Prevalence and determinants of delays in care among premature deaths due to acute cardiac conditions and stroke in residents of a district in India

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Summary

Background Lack of timely care is a predictor of poor outcomes in acute cardiovascular emergencies including stroke. We assessed the presence of delay in seeking appropriate care among those who died due to cardiac/stroke emergencies in a community in northern India and identified the reasons and determinants of this delay.

Methods We conducted a social audit among all civil-registered premature (30–69 years) deaths due to acute cardiac event or stroke in the district. The three-delays model was used to qualitatively classify the delays in care-seeking—deciding to seek care, reaching the appropriate health facility (AHF) and initiating definitive treatment. Based on the estimated time from symptom onset to reaching AHF, we classified patients as early (reached within one hour) or delayed arrivers. We used mixed-effect logistic regression with postal code as a random effect to identify determinants of delayed arrival.

Findings Only 10.8% of the deceased reached an AHF within one hour. We noted level-1 delay in 38.4% (60% due to non-recognition of seriousness); level-2 delay in 20% (40% due to going to an inappropriate facility) and level-3 delay in 10.8% (57% due to lack of affordability). Patients with a monthly family income of >270US$ (aOR 0.44; 95% CI 0.21–0.93) were less and those staying farther from AHF (aOR 1.12; 95% CI 1.01–1.25 for each Km) were more likely to have delayed arrival in AHF.

Interpretation A small proportion of patients with cardiac and stroke emergencies reach health facility early with delays at multiple levels. Addressing the reasons for delay could prevent these deaths.

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Keywords: CVDs; Delay; Health services; Mortality; Stroke

Introduction

Globally 17.9 million people are estimated to die due to cardiovascular diseases (CVD) each year[1] with two-fifths of them being premature deaths in the age group of 30–69 years.[2] Ischemic heart diseases (IHD) and stroke constituted 85% of all CVD deaths in 2019.[3] In India, CVD accounts for 36% of all deaths occurring in the age group of 30–69 years.[4] Preventing these deaths should be a public health priority globally as well as in India.

Lack of timely care is one of the important predictors of poorer outcomes in cardiovascular emergencies. Delayed presentation leads to delay or failure to provide the most beneficial therapies like thrombolysis for myocardial infarction/ischemic stroke leading to poorer disease outcomes. It is estimated that interventions that reduce delays in care in patients with myocardial infarction (MI) could decrease risk of mortality by 30%.[5] A study reported that every 30 min delay in MI patients increased 1-year mortality by 7.5%.[6] It is well established that the sooner a thrombolytic therapy is given to stroke patients, the greater the benefit, especially if started within 90 min.[7] A reduction in delay in receiving appropriate acute care should be the cornerstone of planning acute cardiac and stroke services in all countries.

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Research in context

Evidence before this study

Hospital-based studies in India have reported prehospital delay of more than 6 h among 36%–42% of admitted acute myocardial infarction due to misdiagnosis of symptoms, inadequate prehospital healthcare infrastructure, high cost of care, lack of health insurance coverage, and making multiple stops to the facility.

Added value of this study

This first community-based study from India provides insights on delays in access to acute cardiac and stroke care at various levels and their determinants and reasons among those who died of an acute cardiac condition or stroke, the two most important killers of adults in India. The study enhances the understanding on complex web of health seeking behavior and the mobility of patients between local practitioner, transfers and referrals to reaching an appropriate healthcare facility.

Implications of all the available evidence

The study clearly identified affordability and accessibility as important factors for delays resulting in mortality and identified better insurance coverage and appropriate equipped ambulance linkages along with programs to improve recognition of a heart or brain attack among the populace.

Hospital-based studies from India have shown that between 36% and 42% of admitted acute myocardial infarction (MI) patients have a prehospital delay of more than 6 h.[8–10] Only one-third of ST-segment elevation myocardial infarction (STEMI) patients had a door-to-needle time of less than 30 min within the hospital.[11] Service providers have reported that delays in receiving appropriate cardiac care were due to misperception of symptoms, insufficient prehospital healthcare, high cost of treatment and lack of coverage with health insurance and making multiple visits before coming to the facility.[12] In a tertiary hospital-based study, the mean prehospital time for clinically suspected stroke was 716 min and the mean total in-hospital delay was 94 min. Lack of awareness of stroke symptoms led to the delayed seeking of treatment and in-hospital delays were due to patient admission procedures, lack of staff to transport the patient, and the distance between the stroke unit and radiodiagnosis facility.[13]

These hospital-based studies, reflect the situation of only the patients who reach the hospital. There is a lack of community-based studies from India to provide information on the amount and nature of delays in CVD/stroke patients who do not reach the hospital. This study was done to estimate the delays among persons aged 30–69 years who died prematurely due to acute CVD events including stroke in district Faridabad and identify the reasons and determinants of this delay. The study received ethical clearance from the Institutional Ethics Committee of the All India Institute of Medical Sciences (AIIMS), New Delhi.

Study framework

The study adapts the 'three delay' model (3DM) used in addressing maternal mortality.[14,15] The model proposes three critical points (or levels) of delay in seeking/receiving care - i) in recognizing a health emergency and deciding to seek care, ii) in reaching the right facility for care and iii) in getting a definitive treatment after reaching the hospital. The understanding gained by this model has been used for implementing public health interventions like centralized ambulance services, providing free obstetric care, and setting up first referral units to provide essential obstetric care. However, the delays are systemic and not specific to obstetric emergencies.[16] The same model has been applied for neonatal care as well as to essential surgical care and may apply to cardiac and stroke care as well.[17,18] (Fig. 1).

While there does exist complex interplay between the three phases, one type of delay is not linked inextricably with another. Also, in this model, the first level delay is related to socio-economic and cultural factors, the second level is affected by access to health services and the third level delay is indicative of the quality of care issues (Fig. 1). Reasons or causes in our framework were related to the circumstances of the terminal event and are based on the description of the actions from the onset of symptoms to the time of death. The reasons for the delay were reported by the caregivers and could be related to family-related factors or health-system related factors. These have been identified as recognition, physical and financial access and quality of care.[19] Determinants or risk factors are more distal factors, not directly related to the terminal event but contribute indirectly to the delay. The determinants of reaching a health facility late were related to household-related factors including socio-economic status, distance from the facility, availability of transport etc. as derived from a literature review including maternal death audit instruments.[8–13,20]

Methods

This descriptive study was conducted in two out of three tehsils (Badkhal and Ballabgarh) of the Faridabad district of Haryana, India with an estimated population of 21 lakhs in 2020.[21] We acquired a list of deaths registered between 1st July 2019 and 30th June 2020 from the Birth and Death Registrar's office of both tehsils

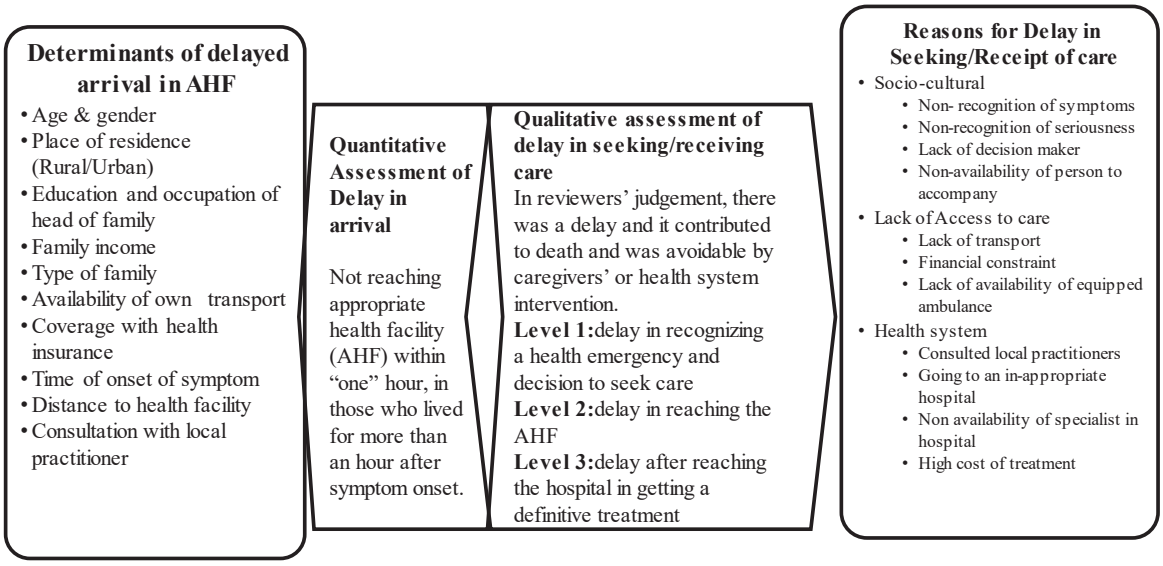

Fig 1: Conceptual framework of the study.

after getting written permission from the Municipal Commissioner, Faridabad. While the initial list was retrospective, bi-monthly visits were made to update the list prospectively from September 2019. All premature (30–69 years of age) deaths that occurred during this period among the residents were arranged by geographical area (sector/village). The list included lay reports of the cause of death and all non-injury deaths were included for verbal autopsy (VA).

The family members of the deceased were approached by trained field workers and explained about the study followed by a request for their consent. The preferred family member was one who was involved in care at the time of the terminal event. We used a validated VA tool that had 5 sections - identification details, a narrative of the terminal event, past history, 42 item symptom checklist, and treatment history.[22] The filled verbal autopsy forms were reviewed by three physicians and the cause of death was assigned as per the International Classification of Disease-10 (ICD-10). All the physicians involved were certified coders of the MINErVA Network.[23] If the physician found difficulty in coding a particular form, this was reviewed by a second physician in the team and the consensus code was considered final. The deaths due to an acute cardiovascular condition and stroke (ICD Codes – I10-11, I13, I20-26, I42, I44-51, I60, I64) were taken up for social audit. The patients who died in sleep or suddenly and did not have a chance to seek care were excluded from social audit.

Assessment of the presence of delay in seeking/receiving care

The family members of the deceased were approached by the trained medical social worker and consent was taken for social audit. A Social audit tool was developed based on a literature review of Maternal Death Audit tool[20] and variables listed in the study framework. We measured delays in seeking care in qualitative terms based on the subjective assessment of the description of the terminal event by the authors. A delay was judged to have happened if, in the reviewers' opinion, it contributed to the death and could have been "avoided" with caregiver or health system intervention.[24] Three of us (MA, RK, KA) jointly reviewed first 10 forms to develop a common understanding of the three delays classification and its reasons. Subsequently, each form was read by one of the authors (MA) to perform a subjective assessment of the reported delay and reasons given for any such delay reported. There could be multiple delays in a single patient, and these were included at all those levels.

Estimation of the delay in arrival to the appropriate health facility (AHF)

Each of the respondents was asked to provide a detailed timeline of the terminal event, especially of the key endpoints like recognition of symptoms, the decision to seek care, reaching the first health facility and all subsequent ones till reaching the final facility. Based on the timelines provided, we estimated the time intervals between the critical points identified in the above definitions.

Estimation of distance to the nearest AHF

We simultaneously carried out mapping of cardiac and stroke services in the district through a health facility survey which included the availability of human resources, equipment and service provision and plotted the

geospatial coordinates of all the health facilities. Based on the reported service availability, we identified hospitals that provided definitive treatment for acute cardiac events/stroke and labeled these as appropriate health facilities (AHF). Definitive treatment was defined as the availability of drug therapy to dissolve the clot or restore flow - fibrinolytic agents (streptokinase, tissue plasminogen activator), or primary coronary angioplasty facility and antithrombins (heparin) therapy.[25] We plotted the geospatial coordinates of the deceased residences and measured the distance between them and the nearest AHF using their GPS coordinates. We also identified the postal code of the residence and treated it as a variable.

The data were analyzed using Stata statistical software version 15.0. After cleaning the dataset, it was noted that details on income were not available for 26 participants. These were imputed based on the median value of the households with the same occupation group as the head of the household. The pathway of care till death was traced for each patient to document their health care seeking. A cumulative frequency curve was drawn to plot time to reaching the facility and death.

Based on the estimated time from onset of symptom to reaching AHF, we classified arrival to a health facility as early (reaching within the first hour) or late. We used mixed-effect logistic regression using age, sex, place of residence, education and occupation of the head of the family, family income, distance to the nearest AHF (as a continuous variable), type of family, health insurance coverage, ownership of transport, time of event and consultation with a local practitioner as fixed effects and postal code as a random effect to identify determinants of delayed arrival. All analyses were done separately for stroke and cardiac events except for the logistic regression due to small numbers. The differences in delays in seeking/receiving care between stroke and cardiac emergencies were tested for significance using Chi-square test. A similar analysis was also done to look at differences between the pandemic period (after March 25, 2020) and the pre-pandemic period.

In addition, we conducted in-depth interviews (IDI) with 6 cardiologists and 2 neurologists/neurosurgeons of the hospitals with definitive treatment in the district to understand their perspective on delays and barriers to care for data triangulation. We undertook a thematic content analysis of these interviews using a deductive approach based on the three-delay model framework.

Role of funding source

Indian Council of Medical Research (funding agency) had no role in study design, data collection, data analysis, interpretation and writing of the paper.

Results

From a total of 7164 deaths registered during the study period in the selected tehsils of Faridabad, 4089 (57%) deaths between 30 and 69 years were identified. Among the 3415 deaths of residents of the selected tehsils, 519 had incorrect addresses and 382 interviews could not be done due to COVID-19 related movement restrictions. Of the 2466 deaths with verbal autopsies, 761 (30.8%) were classified as due to CVDs. Of these, 517 deaths were classified as due to the pre-decided ICD codes and were eligible for assessment of delays in acute cardiac/stroke care. Social audits were done for 435 deaths and the remaining 82 could not be contacted or refused (Supplementary Fig. S1).

The profile of the deceased is shown in Supplementary Table. S1. There was a male preponderance (67.4%), 74.2% resided in urban areas and 81.6% were married. About half of the families had income below USD 270 per month, 21% of families did not own a vehicle and 53% were not covered by any health insurance scheme.

The characteristics of the terminal event are shown in Table 1. An ambulance was used in only 4.1% of the cases (8.1% in stroke cases) and in 32% of cases a vehicle was borrowed or hired to transfer the patient to hospital. Sixty-seven percent of the deaths occurred outside hospitals with about 21% occurring in transit. Only in 19.5% of the cases, the first health facility visit was to an AHF, 81% of which were from urban areas. Among those who sought care, the mean number of facilities visited was 1.7(SD: 1.03).

The care-seeking pathways of the terminal event for stroke and cardiac event are shown in Fig. 2. During the cardiac event, 36% (116/323) did not seek care, 15% (49/323) went directly to an AHF and 13 (4.2%) reached after being referred by the local practitioner. For stroke, these proportions were 23%, 19.6% and 1% respectively. One-fifth (62/323) of those with a cardiac emergency and 21% (24/112) with stroke sought treatment from a local practitioner who were more likely to refer to a non-AHF than AHF. About 4.3% of cardiac and 13.4% of stroke patients who reached a hospital went back and died at home.

The social audit showed that no delay was noted in 48% of cardiac cases and 33.9% of stroke cases (p value < 0.005). One-third of the deaths (38.4%; same in stroke and cardiac cases) reported level-1 delay which was due to non-recognition of symptoms as myocardial infarction or stroke (59.9%) and underestimating the seriousness of the situation (17.3%). In 16.2% of cases consulting a local practitioner was also adjudged to have led to a delay, more for stroke. Twenty percent of the cases (25.9% for stroke; $p < 0.0001$) reported level-2 delays which were attributed to lack of affordability (29.9%), going to an inappropriate hospital (40.2%) and delay in arranging transport (12.6%). Level-3 delay was present in 10.8% of cases (16.1% in stroke; $p < 0.0001$) with lack of affordability (57.4%) being reported as the prime reason. More than one level of delay was seen in 13.1% (57/435) of cases (Table 2). Eighty seven (20.5%)

Parameter	Cardiac event n = 323	Stroke n = 112	Total n = 435
Time of onset of first symptom, n (%)			
6:00 am–1:59 pm	129 (39.9)	58 (51.8)	187 (43.0)
2:00 pm–9:59 pm	100 (31.0)	40 (35.7)	140 (32.2)
10:00 pm–5:59 am	94 (29.1)	14 (12.5)	108 (24.8)
Transport used while taking to the hospital, n (%)			
Did not use transport	127 (39.3)	38 (33.9)	165 (37.9)
Ambulance	9 (2.8)	9 (8.1)	18 (4.1)
Own vehicle	85 (26.3)	28 (25.0)	113 (26.0)
Borrowed or hired vehicle	102 (31.6)	37 (33.0)	139 (32.0)
No. of hospital visited, n (%)			
0	186 (57.6)	49 (43.8)	235 (54.0)
1	80 (24.8)	27 (24.1)	107 (24.6)
2	34 (10.5)	23 (20.5)	57 (13.1)
3	16 (4.9)	7 (6.2)	23 (5.3)
4 or more	7 (2.2)	6 (5.4)	13 (3.0)
Place of death, n (%)			
Home	147 (45.5)	52 (46.4)	199 (45.8)
Transit	75 (23.2)	17 (15.2)	92 (21.2)
Hospital	101 (31.3)	43 (38.4)	144 (33.0)
% Where first hospital visit was to an Appropriate Health Facility	62 (19.2)	23 (20.5)	85 (19.5)

Table 1: **Description of the terminal acute cardiac or stroke event and related care seeking.**

of these 425 cases died during the period of COVID-19 lockdown. Our analysis did not show any significant differences in the occurrence of the three levels of delay during this period.

The median (IQR) time interval between the onset of symptoms and death was 2.0 (0.76, 12.0) hours in a cardiac event and 22.4 (1.8, 75.9) hours in a stroke (Supplementary Fig. S2). Among those who reached an AHF, the median (IQR) time interval between the onset of symptoms and reaching it was 1.5 (1.0, 56.0) hours in a cardiac event and 2.2 (1.1, 9.0) hours in a stroke. Only 10.8% of the subjects reached an appropriate health facility early i.e., within the first "golden" hour of the onset of the symptoms. This was similar in cardiac and stroke cases.

Using mixed-effect logistic regression, we identified that for a given postal code, after adjusting for other variables patients with a monthly family income of >270US$ (aOR 0.44; 95%CI 0.21–0.93) were less and those staying farther from AHF (aOR 1.12; 95%CI 1.01–1.25 for each kilometer distance) were more likely to have a delay (Table 3). We further probed the rural-urban differential. While in bivariate analysis, urban residents had an odds ratio of 0.76 (95% CI; 0.36–1.58), once adjusted for other variables especially distance to AHF, the odds ratio changed to 2.7 (95%CI 0.91–7.97). The mean distance to AHF was 4.1 km (SD 2.2) and 12.2 km (SD 5.3) for urban and rural residents respectively and it was the main contributor to the change in OR after adjustment.

In their interviews, specialists identified poor risk perception and non-recognition or late recognition of symptoms as major reasons for level-1 delay. Additional factors identified were a lack of awareness of the availability of cardiac/stroke services in public facilities, fear of the high cost of treatment combined with poor paying capacity of the people. Lack of adequate ambulance services, awareness and recognition of these conditions by primary care providers and triage capacity of the first responders in the ambulance were identified as additional barriers to reaching the appropriate place of care. The high cost of treatment and fear of over-use of interventions at private facilities were also listed as key reasons for level-3 delay.

Discussion

This is, to our best knowledge, the first community-based study to identify delays in acute cardiac and stroke care among the deceased using social audit methodology. About 55% of the deaths reported a delay and most of it occurred at home due to delay in seeking care and the least occurred at the facility level. The inability to recognize the severity of illness and financial constraints were identified as major reasons for the delays in seeking care. About half of the deceased did not visit any health facility during their terminal illness and only one in ten subjects reached an appropriate health facility within the first hour after onset of the symptoms. Those staying closer to a facility or families with higher income were more likely to reach within the first hour. In general, stroke reported greater delays especially at level 2 and 3.

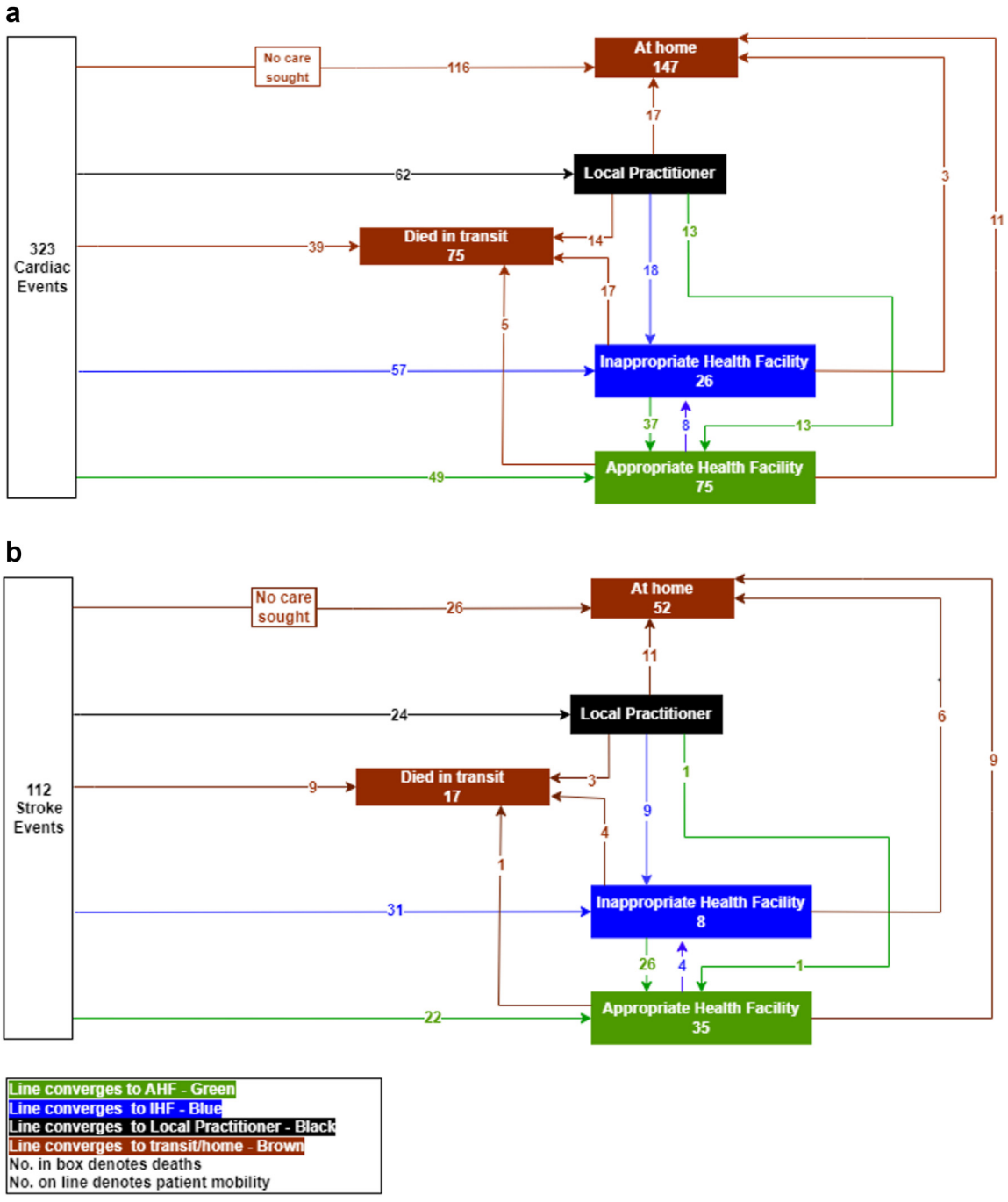

Fig. 2: Care seeking pathways of the terminal event of acute cardiac condition (Panel a.) and stroke (Panel b.).

Previous hospital-based studies from the Indian subcontinent have also reported delays at the level of deciding to seek care. In patients of myocardial infarction and stroke presenting to tertiary hospitals, the mean interval between onset of symptom and arrival at the hospital was reported to be between 6 and 13 h in various studies.[10,13,26–28] This was much lower (around 2 h) in our study as ours was a community-based study and only one-third of the deaths occurred in a hospital. Tertiary hospitals receive referred patients including many from distant places and thus time to arrival could be high.

Levels of delay & reasons[a]	Overall		
	Cardiac event N = 323	Stroke N = 112	Total N = 435
No delay	155 (48.0)	38 (33.9)	193 (44.4)
Level-1 delay	124 (38.4)	43 (38.4)	167 (38.4)
Reasons for Level 1 delay	n = 124	n = 43	n = 167
Non- recognition of symptoms to be related to heart or brain attack	79 (63.7)	21 (48.8)	100 (59.9)
Did not appreciate seriousness of problem	22 (17.8)	7 (16.3)	29 (17.3)
Consulted neighbourhood practitioner	14 (11.3)	13 (30.2)	27 (16.2)
Lack of decision maker	3 (2.4)	2 (4.7)	5 (3.0)
Financial constraint	6 (4.8)	0 (0.0)	6 (3.6)
Level-2 delay	58 (18.0)	29 (25.9)	87 (20)
Reasons for Level-2 delay	n = 58	n = 29	n = 87
Lack of affordability	16 (27.6)	10 (34.5)	26 (29.9)
Going to a hospital where appropriate care was not available.	18 (31.0)	17 (58.6)	35 (40.2)
Delay in arranging transport	10 (17.3)	1 (3.5)	11 (12.6)
Non-availability of a person to accompany the patient	9 (15.5)	1 (3.5)	10 (11.5)
Hesitancy to visit a facility during COVID-19	5 (8.6)	0 (0.0)	5 (5.7)
Level-3 delay	29 (9.0)	18 (16.1)	47 (10.8)
Reasons for Level 3 delay	n = 29	n = 18	n = 47
Lack of money	14 (48.3)	13 (72.2)	27 (57.4)
Non-availability of specialist or ICU bed in the facility	15 (51.7)	5 (27.8)	20 (42.6)

[a]Multiple levels of delays possible in a case.

Table 2: **Level of delays in seeking/receiving care and their reasons among those who died due to acute cardiac and stroke event in district Faridabad.**

While we did not find age to be an important determinant of delay, previous studies have reported older age to be associated with higher delay.[8–10,27–29] Few studies have reported a higher delay among women,[14,28] but many studies including ours did not find so.[27,28,30,31] The primary reason for delay identified in all studies has been the lack of awareness of the symptoms to be related to MI or stroke resulting in non-recognition of the severity of their illness. Our study confirms these findings.

The evidence on the influence of socio-economic factors like education or income on delay are mixed. In general, income has been found to be more important than education in explaining the delay. We found family income to be an important determinant of delay as reported in other studies.[28,29] In our study as well as in the study by Mohan et al.,[9] lack of insurance coverage was not associated with delay. However, unlike 8% coverage with insurance reported in Mohan et al.,[9] our study had a much higher 47% coverage.

Most previous studies have reported that rural residents take longer to reach hospital.[32] Main reasons cited for delay in the rural areas are distance, availability of transport and poorer socio-economic conditions. Our study shows that it is the distance and not socio-economic status that primarily explains this rural-urban difference. Also, Faridabad is largely an urban (65%) district and even rural areas have good road connectivity. Most of the AHF mapped by us were at the centre of the district making them accessible. The classification of rural/urban areas was based on 2011 census. There is rapid urbanization occurring in the district and this could have resulted in misclassification of rural/urban areas.

A low use of ambulance (varying from 3.9% to 37%) and higher use of private vehicle has been almost universally reported among studies from the subcontinent.[9,28,29,31] This is in contrast to developed countries like Hongkong and USA where its use is much higher.[33,34] While we did not find a higher delay if family members consulted a local practitioner or a primary care provider, others have reported so.[27,28] This delay occurs due to the time taken for the consultation as well as due to these care-providers failing to recognize the severity of the condition, not providing immediate care and, referring to an inappropriate hospital.

This study enabled us to compare the delays between stroke and cardiac emergencies. It showed that there was higher likelihood of delay occurring in stroke cases, especially at level 2 and level 3. These may be attributed to poorer availability of stroke services than cardiac services in the district and also elsewhere in India. This was confirmed by service mapping done by us in the district (not published). Due to small number of cases, we could not compare the determinants of delayed arrival between stroke and cardiac deaths.

Parameter	Within 1 h N = 47, n (%)	After 1 h N = 388, n (%)	Crude OR (95%CI)	Adjusted OR (95%CI)
Age in years				
≤60	28 (12.1)	204 (87.9)	0.75 (0.41–1.39)	0.80 (0.41–1.57)
>60	19 (9.4)	184 (90.6)	Reference	Reference
Gender				
Male	34 (11.6)	259 (88.4)	0.77 (0.39–1.50)	1.10 (0.51–2.36)
Female	13 (9.2)	129 (90.9)	Reference	Reference
Place of residence				
Rural	10 (8.9)	102 (91.1)	Reference	Reference
Urban	37 (11.5)	286 (88.5)	0.76 (0.36–1.58)	2.70 (0.91–7.97)
Education of head of the family				
Primary & illiterate	13 (6.2)	196 (93.8)	Reference	Reference
Above primary	34 (15.0)	192 (85.0)	**0.37 (0.19–0.73)**	0.52 (0.24–1.11)
Occupation of head of family				
Professional/semi-professional/clerical	21 (14.5)	124 (85.5)	0.58 (0.31–1.07)	0.60 (0.31–1.16)
Skilled/semi-skilled/unskilled worker	26 (9.0)	264 (91.0)	Reference	Reference
Monthly family income (INR)				
≤270 US$	14 (6.2)	213 (93.8)	Reference	Reference
>270 US$	33 (15.9)	175 (84.1)	**0.35 (0.18–0.67)**	**0.44 (0.21–0.93)**
Type of Family				
Nuclear	16 (11.4)	125 (88.7)	Reference	Reference
Joint	31 (10.5)	263 (89.5)	1.09 (0.57–2.06)	1.56 (0.75–3.23)
Own a transport vehicle				
Four-wheeler/Two-wheeler	42 (12.2)	302 (87.8)	0.42 (0.16–1.09)	0.63 (0.22–1.81)
None	5 (5.5)	86 (94.5)	Reference	Reference
Health insurance status				
Private/Govt. insurance	27 (13.2)	177 (86.8)	0.62 (0.34–1.15)	0.87 (0.44–1.69)
None	20 (8.7)	211 (91.3)	Reference	Reference
Time of onset of symptom				
6:00 am–9:59 pm	31 (9.5)	296 (90.5)	1.66 (0.87–3.17)	1.42 (0.71–2.85)
10:00 pm–5:59 am	16 (14.8)	92 (85.2)	Reference	Reference
Distance to Appropriate Health Facility (in km), median (IQR)	4.1 (2.2, 6.8)	5.2 (3.1, 7.8)	**1.10 (1.01–1.20)**	**1.12 (1.01–1.25)**
Consulted a local practitioner				
Yes	4 (4.7)	82 (95.4)	2.88 (1.01–8.26)	2.39 (0.79–7.21)
No	43 (12.3)	306 (87.7)	Reference	Reference

Table 3: **Determinants of delay in reaching an appropriate health facility from onset of symptoms among acute cardiac and stroke deaths in District Faridabad.**

The strengths of this study are that this is population-based and covers both acute cardiac and stroke care by audit of large number of deaths in a geographically circumscribed area with defined population and universal registration of deaths, using the established three-delay model which are clearly linked to public health interventions. Data triangulation with the qualitative component further validates our finding. The weaknesses were inability to do verbal autopsy in 11% deaths due to COVID-19 restrictions, since only deaths were covered this does not reflect the delays in all acute cardiac or stroke cases. Hospital based studies have shown that during lockdown due to pandemic restrictions, there was an increase in delays in stroke and cardiac patients reaching the hospitals.[35,36] Our sub-analysis, though small in numbers, did not reveal higher health system access delay in deaths that occurred during the period when lockdown was imposed. The delays assessed qualitatively and quantitatively did not always arrive at same conclusion, for example, there might be no delays reported qualitatively yet they may reach AHF after 1 h. Though a formal sample size estimation was not done as a geographical defined area was saturated, the sample size appears to be sufficient to estimate proportion of delays, though not separately for stroke. Due to smaller numbers, estimates for some of the covariates had wide confidence intervals.

The delays identified in the study point out to the need for interventions at population and health system levels. There have been many health system initiatives in India to reduce delays in cardiac and stroke care. These include a hub-and-spoke model for myocardial infarction management, where primary angioplasty is offered to patients presenting to hub hospitals with

catheterization capacities or those close to it (within 30 min) and thrombolysis to those presenting to spoke hospitals, who are then shifted within 2–24 h to the hub hospital for catheterization and angioplasty.[37] Mobile units as specialized ambulances equipped with the personnel, equipment, and imaging capability to diagnose and treat acute stroke in the prehospital setting have been shown to be effective.[38] Mission DELHI (Delhi Emergency Life Heart-Attack Initiative) initiative employs a pair of motorcycle-borne trained paramedic nurses as the first responders to a call, who do clinical assessment, take an ECG, and establish a virtual connect with the cardiologists to deliver specific treatment. By this time, an equipped ambulance arrives and transports the patient for further treatment.[39] Linking primary care physician by telemedicine facilities with cardiologists has also been successfully attempted. A similar telestroke model appropriate for poor resources countries and development of uniform stroke care pathways are also steps in similar direction.[40,41]

While many of these have been implemented in an ad-hoc mode, a fully integrated district level scalable model needs to be developed in an implementation research paradigm. Establishment of cardiac care units at district hospitals under National Programme for Cancer, Diabetes and Cardiovascular Diseases and Stroke is also aimed at improving access to cardiac care in public facilities.[42] These can be strengthened to provide integrated care for stroke and acute cardiac event.

These health system interventions should be supplemented by efforts to create public awareness in recognizing symptoms of heart attack and stroke and by improving insurance coverage for these life threatening conditions. Community educational campaigns to improve symptom awareness to promote early recognition and care-seeking and use of ambulance have been shown to be effective.[43–45] Training of formal and informal primary care providers to recognize these conditions and refer them to an appropriate hospital has also proved useful.[46]

This study confirms the urgency of the need to strengthen cardiac and stroke acute care responses to improve outcomes due to the burgeoning cardiovascular burden in India. We have the necessary evidence to reduce the delays in cardiac and stroke care and the benefits of this must reach people at the earliest.

Contributors

Conceptualizaiton -AK, AR and RK; funding acquisition- AK; study planning-AK, AR, RA and RB; methodology-AK, AR, RB and RK; Supervision-AK, MA and RK; Writing – original draft & Finalization-AK; Data curation & Data analysis-MA; Project administration-MA, RA and RK; Validation-AK and AR; Writing – review & editing-MA, RK, RA, RB and AR.

Data sharing statement

The data used for current study is available with the corresponding author. It can be shared with the researcher upon getting approval from Institutional Ethics Committee.

Declaration of interests

We declare no financial or any other competing interests among authors.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lansea.2023.100222.

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