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# **An Analysis of Prehospital Care System Implementations in Developing Countries**

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## Abstract

Formal prehospital care systems have been implemented to various degrees across the developing world and have been shown to be potentially effective at reducing trauma-related mortality. The WHO report *Prehospital Trauma Care Systems* established consensus guidelines for organizing basic prehospital care systems in developing countries, noting a number of key elements of successful system implementation. This paper reviews the literature with respect to these key elements, identifying 3 basic types of interventions relating to the generation of *local support, system formalization*, and *expansion and standardization*.

## Background

Across the globe, over 5 million deaths per year can be attributed to physical injury, 90% of which occur in Low- and Middle-Income (LMIC) countries.(1) Road traffic injuries alone are the second largest single cause of death among individuals 5-44 after HIV/AIDS. (2) A portion of these mortalities are preventable given the timely application of relatively simple trauma care procedures, and prior research suggests that Prehospital trauma care systems are effective at reducing trauma-related mortality. (3)

Prehospital care systems exist in many forms across the developing world and are implemented formally to varying degrees related to the overall economic and political development of the nation or region in question. In Sub-Saharan Africa for instance, most areas lack formal prehospital care systems, and formally classified levels of care are non-existent. This region is characterized by the prevalence of informal methods for accessing emergency care; typically transport to a fixed healthcare facility by relatives or bystanders.(4,5) In regions with somewhat higher income, prehospital care remains largely informal, and what services exist are typically locally organized by hospitals, NGOs or local governments with varying degrees of centralized organization. Upper-middle income countries such as China and Mexico are characterized by relatively mature EMS systems seeking to expand, standardize and centralize their services to bring higher-quality care to their patient populations.(6)

As progress is made in reducing mortality due to infectious disease, an increasing portion of total mortality will be attributable to injuries and acute complications of chronic disease. In a landmark 2005 report the WHO established the “pressing need to strengthen the quality and availability of systems of prehospital trauma care throughout the world”.(7) This report represents the conclusions of a 5 year WHO study to find consensus among experts in the field of trauma and pre-hospital care. This report finds evidence for the value of Emergency Medical Service (EMS) systems, particularly when focused on trauma care at a basic level. Evidence supporting the implementation of more advanced forms of pre-hospital care in LMIC countries is found to be sparse. The report describes a framework for addressing key elements of EMS system implementation, the features of which are described in Table 1 below.(7)

## Methods

This paper aims to identify how the key elements identified by the 2005 WHO report have been addressed in the implementation of EMS systems in developing countries. The literature on the subject of Pre-hospital care systems in developing countries was hand searched by the author to identify relevant articles. 26 relevant items were identified initially, and the following search string was created to capture additional relevant literature to ensure a full understanding of each investigated region:

("Emergency Medical Service" OR "Prehospital")) AND ("China" OR "India" OR "Thailand" OR "Africa" OR "Pakistan" OR "Ghana" OR "Mexico" OR "LMIC" OR "Developing")

The search produced 630 results in PubMed and 48,000 results in Google Scholar, the first 300 of which were screened for relevant titles. Inclusion of titles from these searches resulted in a total of 62 potentially relevant titles. Selection of articles for inclusion in the formal analysis was based on the following criteria:

- **Describes the implementation of an EMS system or the structure of an existing EMS system**
- **Describes the above in regards to a single municipal, provincial or national EMS system**
- **Describes the above in the setting of a Low or Middle-Income country as defined by the World bank(8)**

Reflecting the heterogeneous nature of research in the field of prehospital care in these regions, a broad inclusion criteria was chosen. A purposive selection was made in the literature to represent a broad range of EMS systems with respect to region, economic development levels, and system models. 10 articles were selected by the author for inclusion in the formal analysis to match the scope of this assignment. Given the largely qualitative and descriptive nature of research on this topic, no quantitative meta-analysis was performed.

The 2005 WHO report “Prehospital trauma care systems” was found in the course of the literature review to be a widely referenced source for implementation guidelines related to this topic, and was chosen to provide a framework for analyzing the selected articles. An analysis of the report by the author yielded a number of key elements to be considered during the implementation of an EMS system as described in Table 1 below.

**Table 1 – Key Elements of EMS system Implementation**

- Lead Organization
  - Identification of an agency responsible for legislative development, regulatory oversight, organization of the system and financing.
- Local Support
  - Generation of regional and local support and involvement that includes members of the local community.
- System Model
  - Selection of processes, models and actors involved with care delivery.
- Medical Direction
  - Active coordination of care, training and quality assurance by a dedicated leadership team.
- Political support
  - Development of ongoing political and legislative support for the financing and regulation of EMS operations.

This framework represents a minor alteration of the list described in Box 2 of the 2005 WHO report (p. 14), with the inclusion of an item to account for the model and actors involved in a given EMS system, which is recognized in the report as playing a key role in implementation success. Each included article was analyzed with respect to the provision for each of the key elements. It must be noted however that owing to the non-exhaustive nature of the literature review and the subjectivity of this qualitative review model, the results found below must be considered to be only an outline of potential solutions and acknowledged implementation gaps in the EMS systems described. This methodology is thought to be subject to significant publication bias, as only a single article containing explicitly negative findings was identified.

## Results

### 1 - Husum et al., 2003 (9)

- Study Description
  - Five-year prospective study of prehospital Trauma system implementation in landmine-dense provinces in North Iraq and Cambodia. Primary findings indicate reduction in total mine-related injury mortality rate from 40% to 15%.
- Lead Organization
  - Study authors play primary role in training initial staff and organizing project. Activity of local agencies in project is not described.
- Local Support
  - “Village University” model of training – Initial training of local paramedics by authors over 3 years, who become instructors for future classes. Further trickle-down training to networks of lay First-responders recruited locally.
- System Model
  - Tiered response system utilizing a “Chain of Survival” from volunteer healthcare workers to professional staff trained in Basic- or Advanced Life Support techniques.
- Medical Direction
  - Provided by Authors during study period. Local medical direction not described.
- Political support

- Agreement with local ministries of health noted, project funding is not described.

This study notes a highly significant impact on landmine injury lethality rates following the implementation of a prehospital care system. Of note is that 97% of patients were managed at a BLS level of care, despite the high level of training provided to local providers. Little is documented in this study relating to the local organization which will need to support the project financially and provide clinical leadership upon the cessation of the study period.

## 2 - Waseem et al. 2010 (10)

- Study Description
  - Descriptive study of the implementation of an EMS system in Punjab province in Pakistan. Findings indicate success in maintaining low (7 minute average) response times.
- Lead Organization
  - “Rescue 1122” created to manage EMS responses at Regional level. No National coordinating organization noted.
- Local Support
  - Emergency Services Academy established to train EMTs drawn from local population.
- System Model
  - Ambulance staff trained to Basic Life Support level. Operations are managed by Rescue 1122.
- Medical Direction
  - Led by motivated, local trauma surgeon. Local Emergency Services Academy founded to train personnel, centralized command structure implemented.
- Political support
  - Legislatively mandated, Government-financed service. Core EMS mission supported by addition of Fire suppression and disaster response functions.

This study describes the implementation of a Basic Life Support ambulance service in Lahore as a pilot project for implementation across the province of Punjab. This implementation is notable for its description of strong legislative support, and a model focusing on the implementation of a BLS ambulance service as prescribed by the 2005 WHO Report. Cost savings are reported by the use of locally produced vehicles and training materials. A relatively low level of utilization is reported (170 calls daily in a city of 5.1 million), which the authors attribute to cultural norms and the presence of informal ambulances. Other researchers have suggested mistrust of ambulance services and a sense of inadequacy as compared to international systems as barriers to Ambulance service utilization.(11) No objective outcome measures are reported to provide evidence to support the effectiveness of the implementation beyond the response time metric.

## 3 - Peralta et al., 2006 (12)

- Study Description
  - Retrospective, descriptive analysis of EMS according to guidelines established by the American Ambulance Association (AAA). This study found that EMS in Mexico City did not meet the criteria established to govern EMS services in the United States.
- Lead Organization

- This study found EMS in Mexico City to be highly decentralized and lacking in common training standards and protocols. No lead organization was found to exist.
- Local Support
  - EMS development organic – Product of local actors filling local EMS Needs.
- System Model
  - Primarily BLS-level services provided by a myriad of private, volunteer and hospital based actors.
- Medical Direction
  - Study finds no indication of physician involvement in clinical aspects of ambulance operations or protocol development. No evidence found of quality assurance programs.
- Political support
  - No explicit financial backing for EMS on provincial or national level. Regulations relating to clinical certifications recently passed.

This analysis of EMS services in Mexico City is hampered by a nearly complete lack of viable data on the studied system, but is able to provide an in depth qualitative description. While EMS in Mexico City is functional with reported response time averages of 7 – 35 minutes, the authors find that EMS is administered by a number of independent agencies with no common medical direction, organization or training. This has resulted in a low level of competence among ambulance personnel, as illustrated by the fact that among staff agreeing to perform a voluntary certification exam at a basic level, 50% failed. Data on cost efficiency and clinical indicators were not able to be procured, making systematic quality assessment impossible.

#### 4 - Geduld et al., 2011 (13)

- Study Description
  - Descriptive study of the implementation of a first-aid training course for taxi drivers in Mahajanga, Madagascar. Stakeholder views indicated success, formal evaluation is underway.
- Lead Organization
  - Effort led by local University Hospital. No formal government involvement is indicated.
- Local Support
  - Local doctors trained to lead classes for local taxi drivers, financed by local hospital.
- System Model
  - Lay responders only, no formal response system.
- Medical Direction
  - No formal medical direction, training overseen and developed by emergency medical specialists in South Africa.
- Political support
  - No political considerations involved, interest in replicating project elsewhere in Madagascar is noted.

This study describes in intervention possible even in the absence of any potential sources of formal organization or ongoing support. Indeed resources are so limited that the single donated Red Cross

ambulance is non-operational due to financial constraints. While no formal organization is created in the intervention, it is hoped that the curriculum developed for this project could be replicated elsewhere.

### 5 - Mould-Millman et al., 2015 (14)

- Study Description
  - Mixed-methods study of Emergency department patients in Ashanti, Ghana. Found National Ambulance Service in Ashanti, Ghana to be well developed, but lacking in reliable financing, public access, and quality assurance processes.
- Lead Organization
  - EMS in Ghana coordinated by the National Ambulance Service (NAS), which directly manages a portion of formal prehospital care, manages dispatch and sets training standards.
- Local Support
  - System organized national/district level. Efforts to illicit local support are not documented.
- System Model
  - National agency in lead, some ambulances semi-autonomously managed by district hospitals. Ambulance scope of practice not described.
- Medical Direction
  - Medical direction provided by NAS doctor – only region in Ghana to do so. Training provided to NAS ambulance staff directly. No formal clinical guidelines exist.
- Political support
  - EMS partially financed at national level, heavy reliance on patient fees for income.

This study describes and analyzes an EMS system coordinated under a lead national agency and trained to set standards, despite a relatively low national level of economic development. Despite a low ambulance to population ratio, ambulance services are able to deliver a significant portion of acute cases to local EDs.(15)

### 6 - Lima et al., 2010 (16)

- Study Description
  - Analysis of the implementation of the National policy for reducing accident- and violence-related mortality and morbidity (PNRMAV) in the EMS system of Recife, Brazil. Study found that fixed prehospital care centers did not meet standards, while the ambulance service was better trained but suffered from communication problems and delays in care.
- Lead Organization
  - National Health Service is lead organization for EMS.
- Local Support
  - Decentralized administration of fixed prehospital care (clinics, non-hospital emergency care units). Local support for EMS not described.
- System Model
  - Tiered response model includes basic and advanced level practitioners. Service in Recife administered by Federally organized Emergency Care Service (SAMU)

- Medical Direction
  - Central medical direction provided by NHS, well defined guidelines for training and protocols are in place.
- Political support
  - National policy supports EMS provision, National Health Service financed to provide services nationally.

This study demonstrates how established guidelines can be used to evaluate the performance of EMS systems, and provide a framework for system improvement. Despite some issues relating to lack of communication and delays due to overcrowding in emergency departments, nationally organized SAMUs provide a high level of care, in contrast to locally managed fixed prehospital care centers.

### 7 - Suriyawongpaisal et al., 2014 (17)

- Study Description
  - This pre-post study seeks to determine the impact of implementing a National Lead Organization, the Emergency Medical Institute of Thailand (EMIT), on EMS in Thailand. Findings indicate reduced response times and increased ambulance coverage, but were not able to demonstrate an improvement in triage accuracy.
- Lead Organization
  - EMIT (established by national statute in 2008) manages dispatch, training and service standards, and coordinates quality assurance.
- Local Support
  - Not described
- System Model
  - Tiered response system formalized by EMIT, operational actors not described.
- Medical Direction
  - Not described
- Political support
  - Statutory support for EMIT, primarily public financing for EMS with increasing use of service fees.

While the quantitative review resulting from this study is unsurprising, the ability to analyze data from across regions in Thailand stands in contrast to the inability to gather these data in countries lacking such centralized organization. This structure has enabled an expansion of services on a standard model that can be audited to ensure high-quality care.

### 8 - Jayaraman et al., 2009 (18)

- Study Description
  - Evaluation of the implementation of a first aid training program in Kampala, Uganda. Findings indicate increased skills usage post-training, and cost effectiveness.
- Lead Organization
  - No lead organization noted, and no organized prehospital care exists in Kampala.
- Local Support



- Local Taxi drivers, police officers, community leaders enrolled to program.
- System Model
  - System integrated with existing actors (Police, taxi) likely to be at the scene of incidents involving trauma. Minimal training - Single day of instruction provided to trainees.
- Medical Direction
  - No formal medical direction exists.
- Political support
  - Political support not noted, but study demonstrates feasibility in terms of cost effectiveness in the framework of Ugandan health spending.

This study describes a minimalist implementation of prehospital care in a region lacking formal prehospital care systems. Training was provided to taxi drivers and police officers in accordance with WHO guidelines on basic trauma care in a single day course.

### 9 - Zimmerman et al., 2013 (19)

- Study Description
  - Evaluation of the implementation of a formal EMS system in Jaffna district, Sri Lanka. Study demonstrated acceptable utilization and cost sustainability over study period.
- Lead Organization
  - Regional Department of Health Services (RDHS) managed project, no national agency for prehospital care exists.
- Local Support
  - Included training of community members in first aid techniques and accessing EMS.
- System Model
  - All-BLS system directed by National Health Service, some ambulances operated by NGOs.
- Medical Direction
  - Development of clinical protocols and continued medical oversight by RDHS physician.
- Political support
  - Support from RDHS, two international grants. No formal regulation of services or statutory financing. Salaries financed by Ministry of Health, operation costs covered by voluntary service fee.

This study describes the development of a prehospital care system in Jaffna, Sri Lanka in 2009 in the wake of the civil war. Implementation followed a US model with substantial international support. This study demonstrates the success of utilizing local support to expand access to emergency care in its relatively high utilization rate, and the feasibility of a system based on the WHO report recommendations. Due to lack of ongoing operational funding or a legal mandate, the future of the system remains uncertain however.

## 10 - Hung et al., 2009 (20)

- Study Description
  - Qualitative, descriptive study of EMS systems across China. Study finds a great deal of variety in system models, levels of training and financing.
- Lead Organization
  - Services organized under Emergency Medical Service System (EMSS), however services are delivered by a wide variety of agencies in various regions, with little centralized control over standards.
- Local Support
  - Heavily regionalized system utilizing local resources.
- System Model
  - Various models of care delivery including standalone emergency care centers, hospital based systems, unified emergency response systems and fire or police based systems.
- Medical Direction
  - No coherent medical direction at national level exists.
- Political support
  - Funding for EMS nominally public, but reliance on fee-for-service is widespread.

This study of the Chinese EMS system reveals a lack of central standardization of training and legal mandates for emergency care. Prehospital care is provided by a patchwork of actors in various regions. This makes synthesis difficult, but the authors note a general lack of coverage in rural areas, a lack of standard referral system and a need for national government support for and regulation of EMS as areas for improvement.

## Discussion

In reviewing the literature, it was found that three general types of implementations could be identified. These included projects to improve local knowledge and informal systems with minimal ongoing public support, the creation of local or regional formal EMS systems, and the expansion and standardization of EMS systems at the regional or national level. Each of the reviewed studies focus on different key elements as described by the WHO, dependant on the socioeconomic and cultural context of the studied system as described below.

### Local Support Generation

In situations where resource availability does not permit the sustainable implementation of formal prehospital care systems, interventions focus on increasing the ability of local actors to provide appropriate initial care and improve access to definitive care. In terms of addressing the key elements described by the WHO report; interventions of this type focus on improving care by building local support for prehospital care. Examples of this type of effort are 4 and 8 above, describing first aid training programs for taxi drivers, policemen, and other local actors at low cost. Such interventions can be helpful in changing societal norms and raising awareness about accessing formal emergency care.

## System Formalization

As awareness about the hazard posed by traumatic injury increases and local leaders become able to dedicate resources to managing a formal prehospital care system, EMS systems are typically developed at the level of the municipality or province. These interventions are often inspired by western EMS systems, and must address a full range of operational issues related to the system model, medical direction and financial/political support. In many cases, such interventions are intended to serve as a model for future national efforts as described in study 2 above, where it is noted that the “Rescue 1122” system is to be implemented in other Pakistani provinces. These regional implementations may in some cases be at risk due to a lack of formal national support as described in study 9, which was heavily reliant on one-time international grants.

## Expansion and Standardization

Studies investigating relatively mature EMS systems tend to focus on expanding coverage of EMS systems to underserved populations in rural and low-income areas, and establishing standards of care across regions or countries. These often focus on the role of the Lead Organization and its effectiveness in organizing prehospital care, or the need to establish one. These studies tend to view centrally organized systems such as the National Ambulance Service in Ghana (Study 5) and the Emergency Medical Institute of Thailand (Study 7) positively. Prehospital care systems developed organically at a local level are seen as less effective, such as the local EMS providers in study 5, fixed prehospital care providers in study 6, and the EMS system in Mexico City in study 3.

Successful EMS systems as described by studies of the third type in this categorization have in common a strong central lead organization. An early focus on the creation of national and/or regional frameworks for EMS may provide long-term benefits as the demand for prehospital care increases in concert with a region’s economic development. EMS systems developed in the context of EMS-specific regulatory frameworks are found to be if not more efficient, at least measureable. It was for instance found to be impossible to determine generally even the most basic of performance measurements in the splintered EMS system of Mexico City.

Local support was found to be a particularly critical element in interventions involving low-income countries and in the successful implementation of formal EMS systems. In addition to interventions aimed solely at building local support for improving prehospital care, studies of formal EMS system implementation often note the critical role of interventions to improve awareness and training among the general population. Studies 1 and 9 both describe the important role of lay first responders in activating the formal care system.

## Conclusions

The 2005 WHO report *Prehospital Trauma Care Systems* provides a useful framework for understanding the key elements of successful prehospital care system implementation in developing countries. Studies on this topic can be classified as describing local support generation, system formalization, or system expansion and standardization. The first and last of these tend to focus on local support and the lead organization respectively. The successful implementation of formal EMS

systems is highly dependent on local support, and the regulatory context in which it occurs may play a large role in the ability to measure the performance of the system as it develops.

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