Global Journal of Emergency Medicine

Research Article
Published: 12 Nov, 2018

Development of an Emergency Nurse-Paramedic Motorcycle Response System for Acute STEMI and Sudden Cardiac Arrest Care in India

*Ramesh A[1], Vanden Hoek TL[2], LaBresh K[3], Campbell T[2], Murthy K[1], Shetty N[1], Begeman RM[2], Edison M[2], Williams P[3], Prabhakar BS[2], Erickson TB[4]**

[1]Department of Emergency Medicine, M S Ramaiah Medical College, India

[2]UIC Department of Emergency Medicine, Center for Global Health, USA

[3]Department of Emergency Medicine, RTI International, USA,

[4]Department of Emergency Medicine, Harvard Medical School, USA

Abstract

India has more cardiovascular disease (CVD) than any other country claiming nearly 5 million lives annually. It is projected that by 2020, nearly 60% of patients with CVD world-wide will be of Indian descent as Indians have a higher genetic predisposition for and earlier risk of CVDs than other ethnicities. Specifically, ST segment elevation myocardial infarction (STEMI) and sudden cardiac arrest (SCA) are major contributors to disability and death in India with over half of patients dying in pre-hospital settings prior to reaching hospitals. The high rates of acute STEMI and SCA through-out India is an expanding public health problem that is currently being addressed by the Heart Rescue India (HRI) program. An innovative pre - hospital system using nurse-paramedic first responders on motorcycles with complementary ambulance unit back-up and transport, when combined with community risk screening and education, provides rapid STEMI/SCA identification and treatment. Our goals are to increase the capacity of the paramedic response system, develop standard protocols for acute CVD management and ultimately improve overall patient survival. This pre-hospital response system may foster a scalable model that can be integrated into the current healthcare system and large urban centers throughout India.

OPEN ACCESS

Correspondence:
Erickson TB, Department of Emergency Medicine, Harvard Medical School, Harvard Humanitarian Initiative, 75 Francis St Boston, MA, 02115, USA, E-mail: timothyberickson@gmail.com

Received Date: *09 Oct 2018*
Accepted Date: *05 Nov 2018*
Published Date: *12 Nov 2018*

Citation:
Ramesh A, Vanden Hoek TL, LaBresh K, Campbell T, Murthy K, Shetty N, et al. Development of an Emergency Nurse-Paramedic Motorcycle Response System for Acute STEMI and Sudden Cardiac Arrest Care in India. Glob J Emerg Med. 2018; 1(2): 1008.

Introduction

India has more cardiovascular disease (CVD) than any other country claiming nearly 5 million lives annually. It is projected that by 2020, nearly 60% of patients with CVD world-wide will be of Indian descent as Indians have a higher genetic predisposition for and earlier risk of CVDs than other ethnicities [1-4]. Specifically, ST segment elevation myocardial infarction (STEMI) and sudden cardiac arrest (SCA) are major contributors to disability and death in India with over half of patients dying in pre-hospital settings prior to reaching hospitals. The high rates of acute STEMI and SCA through- out India is an expanding public health problem that is currently being addressed by the Heart Rescue India (HRI) program [5- 7].

Pre-hospital delays remain a major obstacle in the institution of early reperfusion therapy, which is crucial in salvaging myocardium and reducing adverse cardiovascular events following STEMI [8]. Low public awareness, inadequate emergency transportation infrastructure, and the lack of a coordinated Emergency Medical Services (EMS) system are major contributors to these delays [9]. Pre-hospital care in India is also hampered by a lack of financial means to cover medical transportation costs, as well as a misunderstanding of CVD warning signs and symptoms [10]. Over-populated urban settings with chronic traffic grid-lock contribute to response delays as larger paramedics units have difficulties maneuvering around traffic while rescuing and transporting patients. While timely response to acute CVD symptoms and ST-elevation myocardial infarction (STEMI) care can be facilitated by paramedics, a large proportion of STEMI patients do not access care through emergency medical systems and often opt for self-transport, particularly in urban settings with traffic congestion or remote rural settings with long paramedic response times [11]. To reduce pre-hospital response and transportation times in densely populated areas of India, we describe the establishment of a novel nurse-paramedic motorcycle response system for acute pre-

Table 1: Hub & Spoke Hospitals, with Distance to Hub Hospital.

Hub
M S Ramaiah Memorial Hospital
Spoke
1. People Tree Hospital- 5.8 km
2. Aveksha Hospital- 8.3km
3. Santhosh Hospital- 7.7km
Hub
Suguna Hospital
Spoke
1. Ananya Hospital- 2.2km
2. Sreenivasa Hospital- 3.8km

hospital STEMI/SCA care in the city of Bangalore, India (population 12M) and review the literature of similar motorcycle-based first responder systems.

Methods

To reduce pre-hospital response delays in densely populated areas, a pre-hospital system of STEMI/SCA care is being developed in Bangalore, India using nurse-paramedic on motorcycles for acute CVD events. First responder nurse-paramedics on motorized scooters will be rapidly deployed to assess and stabilize patients prior to the arrival of larger paramedic units accompanied by nurse-physician teams. At the scene, first responders will also perform and transmit an ECG to a cardiac command center. STEMI patients will be rapidly identified and confirmed by an on-call emergency medicine physician or cardiologist. If there is evidence of STEMI, a larger ambulance unit will be dispatched to stabilize and transport the patient to a "spoke" hospital for further care and emergent thrombolytic therapy or a comprehensive "hub" hospital for urgent percutaneous coronary intervention (PCI). Standardized data elements will be used for acute CVD care in the pre-hospital and hospital settings for acute STEMI/SCA using web-portal data entry and quality metric reporting.

In our study, 5 spoke hospitals and 2 hub hospitals within a surrounding population of 500,000 have been identified (Table 1). The system includes 24/7 first responders on motorized scooters who are trained to transmit ECGs to designated hub hospitals for potential STEMI interpretationas well as equipped with automatic external defibrillators (AEDs) for any patient suffering SCA. An ambulance will be simultaneously dispatched for further stabilization with STEMI patients transported directly to a hub hospital for urgent PCI revascularization of the culprit coronary vessel [7].

Data metrics include the following quality measures: time of call by CVD patients, time to arrival by motor scooter and ambulance unit, time from ECG interpretation to thrombolytic administration at the designated spoke hospital, or cardiac catheterization at the designated hub hospital. Goals are to have patients call the emergency response system within 30 minutes from symptom onset, first responders to arrive at the scene within 15 minutes of the initial call, diagnosis of STEMI made within 15 minutes of ECG transmission, and fibrinolytic therapy or PCI administered within 60 and 90 minutes of STEMI diagnosis, respectively (Table 2). Community education programs will further identify at-risk individuals to reinforce the use of these pre-hospital heart rescue action plans. The purpose of this paper is to review the literature reporting nurse paramedic motorcycle-based first response for a variety of conditions to form a basis for the HRI pre-hospital system design.

Literature Review and Discussion

Motorcycle paramedics globally

The concept of motorcycle medics has been described in the emergency medical systems (EMS) literature since the 1990s in both urban and rural pre-hospital settings [12,13]. Although motorcycles often lack the capacity to transport patients, larger paramedic units or ambulances in pre-hospital settings can be supplemented by these smaller more maneuverable vehicles, particularly in crowded urban areas [14].

Recent studies in Africa have reported that systematic motorcycle transportation systems have improved health service delivery to rural village populations. Resource-poor environments in Zambia have documented increased health worker productivity and greater geographical patient coverage [15]. Motorcycle equipped village health team members in Uganda were involved in a proof-of-concept study to strengthen a WHO-sponsored immunization program. The sustained improvements in local immunization systems provided evidence that this approach was an effective framework for enhancing and delivery for Uganda nation-wide [16].

While not the same magnitude as India, there is a high mortality rate due to CVDs in Iran. A major barrier identified for providing EMS in the city of Tehran is inadequate and poor transportation systems. Various reasons cited included unsuitable ambulances, unsafe roads, heavy traffic, and the inability of patients to pay for transportation. The authors also note that pre-hospital EMS models used in the United States and Europe are not practical as they are too costly to implement. For this reason, one high priority component in developing EMS transportation in Iran is the utilization of the motorcycle ambulances, especially in areas of heavy traffic. These smaller vehicles play an important role in reducing response time at the peak of city traffic. Based on their findings, the use of motorcycle ambulances is a well suited and economical method for providing emergency medical services [17].

In Taiwan, a study compared EMS response times of motorcycles and standard ambulance units in a congested urban setting of Taipei. They compared an advanced-life support (ALS) ambulance staffed with a physician, to that of a basic life support (BLS) motorcycle. The motorcycle was driven by a traffic policeman while transporting a nurse with basic medical equipment including oxygen and a trauma kit. In this trial, no motorcycles were equipped with automatic external defibrillators (AEDs). The authors documented and reviewed over 800 calls. They found that the motorcycles arrived before the ambulance 65% of the time, motorcycle and ambulance arrived at the same time in30% of the cases, whereas ambulances arrived at the scene before the motorcycle in only 4% of the calls. In regards to response times, motorcycles arrived: 4.9 +/- 3.0 minutes, ambulances 6.3 +/- 3.4 minutes (P value less than 0.05). The authors concluded that the benefits of motorcycles include significantly reduced EMS response times, proficiency in navigating difficult scenes, and the ability to assist the ALS ambulance with finding the most expeditious route to and from the scene. Disadvantages of motorcycles included less visibility to ongoing traffic (even with flashing lights and sirens), and less stability compared to 4- wheeled vehicles, particularly in inclement weather conditions [18].

Table 2: Quality Measures Heart Rescue India (HRI).

1. Number of calls to central call center / month (rolling total to track usage)
2. Time from MI symptom (chest pain, dyspnea, nausea, diaphoresis, dizziness, syncope) onset to call placed to the center
a. Numerator: number of calls with time <= 60 minutes
b. Denominator: number of calls reporting symptoms listed above
c. Mean time and range for all calls per month
3. Time from initial call placed to center to nurse motorcycle arrival
a. Numerator: number of arrivals <= 15 minutes from call center call
b. Denominator: number of calls
c. Mean time and range for all calls per month
4. Time from initial call placed to call center and first ECG
a. Numerator: Number of patients who call within 30 minutes
b. Denominator: Number of patients who have a first ECG done by first responder
5. Time from first responder ECG diagnosis of STEMI to hospital arrival
a. Numerator: STEMI prehospital setting diagnosis to Hub hospital ambulance arrival within 30 minutes
b. Denominator: number of patient with STEMI diagnosis in prehospital setting
transported to Hub hospital by ambulance
Hospital
6. Percent STEMI patients arriving at the hospital by ambulance
a. Numerator: Number of patients with STEMI who arrive by ambulance
b. Denominator: All STEMI patients who arrive at the hospital
7. STEMI patients with cardiac arrest in prehospital setting and survival to hospital
a. Numerator: Number of cardiac arrest patients with STEMI diagnosed in prehospital setting surviving to hospital arrival
b. Denominator: All cardiac arrest patients with STEMI diagnosed in prehospital setting

Motorcycle paramedic safety

One European investigation addressed the safety of a first-response medical emergency motorcycles (MEM), driven by an emergency medical technician providers. In this investigation, they analyzed the number of crashes, as well as the incidence and nature of injuries sustained. The MEM responders used limited equipment (basic life support and AEDs) to perform initial assessments and interventions. All responders underwent an emergency defensive driving course. A minimum of 2-years of experience with motorcycle riding was required before first responders could apply for the course. The wearing of protective equipment was mandatory (which included a helmet, gloves, jacket, trousers with elbow/knee padding, and reflective clothing material). Over a 3-year period, MEMs operating in a metropolitan EMS group responded to over 3600 calls. MEMs imparted rapid and efficient responses to EMS services in the urban areas studied, with acceptable levels of safety. Accidents included only 12 motorcycle falls, resulting in three injured MEM drivers. No fatality was registered. One serious injury and two slight accidents occurred. Although they noted that motorcycles were less crashworthy than 4-wheeled closed vehicles, they are less visible and more vulnerable to hazardous weather and suboptimal road conditions. They concluded that physical injuries from crashes can be reduced with proper selection of skilled motorcycle riders, specific defensive emergency motorcycle riding habits, and adequate use of protective riding equipment [14]. Our HRI program will only deploy fully-trained motorcycle riders with standardized protective equipment. We also utilize two-wheel motor scooters for first responders. These vehicles are lighter and easier to control than motorcycles and their design is compatible for either male or female drivers. They are safer for driving on congested roads and more cost effective.

Pre-hospital ECGs and STEMI Diagnosis

The 12-lead electrocardiogram (ECG) can capture vital cardiac information in the pre-hospital setting. The pre-hospital ECG has the potential to influence emergency department (ED) management and subsequent cardiologic intervention. Paramedic and physician documentation with a formal pre-hospital ECG hand-off is essential [19]. In one investigation, despite training and a high level of confidence, the paramedics studied were only able to identify acute inferior wall STEMIs and normal ECGs. Given the paramedics' low sensitivity and specificity, they could not rely solely on paramedic ECG interpretation to activate the cardiac catheterization laboratory. Future evaluation of training programs that include assessment, initial training, testing, feedback, and repeat training are recommended [20]. Another group demonstrated that non-physician EMS interpretation of STEMI on pre-hospital ECG had excellent sensitivity and high negative predictive value. This finding supports the use of pre-hospital ECGs interpreted by EMS to help identify and facilitate treatment of STEMI [21].

In many institutions, computer interpretation messages on ECGs are often provided, and may aid the paramedics' diagnosis of STEMI. In one study the data was mixed suggesting that computer messages influence paramedic interpretation, improving accuracy when the computer was correct (true positive for STEMI or true negative for STEMI-mimic), and worsening accuracy when incorrect (false positive for STEMI or false negative for STEMI-mimic). In our current study, the appropriate management and disposition of patients with STEMI in the pre-hospital setting depends on accurate

interpretation of the 12-lead ECG by nurse-paramedics. Pre-hospital paramedic ECG readings of potential STEMI are electronically transmitted and confirmed at our hub center by an on-call emergency physician or cardiologist [22]. Previous studies have shown that paramedic accuracy in reading 12 lead ECGs can range from 86% to 94%. However, recent studies have demonstrated that accuracy diminishes for the more uncommon STEMI presentations (e.g. lateral wall injuries). Unlike hospital physicians, paramedics rarely have an ability to review previous ECGs for comparison. Therefore, ready availability of previous ECGs may also improve paramedic accuracy and enhance their confidence in interpreting STEMIs [23].

Pre-hospital Fibrinolysis Therapy

Despite the supporting published evidence for pre-hospital fibrinolysis (PHF) for STEMI patients by paramedics, the complexity of the process has not been rigorously explored in a stepwise approach. One mapping study of STEMI calls in which paramedics administered fibrinolytics described the process to be complex, containing many steps, but relatively few individual steps were highly hazardous to patient care or safety [24]. In a recent Australian study, pre-hospital thrombolysis was safely and routinely delivered by paramedics in regional and rural settings with good clinical outcomes. Pre- hospital thrombolysis (PHT) were administered by paramedics to STEMI patients if more than 60 minutes from the cardiac catheterization laboratory (CCL), and primary percutaneous coronary intervention (PCI) at the CCL. The incidence of major bleeding (TIMI criteria) in the PHT group was only 1% and no patients in the primary PCI group experienced major bleeding [25].

In another investigation, nurse-paramedic providers were required to determine whether a STEMI was present at the scene, and whether PHF was indicated. Providers radioed their impressions to the receiving hospital and initiated stabilization protocols. The final decision was made by a physician upon arrival to the hospital. In this investigation, 151 patients with chest pain were studied; 21 (13.5%) were positive for STEMI; 17 of the 21 were recognized in the pre-hospital setting by the nurse-paramedic team; 4 of the 21 did not meet ECG requirements but had high suspicion; there were no false-positive diagnoses. Fourteen patients eventually received thrombolytic therapy. The authors noted decreased in- hospital thrombolytic times to administration on average of 22 +/- 13.8 minutes (control group 51 +/- 50 minutes). They concluded a pre-hospital chest pain protocol using ECGs at the scene can speed hospital administration of thrombolytic agents [26].

Paramedic Transport for PCI Intervention

Paramedics play an important role in the early identification of patients with potential CVD who activate the EMS system. Time to reperfusion is linked to survival in patients presenting with STEMI. Primary percutaneous coronary intervention (PCI) is now considered the ultimate strategy when it can be performed quickly. Because the number of cardiac catheterization facilities is limited, pre-hospital systems have attempted to develop protocols to ensure access to primary PCI for patients with STEMI. The pre-hospital ECG has been shown to be a valuable tool to identify STEMI early and its use in the field has allowed paramedics to alert the medical team of an incoming patient [27].

Mortality for STEMI is strongly predicted by the time from first medical contact to reperfusion. Therefore, pre-hospital diagnosis by paramedics in the field has a significant reduction on the door-to-balloon (DTB) times of patients with STEMI undergoing primary percutaneous intervention [28]. Studies note important reductions in time to reperfusion by activation of the catheterization laboratory by EMS from the scene, with acceptably low false-positive rates. This type of field research can inform multidisciplinary policies and bring about meaningful clinical practice changes [29].

Pre-hospital ambulance notification and initiation of treatment of STEMI is associated with significant reduction in door-to-balloon time for primary PCI [30]. In one investigation, paramedics performed pre-hospital STEMI notification using brief communications via EMS 9-1-1 dispatchers as soon as they diagnosed a STEMI on a 12-lead ECG. They found that early notification of STEMI by paramedics through dispatchers resulted in earlier cardiac catheterization lab activation. This practice significantly decreased door to balloon time (DTB) and yielded a higher percentage of patients meeting the DTB≤60 minutes quality metric [31]. Another trial noted the time from hospital arrival to PCI with balloon inflation was significantly shorter during the period in which EMS activated the catheterization laboratory than during the period the laboratory was activated by hospital staff. Thus, paramedics with quality electrocardiogram interpretation training and education can identify patients with acute STEMI and properly activate the catheterization laboratory [32,33].

Pre-hospital Defibrillation and AEDs

Clinically important events and advanced care treatment are common in community STEMI and SCA patients undergoing pre-hospital transport or inter-facility transfer to a PCI center. During transport, patients may require cardiopulmonary resuscitation (CPR) or cardiac defibrillation [34]. Most sudden cardiac arrests (SCA) are due to ventricular fibrillation (VF). The use of defibrillators in hospitals or by EMS personnel can save many cardiac arrest victims. Automated external defibrillators (AEDs) permit defibrillation by trained first responders. AEDs accurately identify malignant ventricular tachy- arrhythmias and frequently result in successful defibrillation. Prompt application of an AED shows a greater number of patients in VF compared with initial rhythms documented by later arriving EMS personnel. Survival is greatest when the AED is placed within 3 to 5 minutes of a witnessed collapse. Community-based studies show increased cardiac-arrest survival when first responders are equipped with AEDs rather than waiting for paramedics to defibrillate [35]. Defibrillation can be carried out by individuals other than physicians such as trained first responders and trained lay rescuers [36]. In addition, general knowledge of EMS activation and familiarization with established principles of cardiopulmonary resuscitation are essential [36]. As such, each of our nurse-paramedic first responders undergo extensive training prior to deployment.

In many low-middle income countries, survival following sudden cardiac arrest (SCA) continues to be tragically low, despite advances in technology and international guidelines for resuscitation. Few cities or EMS agencies report accurate patient outcomes after SCA. Among those who do, survival from witnessed VF ranges from 8% to 40%. One study in a medium-sized U.S. city reported outcomes and incidence of VF over an 18-year period incorporating an aggressive approach to pre-hospital SCA. High survival from witnessed VF-induced SCA (46%) was achieved during the study period. Rapid response, followed by rapid defibrillation, was the major contributor to survival [37]. Most in-hospital nurses intend to use an AED if permitted to do so by a medical directive. Successful implementation

requires educational initiatives focusing on safety and efficacy of AEDs, support from physicians and hospital administrators, and additional training on AED use. The same can be said for nursing AED use in the pre- hospital setting [38].

The role of nurse-paramedics

Pre-hospital triage and transport of STEMI patients have traditionally been undertaken in emergency medical service systems with advanced care paramedics (ACPs). ACPs are however, not available in many regions. A pilot study was conducted to determine the feasibility of pre-hospital STEMI triage in a region with only primary care paramedics or basic life support providers. They found that hemodynamically stable patients with suspected STEMI can be safely and effectively transported directly for primary PCI by paramedics without advanced care training. They concluded that pre-hospital STEMI triage for primary PCI can be extended to regions that have few or no paramedics with advanced care training. This concept applies to the current situation in India [39].

Regarding nurse-paramedics, in Sweden, Finland, Netherlands and Belgium, all ambulances are staffed with at least one nurse. Increased patient survival after out of hospital cardiac arrest were noted with nurses having higher qualifications and more training and experience with emergency care. The Swedish Association for Ambulance Nurses (SAAM) in collaboration with Swedish Society of Nursing published a competence description for ambulance nurses [40]. Most nurses who practice in the pre-hospital setting have a background in anesthesia, intensive care medicine or cardiology. They require special ambulance courses and typically have clinical experience in the ED. Paramedics identify that nurses are good at providing medical care and psychological support to the victims and families, but only a few paramedics recognized the nurse as having a "lead role" in the pre-hospital setting. Some junior paramedics looked upon the nurses as "rivals"; however, more experienced paramedics had a positive attitude toward nurses in this role [41]. It was noted in another article that most physicians recommend that more nurses, especially those with emergency, anesthesia or intensive care experience be involved in the pre- hospital setting. The authors recommend a 3-year nursing program plus a 1-year special ambulance nursing curriculum. They also recommend that both nurses and paramedics update their clinical skills and have hospital clinical experiences in addition to their pre-hospital training [42].

Conclusion

Rapid response to ST-elevation myocardial infarction (STEMI) and sudden cardiac arrest (SCA) the pre- hospital phase is critical, as the administration of the most appropriate treatment in a timely manner is instrumental for mortality reduction. STEMI and SCA systems of care based on networks of medical institutions connected by an efficient emergency medical service are essential [43]. The first steps are devoted to minimize the patient's delay in seeking care, rapidly dispatch a properly staffed and equipped vehicles (such as motorcycles) to make the diagnosis on scene. They can then deliver initial drug therapy, defibrillation when indicated, and transport the patient to the most appropriate cardiac care facility. Primary PCI is the treatment of choice, but thrombolysis followed by coronary angiography and PCI is a valid alternative. These decisions should be gaged by the patient's baseline risk, time from symptoms onset, and primary PCI-related delay. Paramedics and nurses have an important role in pre- hospital STEMI care and their integration is recommended to increase the effectiveness of a system. Strong cooperation between cardiologists and emergency medicine physicians is critical for optimal pre- hospital STEMI and SCA care. Scientific societies have an important role in guideline implementation as well as in developing quality indicators and performance measures. Health care professionals, along with policy and administrative decision makers are encouraged to overcome existing barriers to promote optimal cardiac care [43].

Our innovative pre-hospital system using nurse-paramedic first responders on motorcycles with complementary ambulance unit back-up and transport, when combined with community risk screening and education, provides rapid STEMI/SCA identification and treatment. Our goals are to increase the capacity of the paramedic response system, develop standard protocols for acute CVD management and ultimately improve overall patient survival. Protocols for pre-hospital response to STEMI and SCA also require ongoing evaluation. Our "hub and spoke" model of care with a thrombolysis and cardiac catheterization lab strategy uses a tiered response system with first responders on swift and agile motor scooters complemented with larger ambulance units for patient stabilization and transport. This pre-hospital response system may foster a scalable model that can be integrated into the current healthcare system and large urban centers throughout India.

References

1. Kalra A, Bhatt DL, Rajagopalan S. Overview of Coronary Heart Disease Risk Initiatives in South Asia. Curr Atheroscler Rep. 2017;19(6):25.
2. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med. 2006;3(11):e442.
3. Kohn D. Getting to the heart of the matter in India. Lancet. 2008;372(9638):523-4.
4. Rissam HS, Kishore S, Trehan N. Coronary artery disease in young Indians-the missing link. J Indian Acad Clin Med. 2001;2:128-31.
5. Diepen SV, Girotra S, Abella BS, Becker LB, Bobrow BJ, Chan PS, et al. Multistate 5Year Initiative to Improve Care for Out of Hospital Cardiac Arrest: Primary Results From the Heart Rescue Project. J Am Heart Assoc. 2017;6(9).
6. Nichol G, Aufderheide TP, Eigel B, Neumar RW, Lurie G, Bufalino VJ, et al. Regional Systems of Care for Out of Hospital Cardiac Arrest: A Policy Statement From the American Heart Association. Circulation. 2010;121:709-29.
7. Ramesh A, LaBresh KA, Begeman R, Bobrow B, Campbell T, Chaudhury N, et al. Implementing a STEMI system of care in urban Bangalore: Rationale and Study Design for heart rescue India. Contemp Clin Trials Comm. 2018;10:105-110.
8. Khan A, Phadke M, Lokhandwala YY, Nathani PJ. A Study of Prehospital Delay Patterns in Acute Myocardial Infarction in an Urban Tertiary Care Institute in Mumbai. J Assoc Physicians India. 2017;65(5):24-7.
9. George L, Ramamoorthy L, Satheesh S, Prakasha Saya R, Subrahmanyam DKS. Prehospital delay and time to reperfusion therapy in ST elevation myocardial infarction. J Emerg Trauma Shock. 2017;10(2):64-9.
10. Dubey G, Verma SK, Bahl VK. Primary percutaneous coronary intervention for acute ST elevation myocardial infarction: Outcomes and determinants of outcomes: A tertiary care center study from North India. Indian Heart J. 2017;69:294-8.
11. Mercuri M, Connolly K, Natarajan MK, Welsford M, Schwalm JD. Barriers to the use of emergency medical services for ST- elevation myocardial infarction: Determining why many patients opt for self transport. J Eval Clin Pract. 2018;24(2):375.

12. Spivak M. Motorcycle medics. Delivering patient care from the back of a bike. Emerg Med Serv. 1999;28(1):22-4.

13. Curtis N. Emergency services: leather-clad lifesavers. Nurs Stand. 1994;9(3):18-9.

14. Kiefe CC, Soares Oliveira M. Medical emergency motorcycles: are they safe? Eur J Emerg Med. 2008;15(1):40-2.

15. Mehta KM, Rerolle F, Rammohan SV, Albohm DC, Muwowo G, Moseson H, et al. Systematic Motorcycle Management and Health Care Delivery: A Field Trial. Am J Public Health. 2016;106(1):87-94.

16. Bazos DA, LaFave LR, Suresh G, Shannon KC, Nuwaha F, Splaine ME. The gas cylinder, the motorcycle and the village health team member: a proof of concept study for the use of the Microsystems Quality Improvement Approach to strengthen the routine immunization system in Uganda. Implement Sci. 2015;10:30.

17. Bahadori M, Ravangard R, Nejati M. Development of Emergency Medical Services (EMS) in Iran: Component of Transportation Journal of Society for Development in New Net Environment in B&H. 2016.

18. Chaou Shune Kub, Hand Chang. A Method to Reduce Response Times in Prehospital Care: The Motorcycle Experience. Amer J Emerg Med. 2011;13(6):372-7.

19. Davis MT, Dukelow A, McLeod S, Rodriguez S, Lewell M. The utility of the prehospital electrocardiogram. CJEM. 2011;13(6):372-7.

20. Mencl F, Wilber S, Frey J, Zalewski J, Maiers JF, Bhalla MC. Paramedic ability to recognize ST segment elevation myocardial infarction on pre hospital electrocardiograms. Prehosp Emerg Care. 2013;17(2):203-10.

21. Ducas RA, Wassef AW, Jassal DS, Weldon E, Schmidt C, Grierson R, et al. To transmit or not to transmit: how good are emergency medical personnel in detecting STEMI in patients with chest pain? Can J Cardiol. 2012;28(4):432-7.

22. Pilbery R, Teare MD, Goodacre S, Morris F. The Recognition of STEMI by Paramedics and the Effect of Computer in Terpretation (RESPECT): a randomised crossover feasibility study. Emerg Med J. 2016;33(7):471-6.

23. O'Donnell D, Mancera M, Savory E, Christopher S, Schaffer J, Roumpf S. The availability of prior ECGs improves paramedic accuracy in recognizing ST-segment elevation myocardial infarction. J Electrocardiol. 2015;48(1):93-8.

24. Jensen JL, Walker M, Denike D, Matthews V, Boudreau C, Hill W, et al. Paramedic myocardial infarction care with fibrinolytics: a process map and hazard analysis. Prehosp Emerg Care. 2013;17(4):429-34.

25. Khan AA, Williams T, Savage L, Stewart P, Ashraf A, Davies AJ, et al. Pre-hospital thrombolysis in ST-segment elevation myocardial infarction: a regional Australian experience. Med J Aust. 2016;205(3):121-5.

26. Foster DB, Dufendach JH, Barkdoll CM, Mitchell BK. EMT P Prehospital Recognition of AMI Using Independent Nurse/Paramedic 12-lead ECG Evaluation: Impact on In Hospital Times to Thrombolysis in a Rural Community Hospital. Amer J Emerg Med. 1994;12:25-31.

27. Le May MR, Dionne R, Maloney J, Poirier P. The role of paramedics in a primary PCI program for ST-elevation myocardial infarction. Prog Cardiovasc Dis. 2010;53(3):183-7.

28. Savage ML, Poon KK, Johnston EM, Raffel OC, Incani A, Bryant J, et al. Pre-hospital ambulance notification and initiation of treatment of ST elevation myocardial infarction is associated with significant reduction in door to balloon time for primary PCI. Heart Lung Circ. 2014;23(5):435-43.

29. Lee CH, Van Gelder CM, Cone DC. Early cardiac catheterization laboratory activation by paramedics for patients with ST segment elevation myocardial infarction on pre hospital 12-lead electrocardiograms. Prehosp Emerg Care. 2010;14(2):153-8.

30. Savage ML, Poon KK, Johnston EM, Raffel OC, Incani A, Bryant J, et al. Pre-hospital ambulance notification and initiation of treatment of ST elevation myocardial infarction is associated with significant reduction in door to balloon time for primary PCI. Heart Lung Circ. 2014;23(5):435-43.

31. Stowens JC, Sonnad SS, Rosenbaum RA. Using EMS Dispatch to Trigger STEMI Alerts Decreases Door-to-Balloon Times. West J Emerg Med. 2015;16(3):472-80.

32. Young DR, Murinson M, Wilson C, Hammond B, Welch M, Block V, et al. Paramedics as decision makers on the activation of the catheterization laboratory in the presence of acute ST elevation myocardial infarction. J Electrocardiol. 2011;44(1):18.

33. Cantor WJ, Hoogeveen P, Robert A, Elliott K, Goldman LE, Sanderson E, et al. Miner S Pre hospital. diagnosis and triage of ST elevation myocardial infarction by paramedics without advanced care training. Am Heart J. 2012;164(2):201-6.

34. Wesley K, Wesley K. STEMI patients. Do prehospital events have an effect on outcome? JEMS. 2013;38(10):30-1.

35. Winkle RA. The effectiveness and cost effectiveness of public-access defibrillation. Clin Cardiol. 2010;33(7):396-9.

36. Maisch S, Friederich P, Goetz AE. [Public access defibrillation. Limited use by trained first responders and laymen]. Anaesthesist. 2006;55(12):1281-90.

37. Agarwal DA, Hess EP, Atkinson EJ, White RD. Ventricular fibrillation in Rochester, Minnesota: experience over 18 years. Resuscitation. 2009;80(11):1253-8.

38. Andrews J, Vaillancourt C, Jensen J, Kasaboski A, Charette M, Clement CM, et al. Factors influencing the intentions of nurses and respiratory therapists to use automated external defibrillators during in hospital cardiac arrest: a qualitative interview study. CJEM. 2018;20(1):68-79.

39. Cantor WJ, Hoogeveen P, Robert A, Elliott K, Goldman LE, Sanderson E, et al. Pre hospital diagnosis and triage of ST elevation myocardial infarction by paramedics without advanced care training. Am Heart J. 2012;164(2):201-6.

40. Sjölin H, Lindström V, Hult H, Ringsted C, Kurland L. What an ambulance nurse need to know: A content analysis of curricula in the specialist nursing programme in prehospital emergency care. Int Emerg Nurs. 2015;23(2):127-32.

41. Suserud BO, Haljamäe H. Role of nurses in pre-hospital emergency care. Accid Emerg Nurs. 1997;5(3):145-51.

42. Suserud BO, Haljamäe H. Nurse competence: advantageous in pre-hospital emergency care? Accid Emerg Nurs. 1999;7(1):18-25.

43. Tubaro M, Danchin N, Goldstein P, Filippatos G, Hasin Y, Heras M, et al. Pre-hospital treatment of STEMI patients. A scientific statement of the Working Group Acute Cardiac Care of the European Society of Cardiology. Acute Card Care. 2011;13(2):56-67.