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The current status and challenges of prehospital trauma care in low- and middle-income countries: A systematic review

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Abstract

Background: This review aims to understand the present circumstances on the provision of prehospital trauma care in low- and middle-income countries (LMICs), particularly scoping the challenges experienced by LMICs in this regard. The objective is to systematically evaluate the currently available evidence on this topic. Based on the themes and challenges identified in the provision of prehospital trauma care in LMICs, we provide a series of recommendations and a knowledge base for future research in the field.

Methods: A systematic database search was conducted of original articles that explored and reported on prehospital trauma care in LMIC in EMBASE, MEDLINE, Cochrane database, and Google Scholar, from inception to March 2022. All original articles reporting on prehospital trauma care from 2010 to 2022 in LMICs were assessed, excluding case reports, small case series, editorials, abstracts, and pre-clinical studies; those with data inconsistencies that impede data extraction; and those with study populations fewer than ten.

Results: The literature search identified 2,128 articles, of which 29 were included in this review, featuring 27,848 participants from LMICs countries. Four main areas of focus within the studies were identified: (1) exploring emergency service systems, frameworks, and interconnected networks within the context of prehospital trauma care; (2) transportation of patients from the response site to hospital care; (3) medical education and the effects of first responder training in LMICs; and (4) cultural and social factors influencing prehospital trauma care-seeking behaviours. Due to

overarching gaps in social and health care systems, significant barriers exist at various stages of providing prehospital trauma care in LMICs, particularly in injury identification, seeking treatment, transportation to hospital, and receiving timely treatment and post-intervention support.

Conclusion: The provision of prehospital trauma care in LMICs faces significant barriers at multiple levels, largely dependent on wider social, geographic, economic, and political factors impeding the development of such higher functioning systems within health care. However, there have been numerous breakthroughs within certain LMICs in different aspects of prehospital trauma care, supported to varying degrees by international initiatives, that serve as case studies for widespread implementation and targets. Such experiential learning is essential due to the heterogenous landscapes that comprise LMICs.

Keywords: Emergency medicine, LMIC, prehospital trauma care

Introduction

Trauma (an injury caused by an external physical force) is a leading cause of mortality and morbidity worldwide. It accounts for an estimated 4.4 million deaths each year^[1], with almost 90% of trauma-related deaths occurring in LMICs^[2]. Although injury-related mortality exceeds that of communicable diseases (such as HIV, tuberculosis, and malaria combined), research on strengthening trauma care systems in developing countries remains sparse and much needed^[3]. This is especially true given the rising incidence of trauma globally affecting national economies through increased health care costs and demands, and lost productivity from death and disability.

Traumatic injury stems from road traffic accidents, falls, violent crimes, armed conflicts, and extreme sports amongst other mechanisms. Most trauma-related deaths stem from road traffic accidents and occur prior to arrival at medical facilities^[1,4]. It is well-established that a prompt response and effective prehospital trauma care improve patient outcomes. Prehospital trauma care facilitates medical interventions on scene and provides rapid transportation (with or without concomitant medical support) to hospital for definitive care. The pillars of prehospital trauma care are: (1) activation of the system; (2) prompt response to scene; (3) on-scene assessment and effective field care; and (4) prompt transport to a health care facility for further medical management^[5]. By improving the efficacy of each pillar individually and in conjunction with each other, a reduction in trauma-related mortality and morbidity can be expected through the provision of adequate medical care and support.

In many developed countries, prehospital trauma care is delivered by emergency medical services (EMS) in a manner that is more centralised and widely standardised. However, in LMICs, the provision of prehospital trauma care and EMS remain heterogeneous, widely decentralised from the health care system, and unstandardized^[6]. The World Health Organisation (WHO) recognises this as

an area of priority and advocates for capacity-building in prehospital trauma care and EMS, although less attention is dedicated to improving the actual provision of prehospital trauma care in LMICs.

Prehospital trauma care standards, research, organisational understanding, and care systems originated in large part from developed countries, which have the resources and capabilities required for the widescale implementation of such complex health initiatives. Such resources and capabilities are not universally available. Therefore, mirror implementation of prehospital trauma care models based on developed countries for the LMIC states is somewhat unrealistic, dysfunctional, and ignorant of the unique challenges faced in the latter regions. For example, much greater emphasis is placed on the role of bystanders in transporting trauma patients to medical centres in LMICs, as compared to more economically developed countries, where this is provided in primarily by EMS. However, recent studies have suggested that this trend is changing due to the increasing burden placed on EMS within certain developed countries^[7,8].

This systematic review aims to: (1) identify the existing literature on prehospital trauma care in LMICs and where they originated from; (2) describe the quality of existing studies from this environment (based on research methodology and sample size); and (3) describe the key findings of this existing literature while identifying common themes of prehospital trauma care that may be unique to this environment. It does this with the overarching aim of outlining the current status of prehospital trauma care provision in LMICs while investigating the challenges of its successful implementation.

Methods

Literature Search Strategy

A systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and the Cochrane Collaboration published guidelines. EMBASE, MEDLINE, Cochrane, PubMed, and Google Scholar were searched for original articles on prehospital trauma care in countries defined as low- or middle-income (as per the World Bank's 2021-2022 classifications) from inception to March 2022. An *a priori* protocol was devised for the study, available upon request. The search terms used included "prehospital trauma care", "first aid", "emergency medical services", "basic life support", "low income", and "middle income". The entire search strategy, which was used across all databases, is attached in Appendix 1. Further articles were identified through a manual search of the references lists of articles found through the original search, and use of the 'related articles' function on MEDLINE. The only limits used were the aforementioned time frame and English language.

Study inclusion and exclusion criteria

All original articles published from 2010-2022 were included if they reported on prehospital trauma care in LMICs. Studies were excluded from the review if: 1) inconsistencies in the data impeded extraction of data, 2) the study was performed on an animal model, 3) there was no mention of patient-related data, 4) the prehospital trauma care system was in a country that did not meet the criteria to be an LMIC, and 5) the patient/participant population in the study was fewer than ten. Reviews, case reports, case series (with fewer than 10 patients), editorials, abstracts from meetings, and preclinical studies were excluded. Applying this criteria, two reviewers (SQ and FK) independently selected articles for further assessment following title and abstract review. A third independent reviewer (AAR) resolved any disagreements between the two reviewers. Potentially eligible studies were then retrieved for full text assessment. Covidence was used for data analysis.

Data extraction and critical appraisal of evidence

All full texts of retrieved articles were read and reviewed by two authors (SQ and FK) and a unanimous decision was made regarding inclusion or exclusion. When there was disagreement, the final decision was made by a third reviewer (AAR). Using a pre-established protocol, the following data were extracted: first author, study design, year, country, and qualitative and quantitative main outcomes. A data extraction sheet for this review was developed and pilot-tested using three randomly selected included studies and subsequently was refined accordingly. Data extraction was performed by two review authors (SQ and FK) who carried out the process in duplicate on two separate extraction sheets. Correctness of the tabulated data was validated by a third author (AAR) who evaluated both extraction sheets and assessed full texts where incongruences existed.

Due to the high heterogeneity of the studies, the research group decided not to conduct quality scoring.

Results

Study selection

The literature search identified 2,128 articles, of which 1164 were screened following deduplication. 159 full-text articles were reviewed and assessed in accordance with the inclusion and exclusion criteria. Following critical appraisal, 29 studies^[9-37] were included in this review, featuring 27,848 participants. Figure 1 illustrates the study selection process. A summary of the studies selected, their respective designs, countries of origin, and main reported outcomes can be found in Table 1.

System and organisation of care

Eleven studies discussed the current EMS networks and systems in the context of prehospital trauma care in LMICs^[9,11,15-22,34,37]. With a focus on this area, the greatest hurdles to the successful implementation of utilising EMS in the context of prehospital trauma care were funding, workforce, and resources. These three areas form a spiralling cycle of inadequacy with one another. With

inadequate funding, EMS services are not able to attract qualified and trained professionals for employment (such as skilled paramedics, ambulance drivers, doctors, managerial staff, and support crews), thereby relying heavily on underqualified staff who are severely limited in their prerogative. Furthermore, a lack of funds leads to an inability to purchase EMS resources, which, with a largely poorly trained workforce, makes the system ever more inadequate to deliver prehospital trauma care ^[9, 14, 16, 18, 19]. Poorly resourced, poorly staffed, and poorly performing organisations and systems, public or otherwise, are significantly less likely to attract investment, which is where the standstill in development stems from.

Communication and transportation

Ten studies discussed the method and duration of transportation from response site to hospital ^[9, 10, 12-15, 17, 18, 35, 36]. It is evident that amongst all the differences in prehospital trauma care between high-income countries and LMICs, communication and transportation stand in the spotlight. With a significantly heavy reliance on non-EMS transportation in LMICs, differences in communication between patient/site and medical facilities, and significantly different processes during transportation, this dimension plays a major role in the current state of prehospital trauma care in most LMICs.

Education of health care professionals and lay community

There were 11 studies that discussed the effects of first responder training in LMICs, comprising 7428 participants of various backgrounds, including health care professionals and non-medical community members ^[23-33]. Non-medical community members, in this context, include police officers, firefighters, taxi drivers, commercial drivers, and the general public.

Culture and health-seeking behaviour of population

There were three studies that highlighted the different cultures and health-seeking behaviours of the community ^[10, 12, 22].

Discussion

After reviewing the above literature, the following discussion will focus on the themes emerging from the reviewed articles that reflect the pertinent aspects in the provision of prehospital trauma care in LMICs, including the challenges in each of these aspects. This discussion will be categorised into the following themes:

1. Structure and organisation of prehospital trauma care, with a particular focus on emergency service systems, frameworks, and interconnected networks
2. Communication between different sites and transportation of patients from the response site to hospital care
3. Education of health care professionals and lay community members
4. Cultural and social factors influencing prehospital trauma care-seeking behaviours

Structure and organisation of prehospital trauma care systems

A functional prehospital trauma care system requires structural and organisation integration of EMS within the wider health care system. The current state of EMS in LMICs is very diverse, ranging from well-established EMS (e.g., South Africa) to no EMS capacity at all (e.g., Malawi). Mould-Millman et al. identified that only 30% (16 out of 54) of African countries had access to EMS^[35], localised largely in eastern and southern Africa. It is notable that in many of the remaining 38 countries, there has been little to no observable progress in the last two decades.

Furthermore, within the EMS systems of LMICs, overarching organisational levels also vary greatly. Systems are governed and controlled at national, regional, and local levels. For instance, national policies govern EMS in Vietnam and Colombia, whereas in the African continent, EMS systems are managed predominantly at regional or local levels (such as in Ghana, Nigeria, and South Africa)^[14,18].

Furthermore, the largely well-balanced mix of both publicly funded and private hospitals in LMICs highlights the need for thorough integration systems to be created between emergency services, and for an effective referral system between the two types of institutions. This is particularly because privately funded hospitals contribute to emergency care to a greater degree in LMICs than

in higher-income states. For example, public and private institutions in Pakistan have their own ambulance services that are completely decentralised; each ambulance service is contacted through a distinctly separate hotline, contributing to inefficiencies and wastage of resources within the wider health care system. Furthermore, the standards between the different ambulance services differ significantly with such decentralisation. Centralisation, on the other hand, minimises the variation in standards, barriers to requesting EMS (but not necessarily barriers to utilising emergency care), and public confusion. Emergency services need not necessarily be distinguished between private and public institutions, and can function in a standardised manner between the two, such as in the case of Armenia^[38,39]. It is of particular note that a lack of a national emergency access telephone number, combined with a lack of awareness amongst the population, is a significant barrier to accessing prehospital trauma care, and this can be mitigated through centralisation with national governance^[11]. However, to achieve national governance, the formation of different task forces at multiple levels, involving numerous stakeholders, is required to develop locally relevant policies. Eventually the culmination of these task forces at national levels can aid policy implementation and ensure compliance.

The challenges to the organisation of prehospital trauma care systems can be divided along three dimensions: medical resources, funding of EMS, and workforce.

Medical resources

Availability of ambulance and medical supplies such as oxygen, drugs, and airway adjuncts is essential in providing basic prehospital care. Alongside the acquisition of ambulances, maintenance of these vehicles, equipment, and services requires relatively significant funding. As described by Zakariah et al., routinely collected data can allow stakeholders to make operational assessments of cost-effectiveness and efficacy of ambulance services^[37]. However, this requires a culture of documentation, auditing, and accountability, which is significantly underdeveloped in many LMICs. With such an insight into operational workings, limited medical resources can be better prioritised to achieve the maximum good for prehospital trauma care.

Funding of EMS

When leaders of EMS systems were surveyed by Nielsen et al., the most commonly cited barrier to the provision of EMS was funding^[18]. Funding is essential for capacity building, clinical service delivery, training, health infrastructure, and research. Again, availability of funding varies across LMICs. Where local funding may be restricted and dependent on sociopolitical priorities, external collaboration with global surgery networks can yield successful outcomes, such as that seen in Rwanda^[16]. The international task force to build trauma and EMS capacity in Rwanda was formed following pilot projects on prehospital trauma care in the country, leading to multidisciplinary partnerships and the establishment of an effective trauma care system^[16].

The structure of health care systems also determines whether the cost of hospital transportation and treatment will be free (i.e., borne by the government), paid by patients directly, or covered through private medical insurance. Where costs are paid by patients, this significantly deters those who live in poverty in requesting prehospital trauma care, limits their access to health care through physical means, and can fundamentally delay their care. Monetary considerations of prehospital trauma care in LMICs generally widen the health gap, whilst in high-income countries, it is the converse due to equal and cheap accessibility.

Workforce

Shortages of frontline health care professionals remain a global issue. In LMIC settings^[40] the average physician ratio per 1000 people was 1.4 in 2017^[41]. This barrier is compounded by the fact that developing a workforce requires significant funding in recruitment and training. High workloads and disproportionate income to clinical responsibilities have been quoted as profession-related barriers in a qualitative study involving interviews with health care professionals. Further to that, occupational injuries and lack of professional autonomy or empowerment of paramedics in their daily role contribute to poor morale^[19].

Communication and transportation

Mahama et al. found that a short response interval of <17 minutes by the Ghana National Ambulance Service has a positive correlation with prehospital survival^[7]. This study also reported a median time of transportation from scene to arrival at hospital of 82 minutes – far from meeting the golden hour target – suggesting that response interval (i.e., between emergency call and arrival at scene and hence provision of field care) is an important predictor of survival. This is corroborated by a study by Murad et al. (Iraq), which concluded that in-field response interval is a risk factor for trauma death (11).

Transportation time is influenced by many factors. In rural areas, there are expected difficulties to transport patients due to distance, availability of road systems, and geographical barriers. In inner cities, traffic congestion and lack of dedicated emergency lanes contribute to slower transits (17). Additionally, some road users do not abide by road regulations (17). Not all ambulance services are equipped with global positioning systems for navigation; some rely on maps and ambulance drivers' knowledge of local roads.

In tandem with ambulance transport, communication between the prehospital team and a central dispatch system is key to reduce response interval. The mode of communication includes but is not limited to radio and mobile phones, which can have patchy coverage posing yet another barrier in organisation of care.

Other vehicles may act as alternative transport to health facilities in regions where ambulances are limited or unavailable. A study by Bhalla et al. (India) showed that trauma victims were frequently transported by bystanders in private vehicles (15). Similarly, Nielsen et al. demonstrated that the majority of patients in 13 LMICs across Asia, Africa, and Latin America were transported by commercial and private vehicles (16). This could be an untapped potential in many LMICs using

currently available resources, although it needs to be recognised that provision of first aid may not be possible unless the drivers receive adequate basic medical training.

Tansley et al. carried out a geospatial analysis to assess the provision of ambulance services in Ghana, identifying variation in the access of ambulances in both rural and urban areas. This assessment can be a useful aid for stakeholders when planning service provision as areas where a lack of services can be targeted (33).

Education of health care professionals and lay community

Two-thirds of African countries continue to have no emergency medical services. Trying to replicate a western EMS system in an LMIC may be challenging due to the complexity of these systems, and the time needed to develop effective systems that work for the population in question. To tackle this issue, a 'first responder model' has been suggested as a solution, where lay members are trained to carry out basic prehospital first aid. This has been supported by WHO, who believes this is a useful step in developing EMS in LMICs (38).

The positive role of bystanders at the scene of injury as first responders has been widely discussed. Laypeople often evaluate, call for EMS, and transport trauma patients to hospitals. In Nigeria, the majority of road traffic victims were transported to hospital by bystanders and relatives (12). It is important to firstly establish the needs of the population and work with the local community so that training can be contextualised (24).

Several countries have developed and tested lay first responder training programs to assess whether they are effective. The definition of efficacy in the majority of cases is limited to improved confidence of the trainees, use of the skills in practice, and knowledge retention after a specified period. These studies are yet to investigate whether the programs improve clinical outcomes.

The target audience for these programs has varied from country to country based on the demographic, terrain, and transport links. A study in Uganda used motorcycle taxi drivers, as they

are likely to transport unwell individuals to the hospital (22). Additionally, motorcycle taxi drivers can travel to areas of the country where the transport links and roads are of poor quality. The outcome was favourable with improved confidence levels and understanding of basic first aid. A follow-up study noted that confidence levels and knowledge retention remained high after 2 years, and the majority of those trained had used their skills in practice (22). Similar programs were implemented in Chad and Sierra Leone; both found increased confidence after 6 months (25, 27). The most commonly used skills were relating to haemorrhage control using bandages and tourniquets, closely followed by fracture management.

Common issues that were identified during follow-up interviews were lack of medical supplies, lack of formal recognition leading to mistrust from patients and their families, and difficulty transporting patients to hospitals. Some LMICs have taken measures to solve these issues. South Africa developed a course where responders were integrated into the local EMS, who oversaw training (24). A course in India placed emphasis on using locally available supplies to provide first aid, so that in areas where resources were sparse, first aid could still be given (30).

Bolivia, India, and Rwanda have set up programs to improve prehospital care knowledge of health care professionals (23, 28, 30). Courses were built on similar principles covering topics such as fracture immobilisation, cervical spine stabilisation, extrication, airway management, and triage. Again, training was successful in improving confidence of participants; however, no data on whether they improved clinical outcomes were measured.

Culture and health-seeking behaviour of the population

The culture of seeking formal emergency transport and care in LMIC needs to shift. The majority of study participants in Millman's study, based in Ghana, responded that they would call a taxi instead of an ambulance in hypothetical traumatic emergency scenarios because the former is perceived to be faster (8) – a finding also echoed in a separate study by Takele et al. in Ethiopia (20). Additionally, only 43.8% of Ghana's public knew of the public access medical emergency telephone number.

In India, Shrivastava et al. found that 92.5% of road traffic victims interviewed either did not ring for an ambulance due to reduced awareness, or arrived via different transportation altogether (10). This emphasises the need for a public campaign to educate the community about access to emergency care, especially in the context of trauma.

Limitations

This systematic review is limited to English peer-reviewed literature, with exclusion of grey literature, which may bias perspectives. Based on this systematic review, the current literature on prehospital trauma care in LMICs is heterogenous, with most studies based in the African continent. It is obvious that there are differences in the provision of health care (for example, the existence of a national public health system) and differences in culture across LMICs. Furthermore, each prehospital trauma care system has its own unique challenges within the local context and the wider regional level, further influenced by governance policies and socio-political changes, which add further layers of complexity in examining this issue.

Consequently, a generalised conclusion cannot be drawn on the current status of prehospital trauma care provision in LMICs. However, some of the LMICs do share similar themes of challenges in the provision of this care on issues such as funding, workforce, and resources. This review underpins the heterogeneity of this topic, highlighting that we cannot be too simplistic in our endeavour to understand the health care systems in LMICs. Research assessing prehospital trauma care in other regions such as Asia and South America is lacking, and should form future research priorities.

Conclusion

The studies in this review suggest that the provision and organisation of prehospital trauma care varies at national, regional, and local levels across LMICs. Each prehospital trauma care system has its own unique challenges, although similar themes have been identified. These include funding issues, workforce shortages, and lack of resources. Significant heterogeneity in the data exists, due

to differences in population, health provision, and culture between LMICs. Further research needs to be undertaken to better understand the nuances of the provision of prehospital trauma care in LMICs.

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Table 1: • • •

No.	Author	Publication year	Method	Location	Source of sample and participants	Key findings
1	Mahama et al. (7)	2018	Cross-sectional retrospective review	Ghana	Ambulance logbook	Response interval of <17 minutes and level of consciousness significantly associated with prehospital survival. Increased response interval due to traffic in inner city, no dedicated emergency lanes, inability of other road users to obey traffic road regulations
2	Mould-Millman et al. (8)	2015	Cross-sectional survey	Ghana	468 general public	Most (54.7%) respondents believed EMTs offered high-quality care, but 78.0% believed taxis were faster than ambulances.
3	Ismail et al. (9)	2015	Cross-sectional interview	Pakistan	165 ambulance staff	Ambulances equipped with tools for airway management, however solo drivers mean ambulance is merely a transport tool. Majority of staff not airway-competent.
4	Shrivastava et al. (10)	2019	Cross-sectional questionnaire	India	200 victims of road-traffic accidents	33% of the road-traffic accident victims were not aware of existing EMS. Only a small group of patients were brought to the hospital in ambulances.
5	Murad et al. (11)	2012	Cohort study - prospective	Iraq	2778 patients	Reduction in trauma mortality in Iraq over span of 10 years (three cohorts) with mean prehospital transit interval of 2.5 hours.
6	Ibrahim et al. (12)	2017	Retrospective audit 2012-2014	Nigeria	16024 patients	24.0% presented to ED within 1 hour. Only 2.3% had formal prehospital care and were brought to the hospital by ambulance with significantly shorter arrival time.

7	Kim et al. (13)	2017	Cross-sectional survey	Liberia	62 health facilities	Communication between health facilities was unsystematic - lack of specific protocols (n=3; 5.0%) and standardized documentation (n=26; 44.0%) for referral. Private vehicles were the primary transport mechanism for inter-hospital referral.
8	Jayaraman et al. (14)	2021	Experiential narrative	Rwanda	N/A	Surgical capacity-building requires 1) shared mental model, 2) improving clinical service delivery, 3) investing in systems structure (research, trauma registries, communication)
9	Bhalla et al. (15)	2019	Qualitative - interview	India	50 stakeholders (lawyers, health care professionals, police, taxi drivers, policymakers)	Trauma victims frequently transported by police and bystanders. Medicolegal issues place burdens on good Samaritans. Private hospitals will refuse patient first aid treatment if payment cannot be provided.
10	Nielsen et al. (16)	2012	Qualitative - global survey	13 LMIC	26 health facilities	Commercial drivers, volunteers, and other bystanders provided a large proportion of prehospital transport. Frequently cited barrier to development of prehospital care was inadequate funding.
11	Alinia et al. (17)	2015	Qualitative - interview	Iran	18 participants (health care professionals and police)	Barriers related to people, metropolitan infrastructure, professional and managerial issues.
12	Chokotho et al. (18)	2017	Focus interviews - community members	Malawi	28 community members	No prehospital care system in Malawi. Lack of personal protective equipment is a barrier to first aid provision, no ambulance (private transport), unreliable emergency telephone number (lack of awareness, no reliable phone reception), no emergency management system.
13	Balikkuddembe (19)	2017	Cross-sectional, questionnaire	Uganda	459 trauma patients, 23 health care professionals	Absence of predefined EMS systems, poor quality first aid treatment, insufficient skills/training of first responders, and inadequate EMS resources are barriers to prehospital care in road traffic accidents victims.
14	Takele et al. (20)	2021	Cross-sectional - interview	Ethiopia	546 general public	Lack of awareness of EMS access and lack of integrated EMS system in the city were the barriers that may have contributed to the low utilization.
15.	Delaney et al. (21)	2018	Cohort: prospective	Uganda	154 community members (motorcycle taxi drivers)	Motorcycle riders, course on five major areas: (bleeding control, scene management, airway and breathing, recovery position, and victim transport). Post-test scores showed improvement in all five regions. Data on incidents showed bleeding control and bandaging were most commonly intervened area.
16.	Delaney et al. (22)	2021	Cross-sectional	Uganda	239 community members (taxi drivers)	Taxi drivers were all male. Interviewed taxi drivers who had previously been trained and those who had not. Over 90% felt confident 2 years after receiving

						training. Over 95% of taxi drivers who had previously not been trained were interested in receiving training Common challenges faced included lack of supplies, lack of trust from the public due to no official training recognition, difficulty transporting victims
17.	Rosenburg et al. (23)	2020	Cohort: pre-post study	Rwanda	Cohort 1: 17 health care professionals Cohort 2: 19 health care professionals	Training course on prehospital trauma care for prehospital staff (doctors/nurses) in Kingali. Statistically significant improvement in competences. No change in clinical outcomes measured.
18.	Sun et al. (24)	2012	Cohort: pre-post study	South Africa	628 community members	Emergency first aid responder training: 1 day course: emergency scene management, unconscious patient, violent injuries, and medical emergencies. Individuals were integrated into the EMS system. The course showed statistically significant improvement in retention and use of skills at 6 months (77.48% from 28.2%). Random case audit highlighted effective care provided within the capacity of their knowledge.
19	Hancock et al. (25)	2020	Cohort; pre-post study	Chad	136 community members	Course for LFR with five components: principles and definitions of first aid, scene safety, airway management/ haemorrhage control (ABCs), fracture splinting, and victim transport. Sample included motorcycle taxi drivers, non-governmental organization employees, and Red Cross affiliates. 12-month questionnaires showed continued confidence, over 95% reported using the skills. Issues included lack of supplies and difficulty transporting individuals to hospitals. Suggestions to introduce identification cards and consider LFR teachers to train those who live nearby with refresher training courses.
20.	Olumide et al. (26)	2015	Case-control	Nigeria	128 community members (commercial drives)	Two-day first aid training course for commercial drivers in Nigeria. Statistically significant improvement in first aid knowledge post course. Decline in knowledge after 3 months. First aid training courses can be useful in LMIC but periodic refresher courses are required.
21.	Eisner et al. (27)	2020	Cohort, pre-post intervention	Sierra Leone	4529 community members	A 5-hour training course. Mild reduction in knowledge retention at 6 months, but close to baseline at 9 months. Haemorrhage control was the most commonly used skill by LFR, followed by fracture splinting and immobilisation. Highlights importance of refresher courses. Consider the implementation of a notification system as current LFR system is based on chance of being present at an event.
22.	Boeck et al. (28)	2018	Cohort, pre-post	Bolivia	159 health care	A training course for health care professionals and firefighters. Objectives of the course were

			intervention		professionals and firefighters	scene management, ABC protocol, methods of immobilisation, fracture management, patient extrication and transport, and choking/seizures. Improvement in test scores post course were found.
23.	Jackson et al. (29)	2022	Cohort, pre-post intervention study	Bolivia	453 trauma responders	Two-day course for first responders (4 hours total). Improved confidence post course. 6-12 month follow-up results: 66% had witnessed events, high scores for trauma knowledge and confidence in skills, however only 23% of the initial cohort responded.
24.	Aekka et al. (30)	2016	Cohort, pre-post study	India	48 community members (police, firefighters, health care professional, drivers)	Two-day course for laypersons including police, firefighters, ambulance and commercial drivers, nurses, hospital staff, emergency medical technicians. Topics covered included airway and cervical spine management, haemorrhage management, fracture stabilisation, extrication and scene management, triage, and cannulation. Improved competence in all four areas post course.
25	Vyas et al. (31)	2016	Cohort, pre-post study	India	918 community members (police, health care professionals, taxi drivers, firefighters)	Two courses: acute trauma training (4 hours) and broad trauma training (2 days). Targeted to laypersons, e.g., police, ambulance drivers, fire brigade, taxi drivers. Areas covered; basic life support, airway support, intravenous cannula technique, fracture management, haemorrhage control, cervical spine stabilisation, triage, and communication. Post course scores showed increased confidence.
26.	Mould-Millman et al. (32)	2015	Mixed methods - retrospective quantitative and prospective qualitative analysis	Ghana	30 personnel from government and charity health care facilities, tertiary hospital staff, health care institutions and agencies.	Areas that required further development in the emergency services in the Ashanti region of Ghana included governance, non-patient generated revenue, public knowledge, first responders, community integration, and research.
27.	Tansley et al. (33)	2016	Mixed methods	Ghana	Routinely collected data from ambulance logbook	A geospatial analysis was performed, which noted that with the introduction of a national ambulance service the percentage of the population within a 60 minute catchment area of an ambulance station increased from 37% to 79% over 10 years. A negative correlation between the area population size and access to ambulance services was noted. Significant variation in geospatial access of the ambulance service exists in both rural and urban areas of Ghana.
28.	Zakariah et al. (34)	2017	Retrospective cohort	Ghana	Routinely collected data from	Promotion of ambulance services using tools such as television and radio improved uptake of

					ambulance logbook	services. Development of a training school for emergency medical technicians allowed the service to rapidly expand and more effectively meet the needs of the population. Despite the implementation of services, uptake of national ambulance service remained low due to lack of awareness, accessibility, and funding.
29.	Mould-Millman et al. (35)	2017	Questionnaire-based survey	Ghana	Emergency medical services 'experts'	25 different EMS agencies exist in 16 of the 54 countries in the African continent. The majority are in Eastern and Southern Africa. 8.7% of the total African population have access to EMS. Only 26% of countries have access to a toll-free emergency number.

ABC: airway / breathing /circulation; LMIC: low-middle income country

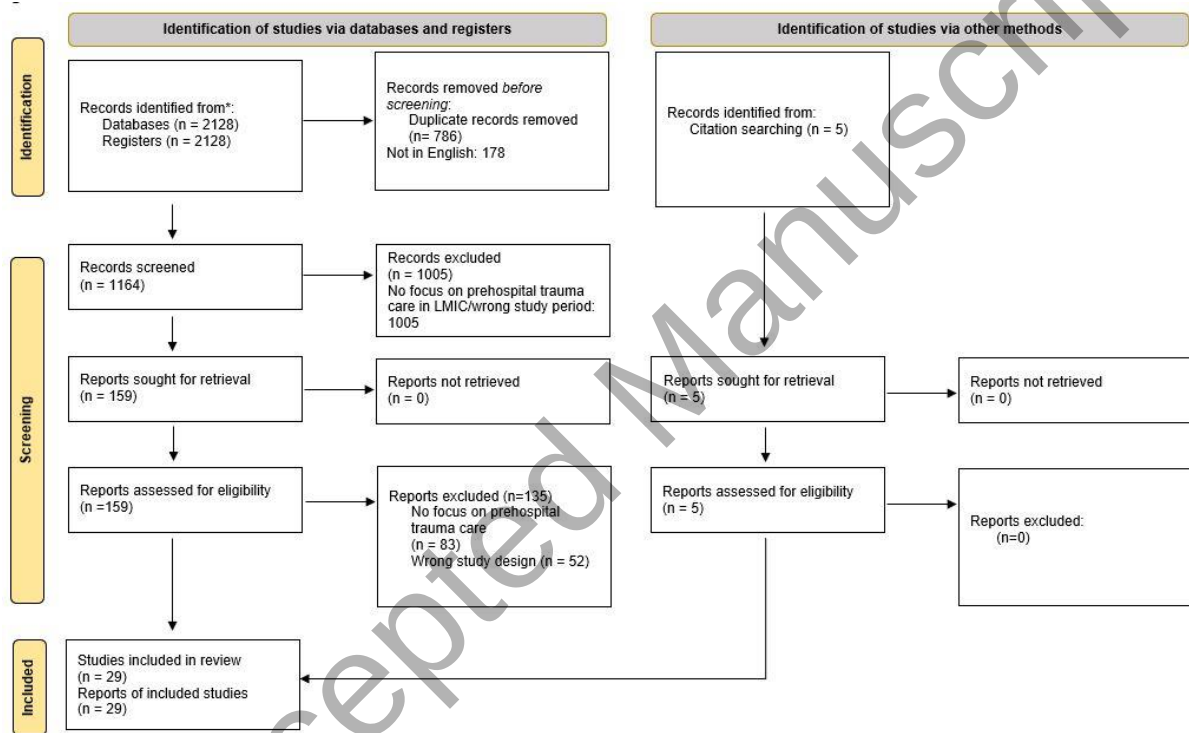


Figure 1 • • •