Article

Assessing paramedic performance and background factors in emerging disease outbreak

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Abstract

Background: Prehospital paramedics played a critical role in the COVID-19 pandemic crisis.
Objectives: This study aimed to evaluate paramedic performance and background factors in the outbreak of this emerging disease.
Methods: This cross-sectional study recruited 335 paramedics selected from 49 emergency medical services stations in Urmia and Tabriz cities, Iran. Data was collected using a questionnaire to assess the demographics and performance of paramedics in caring for COVID-19 patients. The response rate for the questionnaires was 90%. Data were analyzed using descriptive statistics and regression analysis in SPSS version 21. The level of statistical significance was considered less than 0.05.
Results: The average age of the paramedics was 32.81 years (71.3% were 35 years old or younger). Results showed that assessing patients' vital signs, checking for COVID-19 symptoms/signs, administering oxygen and IV fluids, recommending home care, and transporting patients to the emergency department were the most common actions taken by paramedics. Invasive procedures performed by paramedics included cardiopulmonary resuscitation (60.9%), intubation (53.1%), and suctioning (38.8%). However, 15.5% of paramedics reported not performing physical exams on patients due to fear of COVID-19. A statistically significant correlation was observed between paramedics' performance and their education level, educational qualifications, and history of COVID-19 disease ($p< 0.001$).
Conclusion: Study results provide insight into paramedic performance during the COVID-19 pandemic. During emerging disease outbreaks, further training and the provision of necessary personal protective equipment could help paramedics perform all tasks without undue concern for personal safety.

Implications of this paper in nursing and midwifery preventive care:
suggest that improved training and provision of personal protective equipment for paramedics and other healthcare workers including nurses may improve their performance and reduce concerns about personal safety during emerging disease outbreaks. In addition, they should play an active role in educational and preventive programs aimed at reducing the spread of emerging diseases.

Introduction

Emergency Medical Services (EMS) systems provide a variety of healthcare services, including acute care, to meet the healthcare needs of patients. These services are rapidly evolving to meet the challenges of health emergencies such as SARS, and COVID-19 [1]. Studies have shown that during infectious disease outbreaks and crises, the use of EMS systems for patient transport has increased significantly. For example, a study conducted in Sierra Leone found that 64% of confirmed COVID-19 cases were transmitted through the EMS system [2]. Similarly, this figure was reported to be 46% in Turkey [3] and 35% in Iran [4].

Pre-hospital EMS personnel, also known as paramedics, are responsible for triaging, stabilizing, and safely transporting patients to hospitals and providing appropriate preventive care [5]. Several studies have examined the role of EMS during the COVID-19 pandemic. Jouffroy et al. found that pulse oximetry was a valuable criterion for rapid identification of patients with suspected COVID-19 who were transferred by EMS. Their results showed that 7% of transferred patients received mechanical ventilation [6]. In addition, Baldi et al (2020)

observed a 77.4% increase in cases of cardiopulmonary arrest requiring cardiopulmonary resuscitation (CPR) by EMS during the pandemic [7]. Other research suggests that patients who received more appropriate medical interventions before arriving at the hospital had better outcomes and higher survival rates [6,8].

As first responders to emergency calls, paramedics were at high risk of exposure to COVID-19 due to the unpredictability of their work and the need to provide immediate medical care outside of clinical settings. They suffered significant distress due to fear of disease contamination [9]. Then, various factors such as limited resources, harsh working conditions, and psychological pressure may affect the performance of paramedics, and there is little research evaluating the experiences and challenges faced by paramedics during the COVID-19 crisis. In Iran, it remains unclear what caring actions or interventions paramedics did or did not perform? And what factors influenced their performance in treating patients with COVID-19? To optimize EMS during future pandemics, it is important to understand how paramedics interact with patients and protect themselves from infection. Therefore, this study aimed to evaluate the performance of paramedics and background factors during the outbreak of the emerging disease COVID-19 in the cities of Urmia and Tabriz, Iran. Overall, this research has the potential to inform effective policy decisions and guide targeted interventions to strengthen emergency response during a crisis.

Methods

Design and samples

This cross-sectional study aimed to evaluate the performance of prehospital emergency medical personnel during the COVID-19 pandemic. Between March and May 2021, data was collected from 49 rescue stations serving the Urmia and Tabriz, Iran metropolitan areas - with a total population of approximately 3.2 million residents. In these regions, over 700,000 emergency calls are sent to emergency medical centers annually, of which more than 150,000 result in emergency operations requiring the use of ambulances. The COVID-19 outbreak led to a sharp increase in the number of emergency calls and medical transports.

All 335 prehospital paramedics employed in the 49 rescue stations were selected by census. Inclusion criteria included at least six months of professional experience and previous experience caring for at least one patient with suspected or confirmed COVID-19 disease in the prehospital setting. Staff working part-time or in hospital emergency departments were not included in the study. Based on an exclusion criterion, questionnaires with more than 10% incomplete or missing responses were excluded from the analysis.

Data collection and tools

In this study, we used a researcher-developed questionnaire to collect data on paramedics' performance during ambulance missions for COVID-19 patients. The questionnaire was developed based on a literature review to assess two domains: a) demographic and work-related characteristics, and b) pre-hospital medical actions and interventions delivered to COVID-19 patients. The first section included variables such as age, marital status, ethnicity, employment status, work experience, workplace, education level, weekly working hours, work environment, field of study, and average number of missions. The second section consisted of 22 items assessing patients' clinical status based on an emergency severity index (1 item with 5 levels response), medical actions (7 items with yes/no response), and interventions performed by paramedics (14 items with yes/no response). Content and face validity were established by obtaining feedback from domain experts, including 10 nursing faculty members, two emergency physicians, four experienced EMS paramedics, and two emergency dispatchers. Revisions were made based on their comments. For the reliability of the questionnaire, the test-retest method was used with an interval of 10 days in a pilot study with 30 paramedics. The correlation coefficient calculated for this questionnaire was 0.89. In coordination with emergency services officials, contact information for paramedics was collected and questionnaires were distributed to participants via email and social media such as X and Telegram. To maximize response rates, three reminder messages were sent over a two-month period. The response

rate for the questionnaires was 90%. This methodology enabled the collection of a large data set on paramedics' practical experiences in treating COVID-19 patients in the prehospital setting.

Statistical analysis

Data were collected in the SPSS software environment version 21 (SPSS Inc., Chicago, IL, USA) and analyzed using descriptive statistics (frequency, mean, and standard deviation) and univariate and multivariate linear regression tests. The median of nearby points was used to replace missing data. Also, the level of statistical significance was considered to be less than 0.05..

Results

All participating prehospital paramedics were male and had a mean age of 32.81±6.81 years. Over two-thirds (68.7%) were married. Table 1 provides further details on participant demographics.

Table 1: Demographic characteristics of paramedics (N=335)

Variable	Category	N (%)
Workplace	Tabriz	165 (49.3)
	Urmia	170 (50.7)
Age	≤ 35	239 (71.3)
	>35	96 (28.7)
	SD±Mean	6.81±32.81
Marital status	Single	95 (28.4)
	Married	230 (68.7)
	Divorced	10 (3)
Educational degree	Diploma and Under Diploma	16 (4.8)
	Associate degree	115 (34.3)
	BSc	186 (55.5)
	Graduate degree	12 (3.6)
	PhD	6 (1.8)
History of infection with COVID-19	Yes	202 (60.3)
	No	133 (39.7)
History of COVID-19 infection among family members	Yes	216 (64.7)
	No	118 (35.3)

N: Number; BSc: Bachelor of science; PhD: Doctor of Philosophy

Regarding work characteristics, the average clinical work experience was 8.41 ± 6.15 years, with the majority (67.2%) having less than 10 years. Table 2 provides further details on the participants' work characteristics.

Table 2: Working characteristics of paramedics (N=335)

Variable	Category	N (%)
Work experience (year)	≤ 10 years	225 (67.2)
	> 10	110 (32.8)
Workplace	Urban base	204 (60.9)
	Road base	74 (22.1)
	Urban and road base	54 (16.1)
	Aerial emergency base	3 (0.9)
Educational qualification	EMT	236 (70.4)
	Nursing	64 (19.1)
	Anesthesia	11 (3.3)
	Operation room	2 (0.6)
	Others	22 (6.6)
Undergoing necessary on the job training related to COVID-19	Yes	288 (86.0)
	No	47 (14.0)
Work hours per week in EMS	48 hours	72 (21.5)
	72 hours	147 (43.9)
	96 hours	89 (26.6)
	Over 96 hours	27 (8.1)
Average number of missions in a 24-hour shift	1-5	124 (37.0)
	6-10	82 (24.5)
	11-15	50 (14.9)
	16-20	63 (18.8)
	≥ 20	16 (4.8)
Average number of patients suspected of COVID-19 in each 24-hour shift	< 3	151 (45.5)
	3-5	96 (28.7)
	6-10	78 (23.3)
	> 10	10 (3.0)
Average time of contact with a COVID-19 patient	15 min.	56 (16.7)
	30 min.	104 (31.0)
	45 min.	84 (25.4)
	1 hour	63 (18.8)
	Over 1 hour	27 (8.1)

N: Number; EMT: Emergency medical technician; EMS: Emergency medical services

Based on the Emergency Severity Index triage, most COVID-19 patients were in urgent or worse status. Assessment of vital signs and screening for COVID-19 symptoms/signs were the most common measures performed by paramedics. Invasive procedures such as cardiopulmonary resuscitation (60.9%), intubation (53.1%), and suction (38.8%) were also frequently performed. However, 15.5% of paramedics reported that the physical examination was incomplete due to infection control concerns. Table 3 provides additional data on paramedic performance.

Table 3: Clinical status of patients with COVID-19 and paramedics performance

Variable	Category	N (%)
Clinical status of suspected or definite COVID-19 patients in daily missions	Level 1 triage (life threatening)	45 (13.4)
	Level 2 triage (high-risk)	109 (32.5)
	Level 3 triage (urgent)	77 (23.0)
	Level 4 triage (semi-urgent/ outpatient)	91 (27.2)
	Level 5 triage (non-urgent/ non-emergency)	13 (3.9)
Medical actions performed for patients with COVID-19 by paramedics	Taking history of disease	216 (64.5)
	Physical examination	161 (48.1)
	Examination of vital signs (taking respiration rates, pulses, blood pressure, temperature)	317 (94.6)
	Pain examination	118 (352)
	Checking up for pre-determined classic COVID-19 signs	269 (80.3)
	Failure to examine the patient due to fear of contamination with COVID-19	52 (15.5)
	Others	36 (10.7)
Medical interventions performed for patients with COVID-19 by paramedics	Pain relief	91 (27.2)
	Blood sugar monitoring	146 (43.6)
	Taking ECG	80 (23.9)
	Oxygen therapy	310 (92.5)
	Serum therapy	214 (63.9)
	Medication therapy	115 (34.3)
	Patient transport to hospital emergency department	278 (83.0)
	Take IV line access	262 (78.2)
	CPR (BLS)	166 (49.6)
	Intubation	178 (53.1)
	CPR (advanced)	204 (60.9)
	Suction	130 (38.8)
	Giving training and advice for home care	187 (55.8)
	Patient transport without any medical intervention	6 (1.8)

N: Number; IV: Intravenous; ECG: Electrocardiogram;
CPR: Cardiopulmonary resuscitation; BLS: Basic life support

Univariate and multivariate regression analyses revealed that paramedics with a history of COVID-19 infection performed cardiopulmonary resuscitation, intubation, electrocardiography recording, and suction procedures more frequently than others (CPR: p= 0.014; intubation: p=0.012; ECG: p = 0.042; suction: p = 0.044). Those who received adequate training on COVID-19 protocol also performed more invasive procedures. Educational attainment had a significant impact on medication administration. Nurse anesthesiologists in prehospital emergency services administered fewer medications than emergency medical technician graduates (p = 0.019). Mission volume was highly correlated with the cases examined. Higher mission counts within 24 hours were associated with more frequent intubation, CPR, suctioning, ECG acquisition, and medical therapy (p<0.001). More details on the regression analyses are provided in Table 4.

Table 4: Univariate and multivariate linear regression between the demographic and work characteristics of paramedics and their performance

Interventions performed	Variable	Category	Univariate		Multivariate	
			β (95% CI)	p	β (95% CI)	p
Pain relief	Educational degree	Diploma and under	**Reference**			
		Associate's	(-0.0.35, -0.432) 0.198	0.096	(-0.239, 0.372) 0.066	0.669
		BSc	(0.005, -0.461) 0.233	0.045	(-0.112, 0.464) 0.176	0.230
		Graduate degree	(-0.063, -0.605) 0.271	0.112	(-0.108, 0.632) 0.262	0.164
		PhD	(-0.385, 0.523) 0.104	0.635	(-0.348, 0.535) 0.094	0.677
	Educational qualification	EMT	**References**			
		Nursing	(-0.198, 0.048) -0.075)	0.230	(-0.242, 0.022) -0.110	0.103
		Anesthesia	(-0.578, -0.041) -0.309	0.024	(-0.603, -0.053) -0.328	0.019
		Operation room	(-0.927, 0.308) -0.309	0.230	(-0.907, 0.340) -0.283	0.372
		Other	(-0.367, 0.021) -0.173	0.080	(-0.307, 0.209) -0.049	0.710
	Work experience		(-0.016, 0.000) -0.008	0.041	(-0.016, 0.002) -0.007	0.123
Taking ECG	History of infection with COVID-19	No	**References**			
		Yes	(0.003, 0.190) 0.097	0.042	(-0.036, 0.151) 0.058	0.225
	Number of missions in 24-hour shifts		(0.041, 0.111) 0.076	<0.001	(0.033, 0.105) 0.069	<0.001
	Work experience		(-0.017, -0.002) -0.009	0.019	(-0.021, 0.010) -0.006	0.482
	Age		(-0.014, -0.001) -0.007	0.020	(-0.017, 0.01) -0.003	0.671
Intubation	Average number of missions in a 24-hour shift		(0.076, 0.157) 0.116	<0.001	(0.075, 0.155) 0.115	<0.001
	Age		(-0.017, -0.002) -0.009	0.019	(-0.017, -0.002) -0.010	0.012
	On the job training	No	**Reference**			
		Yes	(0.044, 0.351) 0.197	0.012	(0.048, 0.339) 0.194	0.009
CPR	Average number of missions in a 24-hour shift		(0.079, 0.158) 0.119	<0.001	(0.072, 0.152) 0.112	<0.001
	On the job training	No	**Reference**			
		Yes	(0.039, 0.339) 0.189	0.014	(0.043, 0.329) 0.186	0.011
	History of infection with COVID-19	No	**Reference**			
		Yes	(0.018, 0.231) 0.125	0.022	(-0.038, 0.171) 0.067	0.210
Suction	On the job training	No	**Reference**			
		Yes	(0.004, 0.305) 0.154	0.044	(0.002, 0.291) 0.147	0.047
	Number of missions in 24-hour shifts		(0.066, 0.146) 0.106	<0.001	(0.065, 0.145) 0.105	<0.001

Serum therapy	Average number of missions in a 24-hour shift		(0.063, 0.141) 0.102	<0.001	(0.056, 0.136) 0.096	<0.001
	Marriage status	Single	**Reference**			
		Married	(-0.090, 0.139) 0.024	0.678	(-0.055, 0.562) 0.253	0.107
		Other	(-0.077, 0.702) 0.389	0.015	(0.083, 0.139) 0.028	0.619
Patient transport without any medical intervention	History of infection with Covid-19	No	**Reference**			
		Yes	(-0.062, 0.004) -0.033	0.028	(-0.062, 0.004) -0.033	0.028
Medication therapy	Educational qualification	EMT	**Reference**			
		Nursing	(-0.235, 0.024) -0.104	0.118	(-0.235, 0.024) -0.104	0.118
		Anesthesia	(-0.399, 0.174) -0.113	0.439	(-0.399, 0.174) -0.113	0.439
		Operation room	(-1.045, 0.274) -0.386	0.251	(-1.045, 0.274) -0.386	0.251
		Other	(-0.456, -0.042) -0.009	0.019	(-0.456, -0.042) -0.009	0.019

CI: Confidence interval; BSc: Bachelor of science; PhD: Doctor of Philosophy; EMT: Emergency medical technician; ECG: Electrocardiogram; CPR: Cardiopulmonary resuscitation

Discussion

Results of this study showed that most patients with COVID-19 were in urgent or critical condition, requiring paramedics to provide advanced medical care including cardiopulmonary resuscitation, intubation, and airway management. It appears that the patient's condition may have deteriorated and emergency medical intervention may have become necessary due to the nature of the disease, delay in seeking medical care due to fear of infection, and intention to self-care at home [7,10]. During public health crises, it is paramount to educate the public to access medical care promptly before health conditions worsen. A US study consistently found that most patients with COVID-19 were at high risk [11]. Jung et al. reported that 34.4% of Korean patients required advanced cardiac life support [12]. Furthermore, Natalzia et al. found that more than half of COVID-19 patients were unstable [13]. Yang et al. also showed that procedures such as intubation, suctioning, and ventilation were performed in only 16.3% of cases [14].

Another important finding of this study was that paramedics had high-risk contact with patients but remained responsible for providing necessary medical care. In a study by Friedman et al. results showed that shortness of breath increased by 274% during the COVID-19 pandemic [15]. Furthermore, Hilbert-Carius et al. examined patient management and showed that most COVID-19 cases (88.5%) were hospitalized, with intravenous access (90%), serum therapy (77%), and oxygen therapy (28%) being common interventions [16].

Overall, these results highlight the commitment of paramedics as frontline personnel to the well-being of patients when dealing with a novel pathogen. Despite the risk of contamination and stress, medical teams around the world responded decisively by triaging and treating patients with established and novel therapies. Further research should explore mitigating risk factors for healthcare workers through improved protective protocols and support systems. Longitudinal analyses can also shed light on adaptation strategies and lessons learned and applied during a pandemic. Overall, this period has demonstrated the resilience of health workers and health infrastructures under enormous pressure [5].

Furthermore, some of the respondents in this study reported transferring patients to the hospital without any assessment. Consistent with our findings, Yang et al. showed that 3.4% of patients with COVID-19 were transferred without any medical action or intervention (14). Similarly, Felsen et al. found that 22.95% of patients were transferred to hospitals without any treatment [17]. This is consistent with the Nepalese study by Gupta et al. showing fear and anxiety among

prehospital emergency medical services personnel due to the risk of COVID-19 infection [18]. Therefore, the results highlight the need for ongoing support and training to ensure high-quality prehospital care during infectious disease outbreaks. With appropriate on-the-job training and resources, EMS providers can minimize the risk of disease spread while optimizing patient management and safety.

This study found an association between paramedic performance and several background factors, including history of COVID-19 infection, educational level, COVID-19-specific training, and number of missions. Paramedics who received COVID-19-specific training performed more invasive procedures (intubation, suctioning, and cardiopulmonary resuscitation) on patients with the virus. Previous work experience improves the confidence, knowledge and skills of emergency personnel [19]. Walsh found that nurses with limited COVID-19 training provided limited care to infected patients [20]. Therefore, continuing education is recommended to ensure quality patient care. Training should include knowledge of disease pathogenesis and transmission, appropriate personal protective equipment and disinfection, high-risk aerosol generation procedures, and psychological support for patients and providers during a pandemic. Well-trained paramedics and other frontline workers can optimize outcomes through rapid triage, evidence-based decision-making, and compassionate but prudent clinical management of COVID-19 cases, reducing the burden on overwhelmed healthcare systems. Continuing competency-based training remains critical to emergency preparedness and quality care during public health crises. While educational background influenced certain decisions, workload emerged as a critical factor in providing comprehensive care. These findings have implications for optimizing prehospital COVID-19 management through experience sharing, competency-based learning, and resource allocation to ensure that emergency personnel are free to provide evidence-based care.

This study relied on self-reported questionnaires to collect data and evaluate paramedics' performance. It may be subject to recall bias. Furthermore, the research was only conducted in the cities of Tabriz and Urmia in Iran, which limits generalizability to other regions of the country. Future studies using objective performance metrics across a larger geographic area would strengthen conclusions regarding paramedics' competencies at the national level. In addition, the assessment was limited to personnel working in the prehospital emergency service. Comparative analyses of prehospital and hospital-based findings could provide valuable insights to optimize continuity of care for patients with COVID-19.

Conclusion

Results showed that most COVID-19 patients were in urgent or critical status and required paramedics to provide advanced medical care, including CPR, intubation, and airway management. A history of COVID-19 infection, educational level, COVID-19-specific training, and greater number of calls were significantly associated with improved paramedic performance. Notably, despite the risk of infection and work-related stress, paramedics responded decisively to triage and treat patients with established and novel therapies. Overall, this study improves understanding of paramedics' response to COVID-19 and identifies their training needs and priorities. With appropriate on-the-job training and resources, EMS personnel can provide high-quality care during infectious disease outbreaks.

Ethical Consideration

This study was approved by the regional research ethics committee of Tabriz University of Medical Sciences (IR. TBZMED.REC.1399.1079). To collect the data, the necessary coordination with the responsible authorities was also carried out. At the beginning of the questionnaire, there was a question about consent to participate in the study. While the necessary explanations were given to the paramedics, their informed consent to participate in the study was obtained. The principle of data confidentiality was respected by the researchers.

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Conflict of interest

The authors declare no conflict of interest.

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Authors' contributions

Karim Javanmardi: conception and design of the study, data gathering, analysis and interpretation of data, final approval of the study, and critical revision of the article for important intellectual content. Abbas Dadashzadeh: conception and design of the study, provision of study materials or patients, critical revision, final approval of the study, guarantor of the integrity of the overall study, and critical revision of the article for important intellectual content. Hossein Feizollahzadeh: conception and design of the study, analysis and interpretation of data, critical revision, final approval of the study, and critical revision of the article for important intellectual content. Neda Gilani: analysis and interpretation of data and final approval of the study. Mansour Ghafourifard: provision of study materials or patients and final approval of the study. Javad Dehghannejad: administrative and final approval of the study.

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