

Prehospital Care System in Low-Resource Setting: Experiences Learned from Newly Established System in Jimma City, Southwest Ethiopia

Shemsedin Amme Ibro^{1*}, Sheka Shemsi Seid¹, Abdulwahid Awol Ahmed¹, Ismael Ahmed Senbiro¹, Tolasa Takale Moga¹, Muktar Beshir Ahmed², Gemechis Melkamu¹, Gelaw Hailemariam¹, Abdusemed Husen Abo¹, Mohammed Mecha Abafogi¹, Ame Mehadi Abdureman³, Nee-Kofi Mould-Millman⁴

ABSTRACT

Effective emergency care systems could avert a significant portion of the high morbidity and mortality rates attributed to acute illness. Such a system should be structurally integrated, in a continuum style, where care is continuously given in a coordinated sequence. Prehospital care is an important part of the health continuum, but it has been neglected in most African countries for many reasons, mainly due to poor advocacy and a lack of a model to organize the system. A low-resource model was used to establish a formal prehospital care system in Jimma City, the largest city in the south-western part of Ethiopia. A hybrid hospital-based system complemented by volunteer systems was used to establish a local emergency medical service (EMS) system, named Aayyoo Ambulance. The establishment process was financially supported by the government and officially started its operation in October 2020. Initially, emphasis was placed on the foundation of the core elements of the system, and a toll-free phone number (6238) was dedicated to the dispatch center to receive calls and provide a tier-based response. As of the first anniversary, more than 1600 emergency calls were served while a computer-aided dispatch system was implemented. The purpose of this article is to describe the prehospital care system's establishment process, and lessons learned in Jimma City.

Key words: Prehospital care; Ambulance service; Emergency Medical Service; Ethiopia

1. Jimma University, Jimma, Ethiopia
2. University of South Australia, SA, Australia
3. Haramaya University, Harar, Ethiopia
4. University of Colorado Denver, Aurora, CO, USA

Correspondence: Shemsedin Amme

Email: shamsuamme@gmail.com

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1. Introduction

African nations bear overwhelming high rates of global morbidity and mortality burden, with a significant proportion of this burden attributed to acute illness and injury (1). An effective emergency care system can substantially avert the mortality and disability associated with a wide range of acute illnesses and injuries on the continent (2). Such systems should be structurally integrated and occur in a continuum to ensure care is given in a coordinated sequence (3). The prehospital care system (PHC), which is provided outside of the hospital and determines the health outcome of patients independent of hospital-based emergency care, is the first and most important component of this continuum (4, 5). An emergency medical service (EMS) system is a formalized PHC system that operates within a defined jurisdiction under an established entity, where care and services are provided by professionals (6). Despite the dire needs and potential health outcome benefits, PHC remains neglected in most African countries for many reasons (6). It has been reported that less than 9% of the population has access to PHC (6), while there is no evidence of EMS systems in 61% of African countries (7). PHC on the continent is underdeveloped for a number of reasons, including a lack of data on the actual burden of acute diseases, cost fear, a lack of optimal structural and functional models, and subpar advocacy (6).

Ethiopia is one of the countries known for its high morbidity and mortality burden attributed to acute maternal, childhood, and communicable diseases (8, 9). In addition, this burden is accompanied by increased time sensitive acute complications of chronic diseases and injuries (10-12). Despite, such a dire need for an effective emergency care system with a strong foundation in each phase of care, the system remained

underdeveloped in the country. In particular, PHC is a new concept, and a formalized EMS system is a shortcoming in the country. Recently, improved emphasis has been given to emergency care development, particularly concerning human resource training and ambulance distributions to support PHC (13, 14). Furthermore, a few cities with a high load of emergencies and road traffic accidents have been recently targeted by national initiatives to improve emergency services, including the establishment of the PHC system (13). This article describes our first-hand experience in establishing PHC systems and the lessons learned in Jimma City.

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2. Model for PHC systems in resource-limited setting

There is no single universal strategy recommended to organize and implement the PHC system (6, 15, 16). Prehospital EMS has been organized and delivered by several entities, including municipalities, fire departments, legal enforcement, hospitals, non-profit organizations, and private non-hospital organizations (2, 4, 17). The principles and elements of the system vary between environments, organizational settings, health care system differences, community settings, and cultures (2, 4, 16, 17) across the world and even within countries among different regions (17). Therefore, a context-specific strategy is required to handle the high demand

from a variety of emergency conditions in an African setting with limited resources (17). The World Health Organization (WHO) has developed a two-tier system to facilitate the development of sustainable, effective, and low-resource prehospital trauma care systems in Africa (16). The African Federation of Emergency Medicine (AFEM) working group for out-of-hospital care system has suggested the applicability of extending this model to non-traumatic prehospital care while suggesting the local appropriateness and identifying core elements of the system (3). Hence, the key step is understanding the local burden of acute disease and knowing the most efficient way to address it with available resources (15).

The trauma-oriented system devised by WHO has suggested different models to organize PHC in low-resource settings based on the primary entity to provide administrative and regulatory control, resource support, and operational leadership at different levels (16). This includes national (nationally regulated); regional (local or jurisdictional); hospital-based (that are integrated into hospitals); volunteer (community-based); and hybrid (a combination of either of these) systems (16). Taking this into account, a comprehensive PHC system involving both tiers of care can be organized at the local level using a complementary hybrid model of jurisdictional EMS and volunteer systems. A tier-one system, which has been shown to be effective in resource-constrained settings, will be organized by a large number of volunteer community members who have been trained to provide initial rapid medical response at the scene(3, 16). A hospital-based or local (municipality level fire department or legal enforcement) model can also be used to organize a tier-two system that provides professional prehospital care within a defined jurisdiction and will be linked to the tier-one system(3, 6). Moreover, Mould-Millman et al.(18) have clearly

outlined the steps towards establishing such a two-tier emergency medical dispatch system in small- and large-scale areas in the African context, while success stories have been reported in a few countries on the continent(7, 19-24) and countries on other continents such as Pakistan (25). Nevertheless, organizing and sustaining PHC systems, in particular a large-scale two tier system continued to be challenging both technically and financially in resource-limited settings, primarily in many African countries (26-29). As of African countries,(6, 15) including in Ethiopia, the development of the PHC system has lagged behind, due to the lack of EMS legislation, financial systems, standards of care, and communication in the face of limited transportation and trained manpower.

3. PHC in the Context of Ethiopia

Ethiopia has no formalized PHC systems or EMS legislation. However, the Ministry of Health (MOH) has been supplementing at least one ambulance with each district woreda and municipality across the country, while short-term emergency medical technician (EMT-basic) trainings have also been initiated. The ambulances, however, are still traditionally used for obstetric emergency transportation and are predominantly not staffed by EMTs, even if those staffed lack basic medical supplies and equipment. Evidence indicates that more than 80% of ambulances perform no better than commercial taxis (30). Besides limited transportation and trained personnel, the development of the core elements of the PHC system, such as finance, standards of care, and communication systems, lagged behind. The PHC system is fragmented across the country and can be referred to as a "neglect model" given the lack of proper legislation. This is further exacerbated by the lack of well-established evidence and advocacy for PHC development. In such a context, where resources are limited and systems are

fragmented, starting with the establishment of a small-scale PHC system would be beneficial to gain experience before gradually scaling up to a large scale. Hence, a local hybrid model composed of hospital-based and volunteer systems would be a suitable approach. Using this model, a two-tier system can operate under regional or referral hospitals (16). There were several reasons given, but the main ones were two. First, unlike other local models that are operated by the fire department or by legal enforcement, the hospital-based model keeps the PHC system within the healthcare system, in an environment with a lack of previous similar experience (2, 4, 17). Second: hospital-based model can help overcome the paucity of technical expertise while facilitating access to medical and operational resources in such resource-limited settings (16). Besides, this model facilitates the involvement of the local health authorities to regulate and oversee the operation, which may facilitate political support. However, the prominent drawback of this model is that its applicability is limited to urban settings where regional hospitals are available. Recently, the Ethiopian MoH launched a national program called the Major Cities Emergency, Injury, and Critical Care Improvement Program (MEI-CIP) to improve emergency care service and to support the establishment of prehospital care services in selected regional cities,(13) including Jimma as one of its targets three years ago.

4. Establishing PEMS in Jimma

Jimma City, located 352 kilometers from the capital city of Addis Ababa in Oromia regional state, is the second largest city in the region and the first in the southwest part of the country. The city has an estimated population of 250,000 residents. Jimma has four public primary health centers, and five hospitals (two public and three private). Jimma University Medical Center (JUMC) and Shenen Gibe General Hospital (SGGH) are

two public hospitals, and both provide emergency services for patients with trauma and medical emergencies. Before the establishment of Ayyoo EMS Ambulance,(31) the pre-facility service had been provided by the city health office and the Jimma branch of the Ethiopian Red Cross Society, each of which owned one ambulance. This section describes the establishment process of the Aayyoo Ambulance in Jimma City, which is the first public EMS agency in Ethiopia.

4.1 Establishing evidence

In 2018, the lead author and other motivated researchers conducted preliminary research to assess the need and possible ways to establish a formalized PHC system in Jimma City.(32, 33) The aim of this preliminary study was to assess: (1) the local emergency burden; (2) the projected demand for PHC, (3) the status of existing service and barriers to access and community suggested solutions to overcome them; and (4) ambulance use to reach emergency departments. Then we synthesized the findings obtained from this study, which was followed by a review of the literature to determine a possible approach to a formalized PHC system. As mentioned in the previous section, a local hybrid model involving jurisdictional EMS and volunteer community-based systems was identified as a proper model. Finally, we developed a policy recommendation along with strategies and guidelines for implementation, including standard operating procedures (SOPs) and different working documents. Some of the findings of this study have already been published, while others are in the pipeline.

4.2 Leadership and Governance

Fortunately, the national MICIP program which was aimed to improve emergency care service in selected major cities has come to Jimma as soon as we finished the initial preliminary research work. The motivated research team has joined

this national initiative at the request of an invitation to implement the research outputs at hand. The program implementation was collaboratively governed by a steering committee the regional and the local health authority, the University and its teaching hospital's administrative heads. We proposed the research-driven model to establish a PHC system in Jimma city under the scheme of MEI-CIP initiative. The consensus was to organizationally govern the EMS under JUMC, while the city's health office oversees the overall operation. The terms of reference were developed to delineate the organizational structure and guide the establishment. As there is no pre-existing national or local EMS lead agency, the MoH provides regulatory oversight and training.

4.3 Finance

The establishment process was funded by the MEI-CIP project and matching funds from stakeholders, including Jimma University and the Regional Health Bureau. JUMC provides an operational budget, including costs for maintenance, fuel, and equipment. There is no out-of-pocket revenue generated from patients.

4.4 Setting up the System Components

Initially, emphasis was given to developing and setting up the core elements of the system. We first completed all the paper work and guiding documents and branded the new EMS service. This was followed by identifying physical spaces to establish a dispatch center incorporating offices, a call center, and the main ambulance station. Then, we continued with recruiting a toll-free access line, staffing, and recruiting ambulances. JUMC has supplied almost all of these requirements.

4.5 Service Delivery and Coverage

Tier-two system: Aayyoo Ambulance formally launched its service on October 4, 2020. It was

primarily established to serve an estimated 210,000 residents of Jimma City and surrounding sub-urban areas within a 21-kilometer radius. It is the first public EMS agency to operate in Ethiopia. As of its 100 days and 365 days of service commencement, about 242 and 1612 emergency calls were served, respectively. Data during the first year of service shows that half of the served cases were obstetric emergencies (50%), followed by medical illnesses (41%), trauma (8%), and others (1%). The majority of the participants were female. 76.5% and 63.2% were served at night; the mean ($\pm$ SD) response time was 12 $\pm$ 11 minutes, and the maximum was 94 minutes. It offers its services for free, with no strings attached. Aayyoo ambulance uses a tier-based, scoop-run response strategy using basic transporter, basic standard life support (BLS), and advanced life support (ALS) ambulances. Nurses provide basic prehospital care to the patients at the scene and during transportation. Service includes both primary transportation—from the community to a health facility and inter-facility transfers. It deploys mobile clinics and ambulances to escort mass gatherings and public events.

Tier-one system: We established a community-based Tier 1 system, recognizing the critical role of the Tier 1 system in saving lives and preventing disabilities in limited settings. We designed a basic first aid training course in a local language that is to be offered to volunteers recruited from the community. We recruited one third of the recommended standard for community first responder to population ratio in a developing country (2); this corresponds to 170 trainees, including 10 persons from each of the 17

administration kebeles (units) of Jimma city. Finally, 164 volunteers who completed two days of hands-on practice courses were deployed with standard first-aid kits and linked to the dispatch center. The cohort was followed for three months and certified after knowledge and skill retentions were evaluated for the third time.

4.6 Quality improvements

Standardized formats were developed and implemented for documentation. An electronic run sheet was prepared to record data on cases and services. The average response time and accuracy of data records were continuously monitored every month. Interventions were designed and implemented to reduce the initial average response time from 23 minutes to 10 minutes during the first four months. Emergency medicine specialists and nurses working in the emergency department have been providing medical direction to the EMS team.

4.7 Progress achieved

Significant progress was achieved during the first few months of establishment, in particular in terms of human resources, call and information systems, ambulance units, and other facilities. The number of active staff has grown by 25, while the number of active ambulances has increased to 11, including standard BLS (four), an ALS unit (one), and a mobile clinic (one). Efforts were made to digitize dispatch center service by installing two additional VOIP phone extensions, a web-based application for a computer-aided dispatch (CAD) system, and a GPS fleet tracking system in 2021(31). These make Aayyoo Ambulance the first of its kind in Ethiopia, with technology supporting a local model of EMS.

Table 1: Status of the core elements of the EMS at initial development stage

Domains	Status at the initial stage
Working documents	SOPs for call taking and processing, dispatch processes, and protocols for assessment, treatment, and transfer of patients.
	The formats to record calls, dispatch, and care; and electronic run sheets for case registries.
Physical setups	A building for the dispatch center, involving an office, call center, and staff room, along with the required facilities and supplies, was allocated within JUMC near the emergency department.
	Space to establish the main ambulance station and parking were also allocated near the head dispatch center. The municipality has also proposed dedicating space to construct three peripheral stations at every corner of the city, yet only the main station is active.
Public access	The short code for access was 6238 and is a toll-free line (with two extensions). The line was branded as "Aayyoo Ambulance" and advertised to the public through different means.
Health workforce	The dispatch center was staffed by one head person who was an expert in the field, nine professional nurses (including three dispatchers and six EMS nurses), and three call takers.
	Staff received induction training and basic and advanced courses. Professional staff received courses on communication, medical dispatch, and advanced prehospital care. Other staff received basic courses like first aid and communication.
	Staffs were assigned to three-based daily shifts; each shift includes one dispatcher, one call taker, and one ambulance unit that was staffed by a crew of two nurses and one driver.
Ambulance	Initially, four of the six ambulances allotted for service (4 transporters and two basic standard units) were activated. At the time, the ambulance-to-population ratio was 1:35,000.
Communication systems	The phone was the primary means of communication between the dispatch center and field personnel; there were no installed two-way radios, GPS fleet tracking, or dispatch information systems at the time.
Medical products	All ambulances were transporter units equipped with first aid kits alone. But emergency drugs, equipment, and medical supplies were regularly restocked by JUMC in the mini store.
Responsiveness	Daily, a maximum of 5–7 calls were received and served; the average response time even ranged above 30 minutes within the first few months.

4.8 Challenges encountered

The absence of EMS legislation act in Ethiopia puts the legal base of the EMS and the safety of patients and care providers in question (2, 3, 16), only in the case of Jimma but also throughout the country in the future. The lack of a financial system for the EMS system and respective legal frameworks posed challenges to sustainable finance to support EMS operations; thus, there were budget constraints to cover operational expenditures such as ambulance maintenance costs. Moreover, establishing EMS on such a hospital-based model depends on the willingness of the hospital to host it, as legislation and guidelines are lacking in this regard. Therefore,

this puts the fate of the EMS in the hands of hospitals, where major emphasis is given to routine patient service. In fact, the dispatch center has been facing competing interests from traditional ambulances that operate to serve the hospital. Another challenge faced with this model is the abuse and misuse of ambulances as routine hospital service cars, which eventually interferes with service quality (timely response) and professionalism. On the other hand, the lack of institutionalized paramedic training in the country was another challenge to building the human resource capacity of the dispatch center. In addition, the lack of a workforce retention policy and the lack of policies and mechanisms to

ensure the scene staff's safety, in particular during the night, were another challenge posed to the dispatch center. Another major challenge that faced Aayyoo Ambulance was an infrastructure issue, in particular, communication interruptions and a lack of strong support from the local telecom provider. There were repeated interruptions to short-code, which often last for a couple of weeks. Besides, the dispatch center has not yet granted the automated number identifier and automated incident locator, despite their importance in EMS operations and the fact that the call system was digitalized.

4.9 Lessons learned

The establishment of the EMS system in Jimma City taught the following lessons:

- Establishing an effective EMS system starts with identifying and understanding the local context and a suitable model.
- Beginning with a local operating system is an important step toward gaining experience in countries where the national system already falls short.
- In a resource-limited setting, a hospital-based hybrid model can be an option to establish and incubate a PHC system involving both tiers of the system, though the model has its drawbacks and implementation challenges.
- Locally available resources can be tailored to set-up a PHC system and realize access to care.
- Implementation of an EMS system using a hospital-based model relies on the hospital's willingness to support and incubate the service; thus, such a model should be supported by legislation and national guidelines to ensure legitimacy and sustainability of the EMS system as a whole.

5. Conclusions

Formalized prehospital care systems can be realized in resource-limited environments in

Ethiopia and similar sub-Saharan African countries. We emphasize that referral and regional hospitals can play essential roles in incubating and sustaining the prehospital EMS system by providing sustainable access to physical facilities, technical support, equipment, and other resources. The imperative lesson learned from the Aayyoo Ambulance establishment is that existing personnel and physical resources can be collectively tailored to realize the prehospital care system using a hybrid hospital-based model.

Conflict of Interest

The authors declares that they have no conflict of interest.

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