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PRE-HOSPITAL EMERGENCY CARE FOR TRAUMA PATIENTS AT A NATIONAL REFERRAL HOSPITAL IN VIET NAM: A SINGLE-CENTER DESCRIPTIVE STUDY WITH SYSTEM-LEVEL RECOMMENDATIONS

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List of Abbreviation

AHMM : ASEAN Health Ministers' Meeting
ASEAN : Association of Southeast Asian Nations
CAD : Computer-Assisted Navigation
DHM : Disaster Health Management
DOHA : Direction of Health Activities
ED : Emergency Department
EDRM : Emergency and Disaster Risk Management
EMS : Emergency medical service
E-PCR : Electronic Prehospital Care Report
GPS : Global Positioning System
ICD : International Classification of Diseases
ISS : Injury Severity Score
LICs : Low-Income Countries
LMIC : Low- and Middle-Income Countries
MOH : Ministry of Health
MPDS : Medical Priority Dispatch System

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PHEC : Prehospital Emergency Care
RTA : Road traffic accidents
SPSS : Statistical Package for the Social Sciences
VDUH : Viet Duc University Hospital
WHO : World Health Organization

ABSTRACT

Introduction: Pre-hospital emergency care (PHEC) is a critical component of trauma systems and disaster health management, especially in low- and middle-income countries such as Viet Nam. **Objective:** To assess the current PHEC for trauma patients using data from Viet Duc University Hospital (VDUH), one of the leading and representative hospitals in trauma care of Viet Nam. **Methods:** Descriptive, prospective observational study was conducted. All trauma patients admitted to the Emergency Department (ED) of Hospital between 2024 and 2025 were enrolled. Injury characteristics (ICD-11 classification), mechanisms of injury, response times, and PHEC interventions were evaluated. **Results:** Among 500 patients, traumatic brain injury (55.4%) and multiple injuries (54.8%) were most prevalent. PHEC indicators revealed significant limitations: mean response time to reach the scene was 4.54 ± 7.68 minutes, transport time averaged 13.61 ± 10.06 minutes, first aid predominantly provided by bystanders (64.4%), with only 9.8% delivered by trained healthcare personnel. Ambulance deployed via 115 system was low (14.8%), and pre-referral communication occurred in only 12.4%. **Conclusions:** PHEC for trauma patients in Viet Nam remains underdeveloped, with critical gaps in workforce capacity, system coordination, and infrastructure. Strengthening training of professional staff as paramedic, improving emergency dispatch systems, and enhancing inter-facility coordination are essential.

Keywords: Pre-Hospital Emergency Care; Trauma Care Systems; Paramedics; Emergency Medical Services; Disaster Health Management

INTRODUCTION

Injuries represent a major global public health burden, accounting for approximately 11% of total disability-adjusted life years worldwide. Low- and middle-income countries bear a disproportionate share, with nearly 80% of injury-related deaths occurring in these settings. Road traffic injuries, in particular, remain a leading cause of mortality and disability (1).

The failure to adequately respond to mass casualty incidents in situations such as disasters and traffic accidents also leads to an increased risk of morbidity and mortality (2, 3).

Viet Nam reflects this global trend, with injuries contributing significantly to national morbidity and mortality, account for 11.3% of the disease burden. According to a report from the Department of Health Management (now the Department of Disease Prevention), in recent years, there have been between 25,000 and 28,000 deaths annually (accounting for over 6% of the total national deaths related to injuries), with a rate of 28.9/100,000 population, which is quite high compared to the world and the region (4).

Despite improvements in hospital-based trauma care, the pre-hospital phase remains a critical weak point in the continuum of care. Pre-hospital emergency care (PHEC) encompasses all medical interventions provided at the scene of injury and during transport to healthcare facilities. Timely and effective PHEC has been shown to reduce mortality and improve outcomes in trauma patients. However, in many developing countries, including Viet Nam, PHEC systems are fragmented, under-resourced, and lack professional standardization. ASEAN countries frequently experience disasters, resulting in a high risk of morbidity and mortality. Therefore, ASEAN countries' joint statements on PHEC typically within the framework of the ASEAN Health Ministers' Meeting (AHMM) Joint Statement and agreements on Disaster Health Management (DHM), aiming to establish common standards for emergency medical personnel and to build a rapid response network within the "golden hour". A few recent reports indicate that PHEC in ASEAN countries, a crucial part of disaster response, needs improvement to meet the needs such as Indonesia, Malaysia according to the report of okita Akio et al in 2024 (3, 5–7).

In Viet Nam, PHEC is regulated by the latest regulations of the Ministry of Health (Circular 32/2023/TT-BYT, effective from January 1, 2024, is a detailed guidance document of the Law on Medical Examination and Treatment 2023). A prominent content of the circular is to determine the scope of practice of pre-hospital emergency medical personnel, clarify professional responsibilities, limits of intervention and practice procedures in environments outside fixed medical facilities. This regulation contributes to standardizing PHEC activities, improving professionalism and protecting the legitimate rights of both practitioners and patients in emergency situations (8, 9).

Viet Duc University Hospital (VDUH) is one of leading, top-tier trauma and surgical care hospitals in Viet Nam. It's located in Hanoi, receives and treats patients from the entire northern region of the country, serving approximately 40 million people (nationwide, over 100 million).

With a planned capacity of 1500 beds, in recent years the hospital has performed over 80,000 surgeries annually and received over 30,000 trauma patients, primarily those with severe injuries or complex surgeries. The hospital is also a key unit in supporting medical disaster response, participating in mass casualty emergencies and assisting local hospitals with complex surgeries for patients who cannot be transported elsewhere (10).

The data on trauma emergency care at the hospital reflects its activities in trauma emergency care, as well as its response to mass casualty emergencies, a part of disaster response. This study aims to evaluate the current status of PHEC in Viet Nam through data on trauma care from this institution and to propose feasible system-level improvements.

METHODS

Study Design and Setting

A descriptive, prospective observational study was conducted at the Emergency Department (ED) of VDUH, Hanoi, Viet Nam.

Study Population

All trauma patients admitted between 2024 and 2025 were included. We estimated the required sample size using the single-proportion formula ($Z = 1.96$, $p = 0.5$, ±5% precision), giving a minimum of 384, which we increased to 500 to allow for incomplete records. We then drew a random sample of 500 patients from all eligible ED trauma admissions in 2025 using a random number function in Microsoft Excel. Patients were randomly selected continuously throughout the study period who met the inclusion criteria for analysis.

Inclusion Criteria

1. Trauma patients admitted to the ED
2. Patients transferred within 7 days of injury

Exclusion Criteria

1. Non-trauma patients
2. Incomplete medical records

Data Collection

Data were collected at admission using standardized forms and included (11) :

1. Mechanism and location of injury
2. Injury characteristics (ICD-11 classification)
3. Pre-hospital response time
4. Mode of transportation
5. First aid provider
6. ‘’Golden time’’
7. Referral and communication patterns

Data Analysis

Data were entered using Epidata 3.1 and analyzed with SPSS version 20.0. Descriptive statistics were used to summarize findings. Timing variables were analysed on a complete-case basis (n = 236); all other variables were analysed for the full sample (n = 500).

RESULTS

Trends in Trauma Admissions (2024–2025)

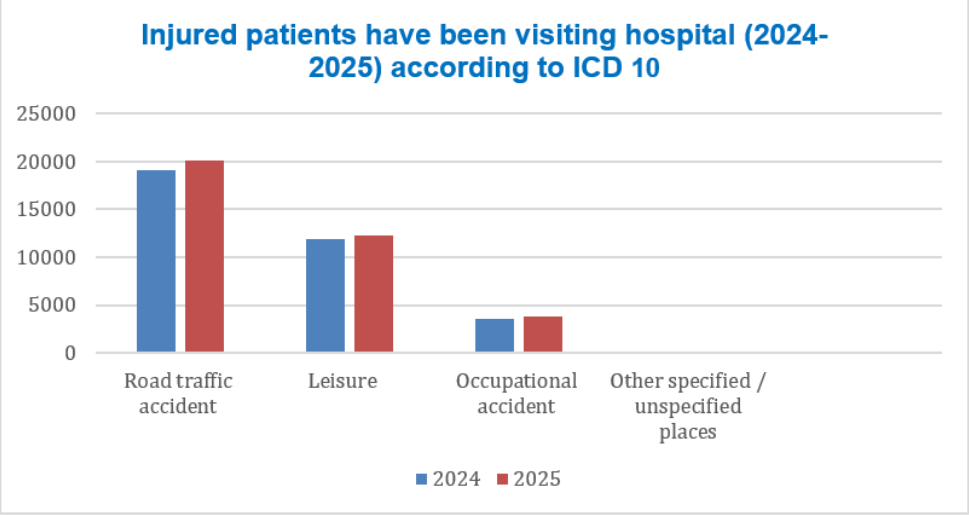


Figure 1. Trends in Trauma Admissions to Hospital (2024-2025)

Source: Viet Duc University Hospital, 2026

A total of 34,634 trauma patients were admitted in 2024 and 36,282 in 2025, corresponding to approximately 100 cases per day. Road traffic accidents were the leading cause, accounting for over 55% of cases in both years.

Characteristics of Subjects

Results of one survey on prehospital trauma care through 500 patients in 2025 showed the characteristics of injuries as follows:

Table 1. Occurrence Sites of Accidents (500)

Accident site	(n)	(%)
Road traffic accident	279	55.8
At home	157	31.4
Working place	51	10.2
Office	8	1.6
School	2	0.4
Other	3	0.6
Total	500	100.0

Source: Chinh et al., 2026

Table 2. Characteristic of Lesions (500)

Type of lesion		(n)	(%)
Multiple injuries	Yes	274	54.8
	No	226	45.2
Brain injury		277	55.4
Maxillofacial injury		156	31.2
Closed chest injury		84	16.8
Closed abdominal injury		78	15.6
Spine injury		105	21.0
Extremities		193	38.6
Pelvis fracture		40	8.0
Vessel injury		13	2.6
Skin and soft tissue		41	8.2

Source: Chinh et al., 2026

Among the analyzed patients, traumatic brain injury: 55.4%; Multiple injuries: 54.8%; Extremity injuries: 38.6%; Maxillofacial injuries: 31.2%; Spinal injuries: 21.0% respectively.

First Aid Provision

Table 3. First Aid Responder at Scene (N=500)

Personnel	(n)	(%)
Health staff	49	9.8
First aid provider of community	120	24.0
Witness person at scene	322	64.4
Him(her) self	9	1.8
Total	500	100.0

Source: Chinh et al., 2026

First aid was primarily provided by bystanders: 64.4%; Community members: 24.0%; Healthcare professionals: 9.8%

Transportation and System Utilization

Table 4. Transportation and System Utilization (n=500)

Transportation	Descriptions	(n)	(%)
Mean	Ambulance (any type)	434	86.8
	Ambulance service (115) *	74	14.8
	Hospital ambulance	200	40.0
	Private ambulance	160	32.0
	Non-ambulance (taxi / private vehicle)	66	13.2
	Total	500	100.0

Note: *In Viet Nam, besides the ambulances of the professional 115-EMS, ambulance services operated by hospitals are also used to provide prehospital emergency care and patient transport. Staff are equipped with emergency skills and vehicles were provided the necessary emergency equipment.

Source: Chinh et al., 2026

Most patients (86.8%) reached the first facility by ambulance, but only 14.8% were transported by the professional 115 EMS system; Taxi/private vehicles: 13.2%.

Response and Transport Times

Table 5. Time to Respond and to Referrer (n=236)

Description	Mean value (X ±SD); (Min-Max)
Waiting time for the ambulance coming to access the patients (minutes)	4.54 ± 7.68; (0-60)
Transporting duration from the accident site to hospital (minutes)	13.61 ± 10.06; (5 -60)

Note: Timing data were documented for 236 of the 500 patients (47.2%); as VDUH is a final-tier referral center, most patients passed through one or more lower-level facilities and the interval from scene to first facility was not consistently recorded.

Source: Chinh et al., 2026

The data was collected from 236 cases and shown that scene response time: 4.54 ± 7.68 minutes; Transport time to hospital: 13.61 ± 10.06 minutes. Median/IQR = 2.7/11.5, so the waiting time for ambulance arrival exceeded 8 minutes in approximately 33% of cases.

Referral Communication

Table 6. Communication for Referral of Patients (n=500)

Descriptions	(n)	(%)
By 115 (dispatching)	62	12.4
DOHA (Direction of Health Activities)	117	23.4
No	278	55.6
Other	43	8.6
Total	500	100

Source: Chinh et al., 2026

Only 12.4% of cases involved prior communication via the 115 system, while 55.6% had no pre-referral contact

DISCUSSION

According to the study of Hari K B et al. (2023) major proportion of deaths from injuries, especially due to road traffic accidents (RTAs), occurs in low-income countries (LMICs) with a large proportion of those deaths occurring before reaching the hospital (12). Poor road safety and the lack of appropriate and timely care for injured individuals might be the causes of this

high number of deaths. Care of the injured person due to an accident starts before arrival in the hospital, and it is believed that prompt and efficient prehospital care reduces morbidity and mortality associated with RTAs. This critical care helps to stabilize patients and prepare them for transport to a health care facility by providing timely and appropriate care in the prehospital setting (13).

PHEC encompasses a range of emergency activities from on-site first aid to emergency medical services (EMS) et the medical facilities. In the State of Emergency Medical Services in Sub-Saharan Africa reported by World Bank in 2021, only about less than 1% of the population in many LICs have access to medical transport services, such as ambulances. In sub-Saharan Africa and Asia, few people have access to PHEC, and these are typically used for transport between healthcare facilities rather than from the scene of an injury. Up to 60% of the population in LMIC countries lives more than 8 km from healthcare facilities or hospitals. Due to the scarcity of emergency facilities in these countries, pre-hospital emergency services are even more crucial to patient survival (13). In the report of Tokita A et al. for about 83 respondents from Indonesia and 109 from Malaysia, the authors identified common challenges. In both countries, inadequate clinical information from ambulances posed a primary challenge in prehospital care quality (6).

Viet Nam still ranks first in terms of injuries, with traffic accidents consistently being the leading cause. In our study (Table 1 and Figure 1), traffic accidents are the leading cause, accounting for a significant percentage (55.8%). The injuries classified according to ICD 11 are the leading causes (Table 2) the most common lesions are 54.8 % in multiple lesions, 55.4 % in brain injuries, 38.6 % extremities injuries and maxillofacial injury in 31.2%. The spine injury was 21.0%, however, this type of lesion is high risk of morbidity and mortality if the first aid was not correct and properly. These figures are consistent with other studies of Dinh Van Quynh (14), Le Xuan Quy (15), Tran Thanh Tam (16).

Current Status of First Aid and Pre-Hospital Transportation

First aid and transportation at the scene are important issues, however, it face numerous obstacles related to infrastructure, traffic, and community knowledge.

1. Lack of first aid at the scene: only 9.8% of patients has received the first aid by health staff at the scene, however, there was 64.4 % (Table 3) by witness person at scene or by someone who was accompanying the patients when accident happened. A study in Thanh Hoa recorded that 40.6% of traffic accident patients had not received first aid

before hospitalization. First aid at the accident scene is often performed by bystanders (nearly 70% of cases) instead of professional medical personnel (15). This inadvertently reduces the effectiveness of PHEC, and in many cases, inappropriate first aid can affect lives and worsen the overall condition of the victims.

2. Transportation means: Although most patients (86.8%) reached hospital by some form of ambulance, use of the professional 115 EMS system was low (14.8%); the majority were carried by hospital or private ambulances (72.0%) that do not routinely provide on-scene emergency care. This rate was higher than that of ambulance use through the 115 service, which accounted for only a small proportion of cases. For example, Pham Ba Hien et al. reported that only 1.7% of trauma patients treated at Dong Da General Hospital were transported by ambulance. Another study reported that 4.8% of patients transferred to a hospital used the (115) ambulance service. Despite these relatively low rates of ambulance utilization, the limited use of prehospital emergency care (PHEC) remains a concern. In general, Viet Nam has approximately 0.2 ambulances per 100,000 population, compared with 0.8 in Singapore, 2–3 in Japan and Taiwan, and 2 in South Korea (17).

In our series, only 14.8% were transported by the 115 EMS system, while 13.2% used taxis or private vehicles with no medical support, increasing the risk of complications during transfer (Table 4).

Another issue regarding transport is the waiting time for the ambulance to arrive at the scene. In our study, the waiting time for ambulance coming to access the scene was 4.54 ±7.68 (minutes); Transporting duration from the accident site to hospital (minutes) was 13.61 ±10.06 (minutes) (Table 5). Some studies show that the average response time for pre-hospital emergency services is currently much higher than the international standard of ≤ 8 minutes (urban) and ≤ 15 minutes (rural). In Dinh Van Quynh's study, of the time from receiving a call to reaching the patient by pre-hospital emergency units over two years (2024-2025), it was found that approximately 30% of patients were reached within 10 minutes, 55% within 10-20 minutes, and 15% within 20-60 minutes (14). According to Tokita, in Malaysia, the average “door-to-needle” time for acute myocardial infarction (time from ED arrival to initiation of thrombolytic therapy) averaged 105 min, exceeding the time of less than 30 min to improve outcomes. In the study of Shilpa A Gaikwad in India, transport vehicles accounted for 33% (n=104) of the obstacles in reaching the emergency department (ED) (2, 6).

Challenges

Some main findings from the survey at VDUH on PHEC services are:

1. Human Resources

The emergency services system in Viet Nam (115) is considered underdeveloped and lacking in professionalization. According to the reports of Nguyen Duy Long (18), Bui Hoang Hai (19), currently, the 115 system operates mainly based on hospitals. This leads to a lack of synchronization and regional linkages, and the system is often stronger in transportation than in on-site emergency services, only 29 provinces have a 115 system, of which only 11 have 115 Emergency Centers; 18 provinces have 115 emergency points assigned to provincial hospitals; 27 provinces still do not have 115 emergency numbers, and 7 provinces have 115 emergency numbers managed by private medical facilities; 17 provinces and cities do not have enough ambulances per capita according to WHO recommendations, mainly densely populated cities. Currently, ambulances only meet 30-40% of pre-hospital emergency needs; Ambulances do not meet equipment standards.

Additionally, no province or city, including major cities, has implemented a multi-tiered pre-hospital emergency care network plan (connecting from initial first aid to hospital admission and treatment) and organized a network that ensures coverage of the entire population; pre-hospital emergency care facilities also lack connection and coordination with rescue and relief units outside the health sector. The pre-hospital emergency care system only meets less than 10% of urgent needs (stroke, accidents) (9).

Regarding personnel: currently, there are no staff trained in pre-hospital emergency care, mainly doctors, medical assistants, and nurses, and only about 50% of the emergency team staff have received general resuscitation and emergency care training (17). Transport personnel: In the report Dinh Van Quynh in VDUH, the accompanying medical staff are mainly nurses (86.6%) (13). According to the Ministry of Health's report, the current number of pre-hospital emergency care personnel per capita is only 1/4-1/5 of the human resource standard for pre-hospital emergency care according to the World Health Organization. Currently, Viet Nam has not established a separate training program for PHEC team, means that there is no professional Paramedic for EMS in Viet Nam currently; There is a lack of specific regulations on the scope of professional activities and the list of technical services for pre-hospital emergency care, so the implementation of techniques at 115 units depends on the capacity of each center/unit; According to the regulations in Circular 32/2023/TT-BYT, each PHEC unit (115 Center

or PHEC team of the provincial general hospital) needs to have at least 15 people and 2 or more ambulances. If the regulations are implemented correctly, the total number of personnel needed is 22,880 people; while the total number of out-of-hospital emergency personnel nationwide is currently only 1,785 people, accounting for 7.8% of the required personnel (9).

There are no regulations on the financial aspects of pre-hospital emergency care. There are no regulations on the list of pre-hospital emergency care techniques, so there is no basis for reimbursing the 115 emergency service for these techniques (19).

2. Lack of Coordination in Referrals

Additionally, the lack of coordinated communication between referring and receiving facilities reduces system efficiency and preparedness. Most referrals (89.4%) were not notified in advance to the receiving hospital in the report of Dinh Van Quynh (15). This makes the receiving hospital passive, reducing the preparation of personnel and equipment to ensure effective emergency care and treatment of patients.

In this study, lack of contact prior to patient referral was the most frequently reported finding, accounting for 55.6% of cases (Table 6). This puts hospitals in a passive position, cause slowing or delay for management of patients and allocation of appropriate personnel, especially in emergency situations, resulting the morbidity and mortality.

3. Time to Access the Victims at Scene

In some researchers of colleagues of Dinh Van Quynh, Pham Ba Hien and Nguyen Duy Long emergency care in Viet Nam found that delays in accessing care remain a critical issue and can be understood through the “three delays” model (6, 10, 18):

a. Delay in Seeking Care: Occurs due to victims or their families misjudging the severity of injuries, fear of hospitals due to being perceived as cold and distant, or anxiety about costs and expenses.
b. Delay in Accessing Care: Due to a lack of awareness of official Emergency Services (115), distrust of government-provided services (believing them to be slower and more expensive than taxis), leading family members to choose the fastest means of transport, such as motorbikes or taxis.
c. Delay in Receiving Care: Related to the process of handling patients upon arrival at the hospital, including the issue of transferring between facilities.

These three factors are among the reasons for the reduced access to pre-hospital emergency services for victims of traffic accidents. These delays collectively contribute to increased morbidity and mortality in trauma patients.

According to report of Yaowapha Siripakarn at al. (2023), 11.5% died within 24 h. After adjusting for age, systolic blood pressure, Glasgow Coma Scale, and ISS, patients who had a scene time over 10 min showed a significant association with mortality (33.3% vs. 8.7%, $P = 0.031$ (20). Intravenous fluid administration at the scene showed a trend toward a significant association with mortality. The author suggested a balance between timely interventions and adequate resources should be considered to optimize patient outcomes. This conclusion is the same as the conclusion of Chen C-H (21), Yuwares S (22).

Recommendations

As recommendation of WHO-Emergency Care System Framework (2018) emphasized on three main aspects of PHEC (23). Additionally, to enhance medical response capabilities for disasters according to WHO Health EDRM Framework (2019) (24).

Based on the research results, the gaps in PHEC system that need to be improved to meet the increasing needs of the people, contributing to improving the quality of trauma care, as part of the medical response in disasters, we propose some following recommendations:

1. System organization

The study also points out shortcomings in PHEC system, lacking uniformity and coordination; therefore, restructuring the Coordination Center is necessary: Transforming the current 115 Centers into independent units under the Department of Health or the People's Committee of the province/city, with centralized coordination functions to enhance operational capacity. The local emergency response network should be reorganized and restructured to suit the population distribution, traffic conditions, and medical facilities in each locality. For large, densely populated cities like Hanoi and Ho Chi Minh City, a complete 115 emergency center model should be implemented, combined with the organization of satellite units by region. For provinces with large territories, difficult transportation, and remote areas, a unit for receiving information and coordinating emergency response should be established in conjunction with the provincial general hospital.

Regarding traffic accidents, which remain a major problem in Viet Nam and account for a large proportion of trauma emergencies as indicated in the study, a two-tiered system should be implemented: Level 1 focusing on reaching victims and rapid transport, while Level 2 involves specialized ambulances.

2. Human Resources Improvement

Human resources are a key issue in PHEC operations; therefore, it is necessary to focus on developing a standardized training program for specialized paramedic personnel.

Standardize Human Resource Identification: Officially incorporate the professional identification of Paramedic into the legal system, with clear training standards and scope of practice. In addition, a sustainable financial mechanism is needed to encourage PHEC development, such as piloting the inclusion of EMS in the list of services covered by Health Insurance.

Along with professional training, training in medical coordination skills is crucial: In-depth training for 115 (Call Takers/Dispatchers) on telephone medical dispatch (Medical Priority Dispatch System - MPDS) to provide timely first aid guidance to callers. Research shows that effective dispatch helps victims reach and transport hospitals sooner.

3. Improvement of Technology and Infrastructure

The development of information technology applications in healthcare is now quite common, and is particularly significant for PHEC: it can reach and advise victims, overcoming geographical and transportation challenges. In addition to improving facilities at 115 centers, PHEC also needs to ensure ambulances meet standards and are equipped with appropriate medical equipment. Proposed application of a coordinate system using CAD (Computer-Assisted Navigation), connected to digital maps (GPS) and available resource information (vehicle location, emergency team readiness), and the application of telemedicine for remote consultation and treatment. Centralized data management by building an electronic pre-hospital emergency record system (e-PCR) to collect and analyze PHEC data, serving to improve quality.

4. Improvement of Linkage, Cooperation, and Coordination

Improving the quality of PHEC requires coordination as it involves many components, from the community to agencies. Therefore, inter-sectoral cooperation is needed: clearly stipulating that traffic police must support PHEC team in accessing the scene as quickly as possible and ensuring the safety of the medical area when the emergency team arrives. It must promptly notify the nearest medical facility if there are injured people requiring emergency care. The study also showed that the time reach to hospitals is still slow; the involvement of the police is expected to significantly improve this, given the inadequate transportation infrastructure in the country.

LIMITATIONS

The study was conducted at a center, although the largest in Viet Nam; however, the data was recorded and documented by healthcare staff, so there are certain limitations. On the other hand, data is collected by software and patient records because electronic medical records have not yet been fully implemented.

The data collected at VDUH was based on examinations of patients and related documents regarding patient have been provided the first aid at scene or other medical facilities, therefore some information may be missing. Furthermore, there were cases where victims were transferred in critical condition or coma but lacked accompanying or witnessing individuals, making data unavailable. Additionally, this study was conducted at a specific point in time and may not represent the entirety of PHEC activities.

As a single final-tier referral center, VDUH receives a disproportionate share of severe and transferred cases, so the case-mix and pre-hospital patterns reported here may not be representative of all trauma patients in Viet Nam. Timing data were also available for fewer than half of the sample, which may underestimate true delays.

CONCLUSION

Pre-hospital emergency care in Viet Nam remains underdeveloped, with critical deficiencies in workforce, infrastructure, and coordination. Strengthening PHEC will not only reduce mortality and disability but also enhance national capacity for disaster and emergency response.

Proposals put forward for the trauma care system in particular, and pre-hospital emergency care in general, need to be a comprehensive and integrated approach—combining

policy reform, system reorganization, workforce development, and technological innovation—is essential to improve trauma outcomes.

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CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

ETHICAL APPROVAL

This study was approved by the Scientific and Ethics Council of Viet Duc University Hospital (Decision No. 122/QĐ-VĐ, dated 12 October 2024) and conducted in accordance. As the study was based on a review of existing hospital records, with no patient contact or intervention, the Ethics Council waived the requirement for individual informed consent. All records were de-identified before analysis.

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