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# Prehospital Care Practice for Critically Ill Patients Presented to the ED: prospective observational study

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## Abstract

# Background

The prevalence of critical illness is increasing globally, placing substantial demand on emergency healthcare systems. In low-resource settings like Ethiopia, prehospital care practices remain underdeveloped, contributing to preventable morbidity and mortality. The level of contemporary avoidable hypoxia and the adequacy of pre-arrival communication, both of which are anticipated to be addressed in the prehospital setting, were not evaluated in Ethiopia.

# Objective

This study aimed to assess prehospital care practices among critically ill patients upon arrival at the emergency department, focusing on mode of arrival, oxygen saturation status, and prehospital communication.

# Methods

An observational study was conducted from August 20 to October 20, 2023, at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital. A total of 202 critically ill patients were enrolled using a convenience sampling technique. Data were collected through structured questionnaires and analyzed using descriptive statistics and chi-square tests via SPSS version 27.

# Results

Ambulance transport was used by 94 patients (46.5%) out of 202 patients, while others arrived via taxi (47%), on foot (4%), or by police/others (2.5%). 174 (86.1%) were hypoxic (oxygen saturation ≤ 93%) upon arrival. Only 63 patients (31.2%) received any form of oxygen therapy during prehospital transport. Oxygen was administered via nasal prongs in 52 (25.7%), face mask in 6 (3%), face mask with reservoir in 2 (1%), and endotracheal intubation in 3 (1.5%) cases. A chi-square test of independence indicated that there was no statistically significant ($p \geq 0.05$) association between mode of transportation and oxygen saturation status $\chi^2$ (1, N = 202) = 2.52, p = 0.112. Prehospital communication was done in only 34 cases (16.8%), indicating that most patients arrived without prior notification.

# Conclusion

The majority of critically ill patients presented with unmanaged hypoxia and lacked prehospital notification, reflecting significant deficiencies in airway management and EMS coordination. These findings underscore the urgent need for a centralized, well-equipped EMS system in Ethiopia, including national protocols for oxygen delivery and prearrival communication.

## Introduction

Patient survival and long-term outcomes for time-sensitive medical emergencies are greatly impacted by prehospital care provided during golden hour(1). For critically ill patients, emergency medical services from the scene of the incident to the receiving health facility are a crucial link in the chain of survival(2). In well-developed systems, these services stabilize patients, prevent secondary complications, and facilitate prearrival notification for smooth transition to definitive hospital care(3–5).

In response to growing global demand for critical care, high-income countries have developed robust Emergency Medical Services (EMS) to reduce preventable morbidity and mortality(6–9). A study from India reported that ambulances were the predominant mode of transport (31%) for critically ill patients, with over half arriving at the emergency department in a hypoxic state(10).

In contrast, developing countries have made limited progress in establishing prehospital care systems despite rapid urbanization, emerging diseases, population aging, rising trauma cases, and recurrent human-made disasters(11–16). Prehospital care in Ethiopia remains underdeveloped and poorly established, hindered by a range of multifactorial barriers(17–24). Addis Ababa's prehospital care system operates as a mixed model, comprising government-led services such as the Addis Ababa Fire and Disaster Risk Management Commission (AAFDRMC) and the Ethiopian Red Cross Society (ERCS), alongside limited private providers(21, 25–28). Some improvements have been limited only to the capital, Addis Ababa, which has a single dispatch center of AAFEPCA with a toll-free "939" call center, along with a few private, including Tebta and Estnfas ambulances, providing EMS throughout the city(28–30).

In such contexts, prehospital care quality is highly variable, and critically ill patients often reach emergency departments through fragmented provider networks(31). Inadequate management of a patient's airway and oxygenation can exacerbate hypoxic insults; failure to communicate with the receiving facility leads to unprepared emergency departments; and inappropriate transportation modes can cause harmful delays and worsen

patient injuries. Despite the clear clinical significance of these components, there is a scarcity of empirical data describing the current state of prehospital care practices specifically within Addis Ababa. The extent of pre-arrival communication and the level of contemporary avoidable hypoxia, which is anticipated to be addressed in the prehospital setup, were not examined in any study. However, prehospital mismanagement results in being rushed to the Emergency Department. Identifying gaps, whether originating in the prehospital system or the emergency department, has important implications for informing targeted strategies, training, and policy interventions to strengthen prehospital care in Addis Ababa and similar urban settings in Ethiopia.

Therefore, this study systematically assessed prehospital care practices among critically ill patients presented to emergency departments in Addis Ababa hospitals, with the following focused objectives: to determine oxygen saturation status on arrival; to characterize modes of transportation and their association with oxygen saturation; and to evaluate the extent of pre-arrival communication with the receiving emergency department.

## Methodology

# Study design, setting, and period

A hospital-based prospective observational study design was conducted at the Emergency Department of Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital which are located in Addis Ababa, Ethiopia. Both are large tertiary hospitals in the country. Tikur Anbessa Specialized Hospital (TASH) is a referral hospital in the country providing trauma and non-trauma cases for all age groups. TASH ED is one of the largest in the country, with 7 priority I (red zone) beds and a total of 60 beds, averaging 70 admissions per day. The two hospitals are located in Addis Ababa, Ethiopia. Addis Ababa is the capital city of Ethiopia and the seat of the African Union headquarters. The city's eleven sub-cities and more than a hundred woredas are home to more than five million people. Situated in the center of the nation, the city's elevation ranges from 2,100 meters at Akaki in the south to 3,000 meters at Entoto Hill in the north. The study was conducted from August 20/2023, to October 20/2023.

## Participants

The study recruited critically ill patients with a high risk of life-threatening conditions (priority I), such as a TEWS ≥ 7 and admission to the resuscitation room (red zone), a GCS ≤ 8, or a compromised airway, breathing, or circulation, based on the South African Triage Scale (SATS), which is the standard triage system implemented in Addis Ababa emergency departments. An oxygen saturation level < 94% is considered hypoxia(10). In this study, 202 critically ill patients were involved.

## Eligibility criteria

All adult (age ≥ 14 years) patients who presented to emergency departments and were critically ill and were triaged to the red zone during the study period were included. Patients with COPD were excluded to minimize confounding factors.

## Sample size determination

The sample size for the study was calculated using the single population proportion formula with the following considerations. Standard deviation corresponding to the 95% confidence interval = 1.96, Proportion of the study population = 0.203, Degree of accuracy required or desired precision (maximum allowable error of the estimate) = 0.03, and adjusted sample for nonresponse rate (10%). Proportion of the study population taking $p$ = 0.203, where $p$ is the proportion of emergency cases in which an ambulance was utilized(30).

## Sampling technique

All critically sick adult patients who met the inclusion criteria and triaged to the red zone of the ED on weekdays (Monday through Friday) between 8 a.m. and 5 p.m. throughout the research period were included. Convenient sampling was employed in the study design due to the practical challenges associated with enrolling all critically ill patients, primarily stemming from the shift duty schedule in the Emergency Department.

# Data Collection Tools and Procedures

After preparing a structured English questionnaire using previously published related literature, data were prospectively gathered on the patient upon ED arrival at triage(10). The structured format was filled out by trained data collectors and reviewed by the principal investigator (PI). Data collectors are fluent in both Amharic, the national language, and English.

## Data Quality Assurance

Every day throughout data collection, the PI checked the accuracy and consistency of the data with the study participants.

## Data analysis

Data taken from patients were coded, and the registry was entered into the computer using Epi Info 7.2.4 and then transferred to the SPSS version 27 software program for further analysis. The chi-square test and descriptive statistics were employed.

## Study Variables

## Independent variables

Selected variables were within the domain of study. These included the patient's sex, the number of trauma and non-trauma victims, mode of transportation to the emergency department, their vital signs at presentation, prearrival communication, and any airway management interventions done upon arrival.

## Dependent (outcome) variables

These included the pattern of patients who presented to the ED with hypoxia, prehospital communication, and the mode of transportation upon ED arrival. Another outcome variable was the correlation between oxygen saturation status and mode of arrival as determined by the chi-square test.

## Ethical considerations

This study was approved by the Institutional Review Board (IRB Ref.No.EM/SM/558/2016 dated 22-August-2023). The consent to participate in the study was waived by the IRB of the Emergency Department, TASH, Addis Ababa University.

### Result

During the 2-month study period, the two hospital EDs treated 5,118 patients, of whom 509 (9.9%) triaged as red. The study recruited 202 critically ill patients with convenience sampling [Figure 1]. There was a male predominance of 117 among 202 (58%) with a mean age of 56.2 years. The demographic and clinical characteristics of critically ill patients upon ED arrival are shown in Table 1.

**Less than half (46%) of critically ill** patients were transported by **ambulance**, with a reminder via various means of transport. Trauma victims comprised 11.4% of critically ill patients. Twenty-three critically injured trauma victims were brought to the ED during the study period, with 16 (69%) brought by ambulance and 7 (31%) brought by other means of transportation.

In this study, 174 critically sick patients (86%) were **hypoxic** upon ED arrival. During the prehospital transfer, 63/202 (31.2%) of patients received oxygen therapy via endotracheal intubation 3 (1.5%), face mask 6 (3%), FM via reservoirs 2 (1%), and nasal pronging 52 (25.7%). Upon arrival at the ED, 43 (21.3%) of patients required invasive ventilation. Oxygen delivery methods and airway management techniques used upon ED arrival are summarized in Fig. 2.

Although 46% of patients were transported by ambulance, the association between mode of transportation and oxygenation status was not statistically significant ($\chi^2$ (1, N = 202) = 2.52, p = 0.112). **Prehospital communication** between the treating team and the prehospital system about the clinical condition accounted for only 34/202 (16.8%) of the patients.

Table 1

| | |
|---|---|
| **Male** | **117 (57.9%)** |
| Female | 85 (42.1%) |
| Trauma victims | 23 (11.4%) |
| Non-trauma victims | 179 (88.6%) |
| Prehospital oxygen support status | 138 (68.3%) |
| No oxygen treatment was given | 63 (29.7%) |
| Oxygen therapy during pre-hospital transfer | 52 (25.7%) |
| INO2 | 6 (3%) |
| Facemask | 2 (1%) |
| Facemask with reservoir | 3 (1.5%) |
| Intubation | |
| Mode of transportation to the ED | |
| Ambulance | 94 (46.5%) |
| Taxi | 95 (47%) |
| Police car | 2 (1%) |
| Man supported | 3 (1.5%) |
| On foot | 8 (4%) |
| Oxygen saturation status | |
| 93–100% | 28 (13.9%) |
| ≤ 93% | 174 (86.1%) |
| TEWS | Minimum 5, maximum 14, mean 7.5 |
| Chronic illness | |
| No comorbidity | 51 (25.2%) |
| With comorbidity | 151 (74.8%) |
| Status of Referral | |
| Home | 84 (41.6%) |
| Police | 3 (1.5%) |
| Health center | 80 (39.6%) |
| Hospital | 35 (17.3%) |

## Discussion

The current study found that 47% of patients were transported by ambulance, while a high proportion (86%) presented with hypoxia. The mode of arrival and oxygen saturation status were not statistically significant (P = 0.112). Prehospital communication was done in 17% of cases.

In this study, a superior ambulance mode of arrival was observed in the current study (46.5%) compared to India(10). Nevertheless, in a prior study, only 31% of patients were transported in ambulances, with a reminder using different modes of transportation. Besides, the current study has also been compared with the previous Ethiopian studies conducted in Addis Ababa (20.3%) and Mekelle (22.7%) (21, 24). The ambulance mode of arrival was increased in the current study. The possible reason may be that a more expanded awareness of the community and the availability of private wing ambulances increased the chance of ambulance utilization.

The current study demonstrated a high prevalence of hypoxia among participants, with 174 out of 202 patients (86%) affected. Additionally, 43 out of 202 patients (21.3%) required invasive ventilation upon arrival at the emergency department. In comparison, a related study conducted in India reported lower rates of desaturation and a reduced need for intubation at ED presentation(10). Among all patients, only 55% were hypoxic, and 19.7% were requiring invasive ventilation in the previous study. Moreover, the percentage of patients who received oxygen therapy during prehospital

transfer was only 20.9% in the previous study, lower than that in the current investigation, 63/202 (31.2%). The possible reason for the observed difference could be that our observational study may be focused on a group of patients who were especially sicker than those in other studies. Unlike the present study, the study population in India may have a chance to be included in the study despite a low triage early warning score.

The study also assessed the oxygen saturation status of participants transported by ambulance. A previous study conducted in India reported that two-thirds of patients received oxygen therapy during ambulance transport, and a substantial proportion (70/94) remained hypoxic(10). In contrast, in the current study, a smaller proportion of ambulance-transported patients (60/95 [63%]) received oxygen therapy, while a higher proportion (50/60 [83%]) remained hypoxic. This discrepancy may reflect differences in the organization of ambulance services, particularly the lack of structured prehospital resuscitation and the administration of oxygen without adequate assessment of ventilation needs and appropriate oxygenation strategies.

Of the 202 critical patients, only 17% had prehospital communication in the current study. A related study has been conducted about the quality of prehospital notifications and teleconsultation involving patients in life-threatening conditions, which significantly improved patients' vital parameters(4, 5). However, none of them stated the proportion of prearrival activation. This is the first study of its kind in Ethiopia to evaluate prehospital activation at ED arrival. Although there is no global standard for an appropriate prehospital notification rate, the proportion of prehospital communication was lower than expected in the current study. The lack of a robust liaison office and an organized EMS establishment are possible explanations for the scarcity of clear **communication** on patients' clinical conditions between the prehospital system and the treating staff within the facility.

**As an implication**, even though prehospital care of critically ill patients was extensively studied, there is a paucity of data on the clinical profile of oxygenation status, prearrival communication, and mode of arrival upon presentation at the ED in Ethiopia. Therefore, the findings could be used to predict the extent of time-sensitive preventable hypoxia, which is expected to be addressed in the prehospital setup. It could also be the basis for alerting responsible bodies to establish well-equipped centralized EMS to maximize the prognosis and outcome of critical patients. Moreover, the evaluation of prehospital communication influences the course of care for critically ill patients by allowing for on-site optimization, streamlining interfacility transit, directing destinations based on the availability of service, and providing warnings to prepare essential logistics at the accepting ED.

Strengths and limitations of the study

The present study has strengths. This study was conducted prospectively at 2 large governmental hospitals, which allowed for comprehensive analyses. This study is a pioneer in our setup, making it possible to evaluate airway status and prehospital communication, which serves as a foundation for future research. There was a limitation in this study. It was challenging to write up a discussion because there were no more papers on the subject of oxygen saturation status and prehospital communication.

## Conclusion

Most critically sick patients, including those transported by ambulances, were hypoxic upon arrival at the ED triage. Approximately 1 in 5 patients who developed an airway impairment required invasive ventilation. The study illustrated suboptimal prehospital airway management, which was time-sensitive and expected to be addressed immediately at the scene to maximize patient outcomes. Prehospital activation between the treating team and the prehospital system about the clinical status of the patient was also limited.

**Recommendations**

Create a well-equipped, centralized emergency medical services system through the Ministry of Health; train healthcare providers specifically in prehospital care; strengthen coordination through robust liaison systems and well-prepared emergency departments; and conduct multicenter studies to enhance generalizability.

## Abbreviations

AAFEPCA: Addis Ababa Fire and Emergency Prevention and Control Authority

AAU: Addis Ababa University

ABCDE: Airway Breathing Circulation Disability Exposure

COPD: Chronic obstructive pulmonary disease

ECCM: Emergency and Critical Care Medicine

ED: Emergency Department

EMS: Emergency medical service

HSTP-II: Ethiopian Health Sector Transformation Plane II

PI: Principal Investigator

TASH: Tikur Anbessa Specialized Hospital

TEWS: Triage early warning sign

ZMH: Zewditu Memorial Hospital

## Declarations

This study was conducted in accordance with the principles of the Declaration of Helsinki. The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Addis Ababa University IRB Ref.No.EM/SM/558/2016). Approval was granted on 22-August-2023. The requirement for individual informed consent was waived by the approving IRBs due to the research's retrospective nature and the analysis of existing, anonymized data, with minimal risk to participants.

**Ethical approval and consent to participate**: Not applicable for this observational study. The requirement for individual informed consent was waived by the approving IRBs. The study has been conducted on hospital based at triage of Emergency Department. All variables of this research are part of the triage sheet and documentation. As a result, hospital IRB permission was enough.

**Consent for publication**: not applicable.

**Availability of data and material:** available and will be given based on the request

**Competing interests**: The authors declare that there is no conflict of interest.

**Funding:** not applicable

Author's contributions: Dr. Mayete Endale Birhane was the principal investigator and corresponding author. The selection of the topic, proposal preparation and presentation, training of data collectors, data entry and clearing, analyzing, and writing of the manuscript were done by Dr. Mayete Endale Birhane.

Dr. Ayto A. Negash: Involved in the development and refinement of the research question, reviewing and improving the study design and methodology, ensuring ethical compliance, offering critical feedback during data analysis and interpretation, and thoroughly reviewing and revising the manuscript to enhance its scientific quality and coherence.

Dr. Gedefaw Tigabu Minwagaw was reviewing and revising the manuscript to enhance its scientific quality and coherence.

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## Figures

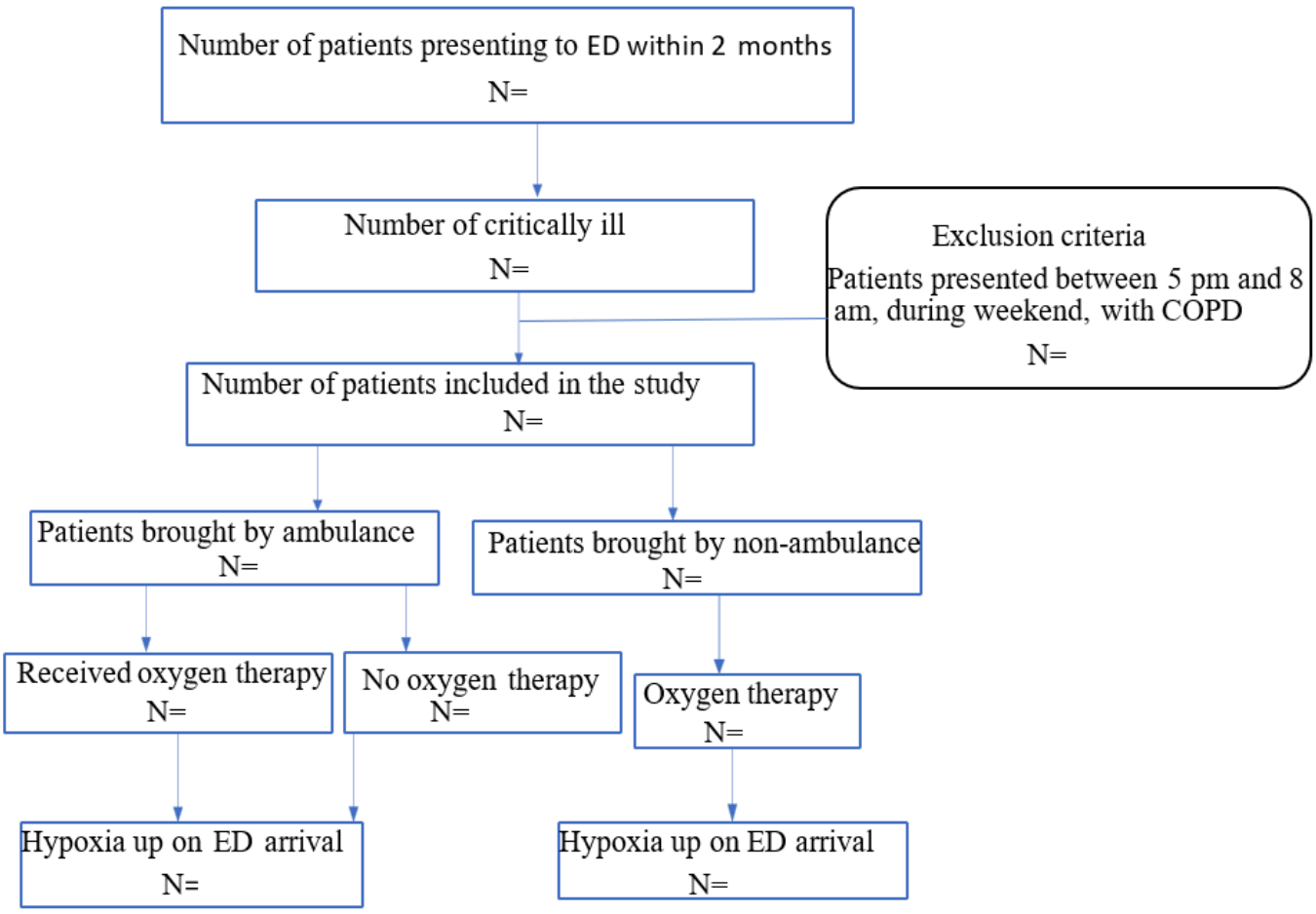



**Figure 1**

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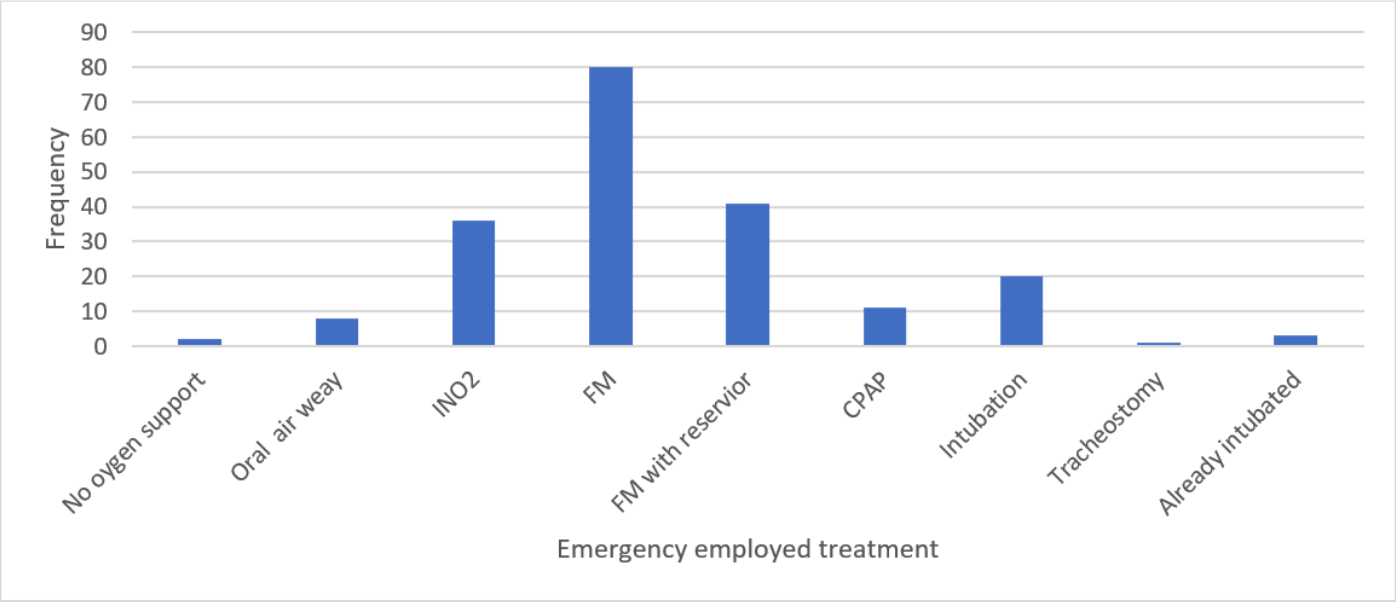



**Figure 2**

Legend not included with this version.