic therapy showed that the absolute mortality reduction was about 30 per 1000 patients presenting within 6 hours of onset of pain and about 20/1000 among those coming 7-12 hours later[5].

A review of 23 randomised trials has shown that primary angioplasty is better than thrombolysis reducing short term mortality (7% vs. 9%), re-infarction (3% vs. 7%) and stroke (1% vs. 2%)[6]. Hence primary angioplasty is the preferred mode of treatment when available; however, even this treatment has to be instituted early to achieve the mortality gains. A pooled analysis of 4 trials has found that infarct size is strongly related to involvement of left anterior descending artery, male gender, (near-) total occlusion of the artery and delay in performing angioplasty – the infarct size was smallest (median infarct size 4%) when symptom-to-balloon time was < 2 hours, and increased with time (8% when the time elapsed is 2-3 hours and 11% when the delay was > 3hours)[7]. Mortality and left ventricular function have been shown to be related to delay in performing primary angioplasty. A study of 1352 patients treated with primary angioplasty found that left ventricular function was best improved (by 6.9% vs. 3.1%) and mortality was lowest (4.3% vs. 9.2%) when reperfusion was achieved within 2 hours of onset of pain[8].

In our hospital, we have been able to reduce the door to needle time for intravenous thrombolysis to about ten minutes because, in our hospital, patients with chest pain can come directly to the ICCU without going through the Emergency Room / Outpatient Registration; an ECG is recorded even as the patient is quickly evaluated to confirm a diagnosis of ST elevation MI and eligibility for

thrombolysis, which is provided free to all patients.

Further, the government of Andhra Pradesh launched the Rajiv Aarogyasri Health Insurance Scheme (now re-christened as NTR Vaidyaseva) in Andhra Pradesh in 2007[9] – under this state sponsored health insurance scheme, patients who are BPL (Below Poverty Line) card holders can obtain free treatment for a list of diseases in hospitals empanelled for this purpose. The state government has also provided a 108 Ambulance service to transport seriously ill patients free of cost to the hospital where they wish to seek treatment from. Thus, while we have been able to minimize our door to needle time to a great extent, and, the government, on its part, has been doing everything it can do, to help patients reach hospitals early and seek treatment, there still remains a significant proportion of patients who come late to the hospital.

Study Objective

To determine the factors which influence, how soon or late, patients with chest pain due to myocardial infarction arrive at an ICCU where they can get appropriate treatment (thrombolysis or percutaneous coronary intervention).

Methodology

Approval from the Institutional Ethics Committee of Andhra Medical College was obtained prior to commencement of the study. Informed consent was taken from all participating patients. 100 patients of acute myocardial infarction who were admitted into the Department of Cardiology were included in the present study. A questionnaire was administered to them on the second day of admission or, if they were too ill to answer, on the next day.

The patients were asked about time of onset of symptoms of acute MI, when and whom they first consulted, what advice was given, when a diagnosis of MI was made, time of reaching the ICCU and time of administration of treatment, including streptokinase. Information was sought about their age, educational status, occupation, distance of home from hospital, mode of transport, what they thought their complaint was due to (cardiac or other), past Coronary Artery Disease and presence of a medical / paramedical person in the family.

Data were analysed to determine the factors affecting the time to arrival at the ICCU, using t-test, chi-square test, univariate and multivariate analysis with a p value of 0.05 for statistical significance.

Results

There were 74 males and 26 females (M:F ratio = 2.85:1). The mean age of the group was 57.57 ($\pm$9.95) years with a range of 24 to 79 years. The mean time from symptom onset to arrival in the hospital ICCU was 28hrs 55min. (SD=96hrs 45min) with a range of half an hour to a week (168 hours). 51 patients came to the ICCU within 6 hours of onset of symptoms – 13 came within 1 hour, 20 within 3 hours and 18 within 6 hours.

12 patients who were residing within 6 km.of the hospital came >6 hours after onset of their pain- one of them coming one week later! On the other hand, 3 patients living 120-150 km. away reached the ICCU within 3 hours.

Time as a dichotomous variable

When the dependent variable of time to arrival in hospital was converted into a binomial variable ($\leq$ 6 hours vs. > 6 hours), and univariate analysis performed, the results were as follows in table 1.

Table 1: Dependent and independent variable of time to arrival in hospital

Independent variable	Dependent variable = Time to arrival at ICCU (dichotomized)			p value
Gender	$\leq$ 6 hrs = 51 >6 hrs = 49	M=39;F=12 M=35;F=14	Chi square value = 0.12	NS
Age	$\leq$ 6 hrs = 51 >6 hrs = 49	Mean=56.25 yrs Mean=58.94yrs	t test	0.17 (NS)
Distance from home to hospital	$\leq$ 6 hrs = 51 >6 hrs = 49	Mean=33.8km Mean=53.4km	t test	0.08 (NS) ?trend
Thought pain is cardiac vs. Not cardiac	$\leq$ 6 hrs = 51 >6 hrs = 49	Suspected Cardiac =34 Suspected Cardiac =16	Chi square value = 10.24	p < 0.05
Visiting a private doctor or clinic vs. Cardiac Centre	$\leq$ 6 hrs = 51 >6 hrs = 49	Visited Clinic = 26 Visited Cardiac centre=39	Chi square value = 7.77	p <0.05
Past history of Acute MI in patient or family	$\leq$ 6 hrs = 51 >6 hrs = 49	Past h/o MI = 35 Past h/o MI = 36	Chi square = 0.09	NS
Education (illiterate vs. educated)	$\leq$ 6 hrs = 51 >6 hrs = 49	No school or to class3=20 No school or to class3=15	Chi square	NS
Medical /para-medical person in the family	$\leq$ 6 hrs = 51 >6 hrs = 49	(para-)medical at home=43 (para-)medical at home=47	Chi square value = 2.5	NS

Only two independent variables, the suspicion that the cause of chest pain could be cardiac (34/51 vs. 16/49), and, visiting a cardiac centre directly (25/51 vs. 10/49) were significantly associated with an earlier arrival to the hospital.

When a logistic regression analysis was done keeping time to arrival at the ICCU as a dichotomous dependent variable, these two variables – suspicion that the chest pain could be cardiac (p=0.014) and visiting a cardiac centre directly (p=0.019) were significantly associated with earlier arrival to the ICCU. However the correlation coefficient was only 0.47 indicating a weak to moderate relation. (significance F = 0.006). The Coefficient of Determination (r^2) was 0.22 – i.e. only 22% of the values fit the model; ideally r^2 should be at least 0.6 or 0.7.

Time as a continuous variable

When time was taken as a continuous variable (which is the more appropriate statistical method) and univariate analysis performed against the other independent variables, the results were as follows in table 2.

Univariate analysis revealed only one significant factor affecting time to arrival – presence of a medical or paramedical person in the family. 10 patients had such a person in the family – 2 doctors, 3 nurses, 2 technicians, 2 medical students and 1 medical representative. The mean time to arrival in these patients was 3.6 hours (SD 3.4) compared to 31.7 hours (SD 101.5) in the rest of the group.

Univariate analysis showed a trend towards statistical significance for two independent variables – the patient thinking it was cardiac pain and visiting a cardiac care centre directly. The mean time to arrival at an ICCU, among patients who thought their pain was due to a myocardial infarction, was 10.9 hours (SD19.9) compared to 46.9 hours (SD133.5) among those who thought their pain was noncardiac (p=0.06). Most of the patients in this group thought it was 'gastric' in etiology. Similarly, the mean time to arrival to the ICCU among those who visited a cardiac centre directly was 11.5 hours (SD 29.8) vs. 38.3 hours (SD 117.2) among those who first visited a doctor in the clinic or a hospital without ICCU facility (p=0.08). A larger study sample might have made both these differences statistically significant.

When time was considered as a continuous variable and multiple regression analysis was performed, there was only a weak correlation (Multiple R of 0.29) which was not statistically significant (significance F = 0.45). The Coefficient of Determination (r^2) too was only 8.9%; none of the independent variables tested reached statistical significance.

Table 2: Time as a continuous variable

Time as a continuous variable	Independent variable		p value
	Gender Male – Female -	Mean time = 21.9 (±37.6) hrs Mean time = 48.9(±179.8) hrs	p=0.45
	Age	Correlation coefficient = – 0.06	No significant correlation
	Distance	Correlation coefficient = – 0.05	No significant correlation
	Thought pain is cardiac vs. Thought Not cardiac	Mean time to ICCU = 10.93 (±19.9) hrs Mean time to ICCU = 46.93(±133.5) hrs	p=0.06 (?trend)
	Visit to a general clinic vs. Visit to cardiac centre	38.3(±117.2) hrs 11.5 (±29.8)hrs	p=0.08 (?trend)
	Mode of transport	ANOVA	p=0.94 (NS)
	Past h /o MI in patient/family vs. No such history	19.7 (35.4)hrs 32.7 (112.5)hrs	p=0.39 (NS)
	Educational status	ANOVA	p=0.59 (NS)
	Presence of (para-)medical person in family vs. No such person	3.6 (3.4) hrs 31.7 (101.5)hrs	p=0.02

Discussion

Patients with acute coronary syndromes, including acute myocardial infarction, must be admitted into an Intensive Coronary Care Unit as quickly as possible so as to initiate reperfusion therapy and preserve as much myocardium as possible so as to reduce subsequent morbidity and mortality. Several studies have shown an inverse relation between symptom-to-door time and administration of Streptokinase[10], LV ejection fraction[11] which is an important prognostic factor in acute MI.

There are two principal phases of delay in treatment of acute MI patients – the pre-hospital phase (symptom to door time) and the hospital phase (door to needle / balloon time). While the former is mainly dependent on patient related factors, the latter can be minimized by measures initiated by the hospital.

A two year study in a general hospital found that while the average time between onset of pain and arrival at hospital was over 6 hours, the door to ECG time averaged 19 minutes while the door to needle time was 51 minutes[12]. Because our hospital has a custom of permitting direct entry of patients to the Cardiology ICCU, without having to go through the Casualty, and because we have round-the-clock services of qualified cardiology personnel, we have been able to minimize our door to needle (streptokinase) time to just over ten minutes. Further, the government of Andhra Pradesh provides free medical treatment, including streptokinase, to patients with acute MI, besides providing free health insurance for all economically disadvantaged patients to undergo such treatment including primary angioplasty free in designated hospitals; the government also runs a free ambulance service on telephoning the number - 108. Thus, even the factor of lack of health insurance or inability to pay which has been implicated in leading to delay in patients of acute MI reaching an ICCU[13] has been effectively addressed. Yet, our study showed that some patients with acute MI still come late to the ICCU – in the present study, only 51 came within 6 hours. Ironically, there were 12 patients living within half an hour distance (6km) of the hospital who came beyond 6 hours, (one of them one wee late), while 3patients living more than 100km. away, came within 3 hours.

As early as 1969-70, two studies found interesting results implying that the patient taking a decision and their psychological makeup were important factors in determining the time to hospital arrival in patients with acute MI[14,15] Arthur Simon and group, in their study divided the Hospital Arrival Time (HAT) into Prodromal period, Patient decision time, Lay consultation time, Medical decision time and Travel time.

The Worcester Heart Attack Study which has been studying temporal trends and delaying factors in acute MI has shown interesting findings[16,17]; – that the average time pain-to-door time has not changed much over the past few decades! It was about 4 hours in 1980s and in the 90s too. Factors contributing to delayed hospital arrival were older age, diabetes and previous MI /angina.

Several subsequent studies have given varying results and could depend on the region where the study was conducted, including geographical, socio-cultural, economic and other factors. Such differences are to be expected – a study of acute MI patients in 5 countries[18] found that median delay ranged from 2.5 hours in England to 6.4 hours in Australia. They attribute the differences to the sociocultural background and nature of medicare (nationalized vs. private).

Some of the studies and the factors which found to be significantly associated with delayed hospital arrival are given in the table 3.

Table 3: Factors associated with delayed hospital arrival

Authors	Year	Place	n=	Delaying factors	No effect
Kathleen Dracup *et al.*[18]	1997	North America	277	Elderly Diabetes Not recognising symptoms as cardiac Waiting for symptoms to disappear Unaware of importance Fear what happens if they seek treatment	Severity of pain
Jerry H Gurwitz *et al.*[19]	1997	Minnesota	2409	Elderly Women Evening onset of symptoms Hypertension Angina & h/o revascularization – came early	
Berglin Blohm *et al*[20].	1998	Sweden	1727	Elderly Women Hypertension	Previous MI
Leslie WS *et al.*[21]	2000	Glasgow	313	Not recognising pain as cardiac Thinking symptoms will resolve Visiting General Practitioner instead of calling Emergency Medical Service	
Elizabeth George *et al.*[22]	2001	South India	1072	Older age Women Daytime onset of symptoms	Previous MI Mode of transport
Ram E Rajagopalan[23]	2001	Chennai	144	Elderly >65 yrs Seeing a General Practitioner first Severe symptoms – came earlier	Gender Hypertension Diabetes Previous MI
Grossman SA *et al.*[24]	2003	Boston	374	Older age Atypical symptoms	
Ayrik C *et al.*[10]	2006	Turkey	520	Elderly Women Diabetes	
Franco B *et al.*[25]	2008	Brazil	112	Recognising symptoms as cardiac – came earlier Unmarried – earlier	
Song L *et al.*[26]	2010	Beijing	498	Ambulance later (but earlier care)	

Liaqat *Ali et al.*[27]	2011	Pakistan	185	Women Diabetes, hypertension Seeing a General Practitioner first Unawareness of CAD Distance	
Brokalki H *et al.*[28]	2011	Greece	477	Absence of attendant Diabetes Distance Absence of nausea /vomiting	
Prashantha B *et al*.[29]	2013	Lucknow	220	Decision taking time Unawareness of seriousness Rural Literacy Socioeconomic status	
Farshidi *H et al.*[30]	2013	Iran	227	Unawareness of CAD Self medication (educated & family h/o CAD – came earlier)	age gender mode of transport
Saberi F *et al.*[31]	2014	Kashan	117	Location mode of transport	--
Mussi *FC et al.*[32]	2014	Salvador	97	Not recognizing symptom as cardiac	gender

A meta-analysis of 73 studies has concluded that the patient's uncertainty about their symptoms, advanced age and female gender are important delaying factors, others being a lower socioeconomic status / literacy and history of hypertension, diabetes or angina; some of those studies found a quicker arrival among smokers and those with a past MI[33]. There is thus a need for each region to determine the factors which determine how early or late a patient with AMI would attend the ICCU.

A univariate analysis of the factors studied showed two factors were significantly different in those who came early and those who came late – thinking that their complaint was cardiac and visiting a local practitioner vs. a cardiac centre first. Age, gender, education, a prior history of AMI in them or their family, or presence of a medical /paramedical person in the family, were not significantly different in the two groups.

Two thirds of patients (34/51) of those who reached the ICCU within 6 hours came because they were worried that their complaint was cardiac in origin, while only about one third (16/49) of those who arrived late thought their pain was cardiac in origin. This fact was brought out half a century ago when Thomas Hackett and group concluded that "patients who recognized their heart as causing the symptom sought help sooner than those who displaced the cause to other organ systems and patients who interpreted the symptom solely in terms of excluding the heart as causal delayed the longest"[14]. Arthur Moss in his 1970 paper divided the Hospital Arrival Time into 3 intervals – a Decision Time, an Unaccounted for Time and a Transportation Time (which was relatively constant at about 25 min.) – Decision Time consumed over half of the HAT and the patient's psychological makeup of the patient is an important factor in the decision making process.[15] Several subsequent studies also concluded that patients 'not recognising their symptom as cardiac' come later than those who attribute their pain to the heart.[18,25,32]

Similarly, just under than half of the early-comers (26/51) visited a general practitioner or a hospital without ICCU facilities before being referred here, compared to about 80% of late-comers (39/49). A similar conclusion was drawn by others[21,23,27] including a substudy from the Indian subconitinent[23] and one from Pakistan[27]. In the Indian study, nearly 40% of cases were misdiagnosed initially, leading to delayed ICCU arrival.

Logistic regression analysis revealed that these two factors – suspicion that the pain was cardiac, and, coming directly to the ICCU, showed a weak to moderate correlation with early arrival to the ICCU (correlation coefficient = 0.47)

This is the general statistical method adopted by many studies – dichotomizing the continuous variable of time into < 6 hours and > 6 hours. This approach has been frowned upon and is not advised except under special situations.[34] It is often quoted that categorizing continuous variables into intervals is a disaster.

Hence we have performed a univariate analysis and a multiple regression analysis retaining time in its pristine form – as a continuous variable. Univariate analysis revealed a significant difference only for the presence of a (para-)medical person in the family – the mean time to arrival in this group was 3.4 hours (SD 3.6) vs. a mean time of 31.7 hours (SD 101.5) in the group which did not have any medical or paramedical person in the family. We could not find this factor being studied in about 50 research articles on this subject nor is this factor listed in the meta-analysis[33] or the 2006 AHA Scientific Statement on Reducing delay in seeking treatment by patients with ACS and stroke[35] (aha statement 2006 – debra k moser *et al*). We hypothesise that presence of a medical or paramedical person in the family would help hasten the decision to seek medical aid for the patient's complaint.

The two factors of the patient thinking their symptom is cardiac in origin and visiting a general practitioner first, did not show significant difference in the univariate analysis but only a trend – large samples may have given clearer results. With time as a continuous variable, when we did a multiple regression analysis, none of the factors showed any significant differences in the early vs. late arrivals; the correlation was weak and did not reach statistical significance.

Studies conducted in Indian hospitals showed different reasons for delay in AMI patients reaching a cardiac ICU – female gender, elderly, assuming the pain is gastric in origin, unawareness of the seriousness of AMI, and, visiting a general practitioner first[13,22,23,29]. The time taken for decision making was an important factor[29] and the main reason for this was assuming the pain was noncardiac, followed by unawareness of the seriousness of a cardiac event. The present study too showed that thinking the pain was noncardiac was an important contributor to delay and the common organ implicated was the gastro-esophageal system.

Similarly, visiting a doctor in the clinic or a general practitioner has been found to be an important contributor to delay in patients with MI reaching an ICCU. It has been suggested that a patient visiting a GP and delaying a visit to the ICCU may inherently be a 'delayer'[23] and (s)he misinterprets the doctor's advice and takes into cognizance only those words that strengthen their own belief that it is a noncardiac pain[36]. However, we have found, during the individual interviews, that much time is wasted in sitting in the waiting hall of the doctor for their turn, then having to go to a lab for an ECG (not all doctors have ECG machines with them) and again returning to the doctor for an opinion. On the other hand, when patients with chest pain visit the Emergency Room of a hospital are immediately seen by the duty doctor and an ECG is taken before an appropriate decision to thrombolyse is taken. The Chennai study found that 40% of acute coronary syndromes seen by GPs were misdiagnosed[23], calling for their education to read ECGs.

The above two factors highlight the need to educate the public regarding recognising symptoms of acute coronary syndrome, its seriousness, and, visiting a cardiac care unit immediately or at least a hospital where the ECG and doctor (who can interpret the ECG) are available together. Moreover, wireless transmission of ECG has been found to be a useful pre-hospital strategy to triage a patient with chest pain[37]; in these days of multiple modes of fast and cheap modes of communications

technology, transmitting the ECG images for an expert opinion is a feasible proposition, for example, through whatsapp. Public education, however has given mixed results with one study showing that only patients with a recent MI benefited from a campaign to call 911 fast[38] – hence there is a need to design a health education campaign that will work.

Gender and age did not show any significant impact on time to arrival in the present study, nor did mode of transport, educational status or past history of MI in the family. It is heartening that gender and age did not influence the time to arrival as several other studies have shown that women and the elderly arrive later to the ICCU, compared to the younger patients and men[18,19,20,22]. This would mean that in our region, women and elderly are not neglected but their health is given equal importance. Access to various modes of transport including own vehicles, hired vehicles and the government run ambulance services, has made this an insignificant determinant of time taken to arrive at the ICCU.

Distance showed a trend towards significance, which would be expected of course, but obviously it has been overpowered by the decision making factor and visiting a doctor (rather than the ICCU directly). Similarly, our analysis above has shown that presence of a medical or paramedical person in the family is associated with a quicker arrival to the ICCU.

Though the present study has shown only a couple of factors to be of statistical significance, these would be important for the representative group as a whole. Studying the individual interviews revealed that each of the other factors too could be important in a given individual. Hence though educational strategies and campaigns should stress on the importance of convincing the public to recognize a cardiac chest pain and visit an ICCU immediately, the other factors of availability of cardiac centres at accessible distances and easy modes of transport must also be addressed. Previous studies of public health education interventions have yielded mixed results – while studies in Sweden[39] & Switzerland[40] showed benefit in reducing the time to arrival, a large US campaign – REACT – failed to show any benefit[41].

The American Heart Association Scientific Statement[35] has suggested that public health educational campaigns should shift from just information-giving to addressing social, cognitive and emotional factors that can delay decision making in patients with chest pain.

We, in our institution, hope to use the print and television media innovatively, through ads and jingles, to educate the public in our region about acute coronary syndromes, their seriousness and the need to seek early medical aid, and, availability of cardiac centres in their vicinity, besides, providing a toll-free 24 hour telephone service with net connectivity so that patients with chest pain can call and send their ECGs by Whatsapp if needed. This strategy, we believe, will successfully supplement the exixting government provided health insurance scheme and free ambulance service, mentioned above, and thus help patients with chest pain seek immediate medical aid at a cardiac centre.

Conclusion

To conclude, various factors determine whether a patient with symptoms of acute myocardial infarction will arrive at the ICCU early or late, and, the most important of these are perception of the patient that the pain could be due to a cardiac pathology, and, visiting an ICCU directly instead of going to a doctor's clinic first. Presence of a para-medical person in the family also helps patients arrive early at the ICCU. Thus, public health campaigns to educate the people to recognize symptoms of an acute coronary event and immediately visit a nearest cardiac centre would help in initiating definitive treatment early which would save more myocardium and lives.

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