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Title: Exposure Risk Assessment and Risk Management of Pre-Hospital Paramedics During COVID-

19 Pandemic

Authors: Karim Javanmardi¹, Hosein Feizollahzadeh², Neda Gilani³, Abbas Dadashzadeh²,*

Dehghannejad²

1. School of Nursing & Midwifery (Urmia University of Medical Sciences Urmia, Iran.

2. Department of Medical Surgical Nursing, School of Nursing and Midwifery Tabriz University of Medical

Sciences ¿Tabriz, Iran.

3. Department of Statistics and Epidemiology, Faculty of Health, Tabriz University of Medical Sciences,

Tabriz, Iran.

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Abstract

Background: Pre-hospital paramedics providing immediate care to patients with contagious disease

were at high risk of infection. This study aimed to assess the exposure risk and risk management of

pre-hospital paramedics during the COVID-19 pandemic.

Materials and Methods: A cross-sectional study was conducted among 335 paramedics from 49

emergency medical stations in two cities located in northwestern of Iran who were recruited through

census. Data was collected using a World Health Organization questionnaire to assess the COVID-

19 exposure risk of health workers.

Results: The results showed that the highest risk of exposure (86.0%) was in the domain of

occupational exposure and that 55.2% of paramedics were at high risk of exposure to COVID-19.

Among paramedics, 95.2% used personal protective equipment when caring for patient and 93.1%

when performing aerosol-generating procedures.

Discussion: The results of this study highlight that pre-hospital paramedics have a high exposure risk

in designated COVID-19 missions, while this exposure is reduced through infection prevention

measures.

Conclusion: A significant number of pre-hospital paramedics were found to be at high exposure risk

to COVID-19 during ambulance missions. Therefore, adherence to contact and droplet precautions,

taking airborne precautions during aerosol-generating procedures, access to appropriate PPE, proper

use of PPE, and appropriate training courses may lead to exposure risk management and improve

their safety.

Keywords: COVID-19, Emergency, Occupational Exposure, Paramedic

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Introduction

Pre-hospital emergency medical technicians or paramedics provide medical care in diverse, unique, uncontrolled, and dangerous environments (1). Accordingly, they encounter numerous infectious patients with unknown histories who require urgent treatment, which may expose them to infectious diseases (2). Because of caring for patients and providing emergency care such as cardiopulmonary resuscitation (CPR), suctioning and intubation, paramedics are at high risk of infectious diseases (3). Therefore, paramedics risk management and safety is an important issue in emergency management.

Exposure risk is defined as contact with a suspected or infected COVID-19 patient without the use of standard personal protective equipment (PPE) components by pre-hospital paramedics (4), and risk management involves the activities undertaken to reduce exposure to COVID-19 disease (5).

During the recent COVID-19 pandemic crisis, pre-hospital paramedics were the first healthcare providers for patients and played an essential role in health outcomes (6). They were put at great risk to save patients' lives (7, 8). In a 2020 study by Ashinyo et al., in Ghana, 80.4% of pre-hospital personnel were at high COVID-19 exposure risk (9), and this rate was 32.7% in another study from Korea (10). As an emerging and contagious disease, the COVID-19 pandemic poses a major challenge for pre-hospital paramedics that requires strict adherence to protocols (11). During this time, emergency medical service (EMS) dispatch missions worldwide increased dramatically. Because paramedics encountered many infected patients, they were at higher risk of illness, and an unprecedented workload was imposed on them (6, 7, 12-15). Study results showed that during this period, the number of missions to transport patients with acute respiratory distress syndrome and CPR increased by 56% and 58%, respectively (13-16). To avoid infection, paramedics should strictly follow protocols and guidelines and use personal protective equipment (PPE) (17). They should take advantage of PPE to comply with standards when transporting or caring for patients with COVID-19 (17, 18). The use of PPE was part of EMS standards when dealing with COVID-19 patients, which was recommended by WHO (19). PPE offers different levels of protection depending on the nature of its components, which include gloves, face masks, N95 masks, face shields, protective clothing, etc. (20). Adequate access to PPE components as well as their proper and principled use reduces the risk of paramedics' occupational exposure to the disease (6). Lack of access to this equipment and absence of knowledge and training can cause irreparable harm to paramedics (21). Subsequently, it is important to evaluate and manage the risk ratio among paramedics during the COVID-19 pandemic (22). The provided information can help improve paramedic safety during emerging diseases and pandemic crises.

According to Iran EMS system report, during the recent COVID-19 pandemic, daily calls to emergency medical care unit escalated unprecedentedly and the number of missions increased by 35%, with 10-20% of daily missions dedicated to patients who were suspected or infected with COVID-19 (7). However, the exposure risk rate, level of risk management and safety of paramedics are not known in most cities of Iran. The aim of this study was to assess the exposure risk and risk management of paramedics during the COVID-19 pandemic in Tabriz and Urmia cities in Iran.

Materials and Methods

Design and samples

This descriptive, cross-sectional study was conducted between March and May 2021. Data was collected from 49 rescue stations serving the metropolitan regions of Urmia and Tabriz located in northwestern of Iran with a total population of approximately 3,200,000 residents. In these regions, over 700,000 emergency calls are received by 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.

In this study, sampling was done by census, the sample size was equal to the population size, and all 335 pre-hospital paramedics employed in 49 emergency medical stations were selected. Inclusion criteria were at least six months of work record and previous experience of caring for at least one patient with suspected or confirmed COVID-19 disease in the pre-hospital setting. Employees who work part-time or in hospital emergency departments were not included in the study. Based on exclusion criterion, questionnaires with more than 10% incomplete or missing responses were excluded from analysis.

Data collection and tools

The data collection tools consisted of two questionnaires. The first questionnaire covered demographic and professional characteristics such as age, marital status, highest level of qualification, history of COVID-19 infection (you and your family), work experience, hours of work per week, place of work, field of education, average number of missions, average number infected patients with COVID-19 and median duration of contact with each patient.

The second questionnaire was adapted from a questionnaire developed by WHO to assess the risk and management of exposure to COVID-19. This tool is intended for healthcare facilities working with COVID-19 patients; it helps assess the risk to healthcare workers (HCWs) after exposure and

provides recommendations for their management (23). The questionnaire consists of three domains: community exposure to the COVID-19 virus (2 items with yes/no response), occupational exposure to the COVID-19 virus (6 items with yes/no response), and adherence to infection prevention and control measures when in contact with suspected or infected COVID-19 patients (22 items with four-point Likert scale response). This questionnaire assesses the type of activity in which HCW is involved. In addition, it measures the level of risk based on low or high-risk events. If an HCW answers "yes" on a community and occupational exposure subscale to any of the activities reported in the scale, the individual is considered to be at high risk of exposure to the COVID-19 virus. If an HCW selected the "always as recommended" response to any of the IPC measures when earing for a confirmed COVID-19 patient, the individual was considered to be at low risk of COVID-19 infection. If an HCW responds to other options, the individual is assessed as being at high risk for infection with the COVID-19 virus (9, 24, 25).

To calculate the overall exposure risk score, one point was assigned to high-risk items and zero points to low-risk items, and the sum of overall scores of the questionnaire items was considered as the person's total exposure risk score (score range = 0-30). Finally, considering the score of 50%, values \geq 15 were considered high risk of exposure to COVID-19 and those <15 were considered low risk of exposure (9).

In the present study, the questionnaires were first translated into Persian by a professional translator and then translated back into English by another professional translator. The translators and researchers evaluated all versions of the questionnaires, and the final Persian version of the questionnaires was developed and approved through consensus after finding good agreement for all items. For content validity, the Persian version was given to 10 professors of Tabriz Faculty of Nursing and Midwifery and their suggestions were taken into account, and face validity was done based on interviews with 10 pre-hospital paramedics. The reliability of the scale was assessed using Cronbach's alpha coefficient in a pilot study with 30 pre-hospital paramedics ($\alpha = 0.89$). These paramedics were not included in the research sample. To collect data, the questionnaires were administered online via Porsline (https://survey.porsline.ir), namely an online survey tool widely used in Iran. In coordination with the emergency services, contact information for paramedics was collected and the link to the questionnaires was distributed to participants via e-mail and social media, including X (WhatsApp), Telegram, and Short Message Service (SMS). 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 dataset on practical experiences of paramedics in treating COVID-19 patients in the pre-hospital setting.

Statistical analysis

The collected data were analyzed using descriptive and inferential statistics such as chi-square, Fisher's exact test, as well as univariate and multivariate linear regression using SPSS software (version 21).

Ethics approval and consent to participate

This study was approved by regional research ethics committee of Tabriz University of Medical Sciences (IR. TBZMED.REC.1399.1079). To collect the data, the necessary coordination was also done with the responsible authorities. 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.

Results

In this study, all participating pre-hospital paramedics were male with a mean age of 32.81 ± 6.81 years. Their mean work experience was 8.41 ± 6.15 years. Over two thirds (68.7%) of paramedics were married. Pre-hospital paramedics reported being in close contact with COVID-19 patients while providing care services, with an average of 30 minutes of contact with each patient during emergency missions. Tables 1 and 2 provide further details on demographic features of participants.

Insert Table 1-2

| Table 1. Demographic characteristics of paramedics $(N = 335)$ | | | | |
|----------------------------------------------------------------|---------------------------|------------|--|--|
| Variables | Sub-group | Number (%) | | |
| 05 | 35 ≥ | 239 (71.3) | | |
| Age | > 35 | 96 (28.7) | | |
| | Mean ± Standard deviation | 32.81±6.81 | | |
| | Single | 95 (28.4) | | |
| Marital status | Married | 230 (68.7) | | |
| | Divorced | 10 (3) | | |
| | Diploma and under diploma | 16 (4.8) | | |
| Highest level of qualification | Associated degree | 115 (34.3) | | |
| | Bachelor | 186 (55.5) | | |
| | Master of Science | 12 (3.6) | | |
| | Ph.D. | 6 (1.8) | | |
| COVID-19 history | Yes | 202 (60.3) | | |
| COVID-19 History | No | 133 (39.7) | | |
| COVID-19 history | Yes | 216 (64.7) | | |
| in family members | No | 118 (35.3) | | |

| Table 2. Occupational | characteristics of para | medics $(N = 335)$ |
|-----------------------|---------------------------------------|--------------------|
| Variable | Sub-group | Number (%) |
| *** | ≤10 | 225 (67.2) |
| Work experience | >10 | 110 (32.8) |
| (years) | Mean ± SD | 8.41±6.15 |
| | Urban emergency station | 204 (60.9) |
| Work place | Non-urban emergency station | 74 (22.1) |
| work prace | Urban and Non-urban emergency station | 54 (16.1) |
| | Aerial emergency station | 3 (0.9) |
| | EMT | 236 (70.4) |
| | Nursing | 64 (19.1) |
| Field of education | Anesthesia | 11 (3.3) |
| | Operating room | 2 (0.6) |
| | Other | 22 (6.6) |
| Training on COVID-19 | Yes | 288 (86) |
| Training on COVID-19 | No | 47 (14) |
| | 48 | 72 (21.5) |
| Working hours per | 72 | 147 (43.9) |
| week in EMS | 96 | 89 (26.6) |
| | Over 96 | 27 (8.1) |
| | 1-5 | 124 (37) |
| Average number of | 6-10 | 82 (24.5) |
| missions in a 24-hour | 11-15 | 50 (14.9) |
| shift | 16-20 | 63 (18.8) |
| | ≤20 | 16 (4.8) |
| | 3> | 151 (45.5) |
| Average number of | 3-5 | 96 (28.7) |
| suspected patients | 6-10 | 78 (23.3) |
| | 10< | 10 (3) |
| | 15 min | 56 (16.7) |
| Mean duration of | 30 min | 104 (31) |
| contact with each | 45 min | 85 (25.4) |
| COVID-19 patient | 1 h | 63 (18.8) |
| | Over 1 h | 27 (8.1) |

EMS: Emergency Medical Service EMT: Emergency Medical Technician

Regarding exposure to COVID-19, 93.4% of paramedics had a history of indoor contact with COVID-19 patients. Tables 3-5 provide further details on participants' exposure risk to COVID-19 and risk management.

Insert Tables 3-5

| of being with COVID-19 patients in a common place y of traveling with a COVID-19 t with a distance of 1 meter from each other ct care of a COVID-19 patient o-face contact with a COVID-19 patient | Yes No Yes No Yes No Unclear Yes No Unclear Yes No Unclear Yes | | (%) 313 (93.4) 22 (6.6) 239 (71.3) 96 (28.7) 306 (91.3) 10 (3) 19 (5.7) 300 (89.6) 15 (4.4) 20 (6) | <0.001 <0.001 | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|--|
| y of traveling with a COVID-19 t with a distance of 1 meter from each other ct care of a COVID-19 patient o-face contact with a COVID-19 patient al interventions on the COVID-19 | Yes No Yes No Unclear Yes No Unclear | | 239 (71.3) 96 (28.7) 306 (91.3) 10 (3) 19 (5.7) 300 (89.6) 15 (4.4) | <0.001 | |
| t with a distance of 1 meter from each other ct care of a COVID-19 patient o-face contact with a COVID-19 patient al interventions on the COVID-19 | No Yes No Unclear Yes No Unclear | | 96 (28.7) 306 (91.3) 10 (3) 19 (5.7) 300 (89.6) 15 (4.4) | <0.001 | |
| o-face contact with a COVID-19 patient patient | Yes No Unclear Yes No Unclear | | 306 (91.3) 10 (3) 19 (5.7) 300 (89.6) 15 (4.4) | | |
| o-face contact with a COVID-19 patient | No Unclear Yes No Unclear | | 10 (3) 19 (5.7) 300 (89.6) 15 (4.4) | | |
| o-face contact with a COVID-19 patient | Unclear Yes No Unclear | | 19 (5.7) 300 (89.6) 15 (4.4) | | |
| patient I interventions on the COVID-19 | Yes No Unclear | | 300 (89.6) 15 (4.4) | <0.001 | |
| patient I interventions on the COVID-19 | No Unclear | | 15 (4.4) | < 0.001 | |
| patient I interventions on the COVID-19 | Unclear | | ` ' | < 0.001 | |
| | | | | <0.001 | |
| | 168 | | | | |
| ' 1 ' ACD | No | | 235 (70.1) 52 (15.5) | < 0.001 | |
| patient during AGPs | Unclear | | 48 (14.4) | <0.001 | |
| | intubation Yes | | 178 (53.1) | 0.275 | |
| | mudation | No | 157 (46.9) | 0.273 | |
| | Nebulizer | Yes | 62 (46.9) | < 0.001 | |
| Presence/ performing at the patient beside | treatment | No | 273 (81.5) | \0.001 | |
| | Collecting | Yes | 32 (9.6) | | |
| | sputum samples | No | 303 (90.4) | <0.001 | |
| | Suction | Yes | 130 (38.8) | <0.001 | |
| | Suction | | ` ′ | | |
| | Tracheotomy | | ` / | < 0.001 | |
| | Tracincotomy | | | \0.001 | |
| . 15 | Bronchoscopy | | | <0.001 | |
| .00 | | | ` ′ | | |
| 1811 | CPR | | | | |
| | | | | <0.001 | |
| | Other | | | | |
| | e/ performing at the patient beside during AGPs | e/ performing at the patient beside during AGPs Tracheotomy Bronchoscopy CPR | e/ performing at the patient beside during AGPs Tracheotomy Bronchoscopy CPR Yes No Yes | Suction Yes 130 (38.8) No 205 (61.2) | |

CPR: Cardiopulmonary Resuscitation AGP: Aerosol-Generating Procedure

| Items | Risk level | Number (%) | p* | |
|-------------------------------------------------------------------|-------------------------------|------------|----------------|--|
| Using PPE during care of COVID-19 | Yes 319 (95.2) No 16 (4.8) | | <0.001 | |
| patients | | | | |
| Gloves | Low risk | 183 (54.6) | < 0.001 | |
| Gloves | High risk | 152 (45.4) | <0.001 | |
| Moole | Low risk | 221 (66) | د <u>۵</u> 001 | |
| Mask | High risk | 114 (34) | < 0.001 | |
| Face shield | Low risk | 63 (18.8) | < 0.001 | |
| Face shield | High risk | 272 (81.2) | <0.001 | |
| Corre | Low risk | 63 (18.8) | < 0.001 | |
| Gown | High risk | 272 (81.2) | <0.001 | |
| Damassina and sanlasina DDE | Low risk | 195 (58.2) | 0.002 | |
| Removing and replacing PPE | High risk | 140 (41.8) | 0.003 | |
| Hand hygiene before and after touching | Low risk | 208 (62.1) | 0.001 | |
| the COVID-19 patient | High risk | 127 (37.9) | < 0.001 | |
| Hand hygiene before and after any clean or aseptic procedure on a | Low risk | 208 (62.1) | < 0.001 | |
| COVID-19 patient | High risk | 127 (37.9) | <0.001 | |
| Hand hygiene before and after contact | Low risk | 247 (73.7) | -0.001 | |
| with body fluids of COVID-19 patient | High risk | 88 (26.3) | < 0.001 | |
| Hand hygiene even with gloves after | Low risk | 227 (67.8) | | |
| touching COVID-19 patient's surroundings | High risk | 108 (32.2) | <0.001 | |
| Regularly disinfecting frequently- | Low risk | 125 (37.3) | | |
| touched surfaces (at least three times a day) | High risk | 210 (62.7) | < 0.001 | |

PPE: Personal Protective Equipment

| Table 5. Paramedics adherence to infect procedures $(N = 335)$ | tion prevention and c | ontrol measures durin | g aerosol-generatin | |
|--------------------------------------------------------------------------------|-----------------------|-----------------------|---------------------|--|
| Items | Risk level | Number (%) | p* | |
| Using PPE during AGPs for COVID-19 | Yes | Yes 312 (93.1) | | |
| patients | No 23 (6.9) | | <0.001 | |
| Gloves | Low risk | 210 (62.7) | < 0.001 | |
| Gloves | High risk | 125 (37.3) | <0.001 | |
| N-95 mask | Low risk | 190 (56.7) | < 0.001 | |
| N-93 Illask | High risk | 145 (43.3) | <0.001 | |
| Face shield | Low risk | 63 (18.8) | < 0.001 | |
| race sinera | High risk | 272 (81.2) | ₹0.001 | |
| Gown | Low risk | 80 (23.9) | < 0.001 | |
| Gowii | High risk | 255 (76.1) | X0.001 | |
| Apron | High risk | 29 (8.7) | < 0.001 | |
| Aproli | Low risk | 306 (94.3) | <0.001 | |
| Removing and replacing PPE after | Low risk | 193 (57.6) | 0.006 | |
| AGPs | High risk | 142 (42.4) | 0.000 | |
| Hand hygiene even with gloves before | Low risk | 215 (64.2) | | |
| and after touching the COVID-19 patient during AGPs | High risk | 120 (35.8) | < 0.001 | |
| Hand hygiene before and after AGPs for | Low risk | 226 (67.5) | < 0.001 | |
| COVID-19 patient | High risk | 109 (32.5) | <0.001 | |
| Hand hygiene even with gloves after touching COVID-19 patient's | Low risk | 227 (67.8) | <0.001 | |
| surroundings during AGPs | High risk | 108 (32.2) | | |
| Regularly disinfecting frequently- touched surfaces (at least three times a | Low risk | 139 (41.5) | 0.002 | |
| day) during AGPs | High risk | 196 (58.5) | | |

AGP: Aerosol-Generating Procedure

In terms of exposure risk rate, the highest exposure risk (86.0%) was found in the domain of occupational exposure and in general, 55.2% of paramedics were at high risk of exposure to COVID-19. Tables 6-7 provide further details on paramedics' exposure risk rates and regression analyses.

Insert Table 6 -7

| Table 6. Distribu | tion of COVID-1 | 19 exposure risk for | paramedics | |
|-----------------------------------------|-----------------|----------------------|-------------------|---------------|
| Domains | Risk level | Number (%) | p* | |
| Community | Low risk | 105 (31.3) | < 0.001 | |
| exposure | High risk | 230 (68.7) | <0.001 | |
| Occupational | Low risk | 47 (14) | رم مرم درم مرم | |
| exposure | High risk | 288 (86) | < 0.001 | |
| Adherence to infection | Low risk | 203 (606) | < 0.001 | |
| prevention measures | High risk | 132 (39.4) | <0.001 | |
| Total score of | Low risk | 150 (44.8) | 0.063 | |
| exposure risk | High risk | 185 (55.2) | 0.003 | |
| | * Chi-s | quare test | | 3 |
| | | | Kegly | |
| and multivariate l mong pre-hospital | | between socio-dem | ographic feature | s and the exp |

| 37 ' 11 | G 1 | ramedics Univariate | | Multivariate | | |
|--------------------|--------------------------------------|----------------------|---------|-------------------------|---------|--|
| Variable | Sub-group | β (CI: 95%) | p-value | β (CI: 95%) | p-value | |
| | Bachelor | Reference | | | | |
| Highest level of | High school diploma or under diploma | 12.28 (2.54-22.02) | 0.014 | 6.41 (-5.69-18.51) | 0.298 | |
| qualification | Associate degree | 0.521 (-3.91-4.96) | 0.818 | 1.17 (-3.51-5.86) | 0.622 | |
| 1 | Master of Science | 6.82 (-4.31-17.96) | 0.229 | 8.98 (-2.05-19.99) | 0.110 | |
| | Ph.D. | 18.32 (2.80-23.82) | 0.021 | 17.82 (0.711-34.94) | 0.041 | |
| Field of education | EMT | Reference | | | | |
| | Nursing | 1.88 (-3.39-7.16) | 0.483 | 0.556 (-5.02-6.13) | 0.845 | |
| | Anesthesia | -1.33 (-12.87-10.21) | 0.821 | -0.841 (-12.35-10.67) | 0.886 | |
| | Operating room | 19.99 (-6.59-46.56) | 0.140 | 20.12 (-6.02-46.27) | 0.131 | |
| | Other | 12.93 (4.59-21.28) | 0.002 | 7.86 (-2.77-18.50) | 0.147 | |
| COVID-19 history | No | Reference | | | | |
| in family members | Yes | 5.48 (1.20-9.76) | 0.012 | 5.65 (1.38-9.92) | 0.010 | |
| Aggas to IV line | Yes | Reference | | | | |
| Access to IV line | No | -5.26 (-10.24-0.274) | 0.039 | -7.11 (-12.11 to - 2.12 | 0.005 | |
| PCC | 30 | -3.20 (-10.24-0.274) | 0.039 | -7.11 (-12.11 t0 - 2.12 | 0.003 | |

Discussion

The results of this study showed that most pre-hospital paramedics were at high risk of exposure to COVID-19, and the highest risk of exposure was found in the domain of occupational exposure. Some paramedics and their families contracted COVID-19. Consistent with the present study, other investigations concluded that healthcare workers had high rates of exposure to COVID-19 (9, 10, 26, 27).

These results are also consistent with reports of previous epidemics such as severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) (20, 28).

The high risk of exposure to a contagious disease such as COVID-19 should be managed appropriately as it could lead to infection as well as psychological effects such as burnout, reduced job satisfaction, intention to leave the job, etc. The results of a study showed that burnout was high among those who cared for long-term infected patients and among those who had a history of COVID-19 (29). In this regard, Lee and Kim (2020) emphasized that relevant organizations and managers must further focus on preventive measures in the workplace to control the pandemic (10). Since pre-hospital paramedics are at the forefront of the emergency response to pandemic (6) and are at high risk of exposure in the workplace, it is recommended that they should be properly trained and fully comply with infection control standards (20, 30).

In the present study, most paramedics adhered to infection prevention measures and used personal protective equipment when caring for patients and performing aerosol-generating procedures, which may lead to appropriate exposure risk management and improvement in their safety. While the results of some other studies indicated that compliance with infection prevention measures and the use of personal protective equipment by pre-hospital paramedics is challenging (1, 17).

Gulsen et al. reported a low prevalence of COVID-19 among pre-hospital emergency personnel in Turkey. They explained that timely provision of necessary PPE, regular work programs, planning multiple scenarios for unexpected situations, and involving staff in decision-making are effective in controlling the disease and reducing exposure among them (19). Murphy et al. (2020) reported that to reduce occupational exposure in pre-hospital paramedics, the implementation of risk reduction strategies and adequate access to PPE, as well as principled and proper application of it, are the most useful measures (31).

In this study, the risk of exposure to COVID-19 was higher among staff who provided more intensive medical care to the infected patients. Given that prolonged contact with infected individuals increases the risk of illness (1), paramedics must use standard PPE and decrease the time allotted to such patients as much as possible to improve their safety (1, 32).

Limitations

This study relied on self-reported questionnaires to collect data and evaluate paramedics' performance. Therefore, there may be a recall bias. Furthermore, the research was only conducted in the cities of Tabriz and Urmia in Iran, which limits transferability to other regions of the country. Future studies using objective performance metrics across a larger geographic area would strengthen conclusions regarding paramedics' competencies at a national level. In addition, the assessment was limited to the personnel of pre-hospital emergency service. Comparative analyzes of pre-hospital and hospital-based findings could provide valuable insights to optimize the continuity of care for patients with COVID-19. Another limitation of our study was online data collection, as a result of which the accuracy and authenticity of the subjects may be different from a field survey.

Conclusions

Pre-hospital paramedics were at high risk of exposure to COVID-19, and the highest risk of exposure was found in the domain of occupational exposure. Hence, staff training, adequate access to PPE and training on its use, adherence to standards in implementing protective protocols, minimizing the length of stay intended for infected patients, and disinfection of ambulances and medical equipment will be helpful in preventing the spread of COVID-19 in order to prevent and reduce the risk of infection.

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Consent for publication

Not required.

Availability of data and materials

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Conflict interest

The authors declare no conflicts of interest.

Author's contribution

XXX: Conceptualization, methodology, data collection, analysis and interpretation of data, and analys

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Accepted M writing of the article; XXX: Supervision, critical review, revision and final approval of the version to be submitted; XXX: Supervision, critical review and revision; XXX: Supervision, analysis and

References

- 1. Alshammaria A, Baila JB, Parilloa SJ. PPE misuse and its effect on infectious disease among EMS in Saudi Arabia. Journal of Student Research. 2019;8(1):51-8. doi: https://doi.org/10.47611/jsr.v8i1.592
- 2. Costa M, Oberholzer-Riss M, Hatz C, Steffen R, Puhan M, Schlagenhauf P. Pre-travel health advice guidelines for humanitarian workers: a systematic review. Travel medicine and infectious disease. 2015;13(6):449-65. doi: 10.1016/j.tmaid.2015.11.006.
- 3. Al-Shaqsi S. Models of international emergency medical service (EMS) systems. Oman medical journal. 2010;25(4):320. doi:10.1001/jama.2020.1585
- 4. Kaur R, Kant S, Bairwa M, Kumar A, Dhakad S, Dwarakanathan V, et al. Risk stratification as a tool to rationalize quarantine of health care workers exposed to COVID-19 cases: Evidence from a tertiary health care center in India. Asia Pacific Journal of Public Health. 2021;33(1):134-7. https://doi.org/10.1177/1010539520977310
- 5. Shrivastava SR, Shrivastava PS. Standardized risk assessment and management of exposure amongst healthcare workers to coronavirus disease 2019. Germs. 2020;10(2):126. doi: 10.18683/germs.2020.1196
- 6. Gibson CV, Ventura CA, Collier GD. Emergency Medical Services Resource Capacity and Competency Amid COVID-19 in the United States: Findings from a National Study. Available at SSRN 3576776. 2020. doi: 10.1016/j.heliyon.2020.e03900.
- 7. Jalili M. How should emergency medical services personnel protect themselves and the patients during COVID-19 pandemic? Frontiers in Emergency Medicine. 2020;4(2s):e37-e. doi: 10.22114/ajem.v0i0.376
- 8. Greenland K, Tsui D, Goodyear P, Irwin M. Personal protection equipment for biological hazards: Does it affect tracheal intubation performance? Resuscitation. 2007;74(1):119-26. https://doi.org/10.1016/j.resuscitation.2006.11.011
- 9. Ashinyo ME, Dubik SD, Duti V, Amegah KE, Ashinyo A, Larsen-Reindorf R, et al. Healthcare Workers Exposure Risk Assessment: A Survey among Frontline Workers in Designated COVID-19 Treatment Centers in Ghana. Journal of Primary Care & Community Health. 2020;11:2150132720969483. doi: 10.1177/2150132720969483.
- 10. Lee J, Kim M. Estimation of the number of working population at high-risk of COVID-19 infection in Korea. Epidemiology and health. 2020;42. doi: 10.4178/epih.e2020051
- 11. Smereka J, Szarpak L. COVID 19 a challenge for emergency medicine and every health care professional. The American Journal of Emergency Medicine. 2020;38(10):2232-3. https://doi.org/10.1016/j.ajem.2020.03.038

- 12. Baldi E, Sechi GM, Mare C, Canevari F, Brancaglione A, Primi R, et al. Out-of-hospital cardiac arrest during the Covid-19 outbreak in Italy. New England Journal of Medicine. 2020;383(5):496-8. doi: 10.1056/NEJMc2010418.
- 13. Ehrlich H, McKenney M, Elkbuli A. Defending the front lines during the COVID-19 pandemic: Protecting our first responders and emergency medical service personnel. The American journal of emergency medicine. 2021;40:213-4. doi: 10.1016/j.ajem.2020.05.068
- 14. Stella F, Alexopoulos C, Scquizzato T, Zorzi A. Impact of the COVID-19 outbreak on emergency medical system missions and emergency department visits in the Venice area. European Journal of Emergency Medicine. 2020;27(4):298-300. doi: 10.1097/MEJ.00000000000000724
- 15. Cavaliere GA. COVID-19: Is Now the Time for EMS-initiated Refusal? Journal of Emergency Medical Services. 2020. https://www.jems.com/patient-care/is-now-the-time-for-ems-initiated-refusal/
- 16. Fernandez AR, Crowe RP, Bourn S, Matt SE, Brown AL, Hawthorn AB, et al. COVID-19 preliminary case series: characteristics of EMS encounters with linked hospital diagnoses. Prehospital Emergency Care. 2020;25(1):16-27. doi: 10.1080/10903127.2020.1792016.
- 17. Holland M, Zaloga DJ, Friderici CS. COVID-19 Personal Protective Equipment (PPE) for the emergency physician. Visual journal of emergency medicine. 2020;19:100740. doi: 10.1016/j.visj.2020.100740
- 18. Sprague RM, Ladd M, Ashurst JV. EMS Resuscitation During Contamination While Wearing PPE. 2018. PMID: 30475565.
- 19. Gulsen MF, KURT M, Kaleli I, Ulasti A. PERSONAL PROTECTIVE EQUIPMENT (PPE) USING IN ANTALYA 112 EMERGENCY AMBULANCE SERVICES DURING OUTBREAK. medRxiv. 2020. https://doi:10.24966/ETS-8798/S1002
- 20. Visentin LM, Bondy SJ, Schwartz B, Morrison LJ. Use of personal protective equipment during infectious disease outbreak and nonoutbreak conditions: a survey of emergency medical technicians. Canadian Journal of Emergency Medicine. 2009;11(1):44-56. doi: 10.1017/s1481803500010915.
- 21. Maguire BJ, Shearer K, McKeown J, Phelps S, Gerard DR, Handal KA, et al. The ethics of PPE and EMS in the COVID-19 era. JEMS. 2020. https://www.jems.com/operations/equipment-gear/ethics-of-ppe-and-ems-in-the-covid-19-era
- 22. Labrague LJ, de Los Santos JAA. Fear of Covid-19, psychological distress, work satisfaction and turnover intention among frontline nurses. Journal of nursing management. 2021;29(3):395-403. doi: 10.1111/jonm.13168.

- 23. Organization WH. Risk assessment and management of exposure of health care workers in the context of COVID-19: interim guidance, 19 March 2020. World Health Organization; 2020. WHO/2019-nCoV/HCW_risk_assessment/2020.2
- 24. Khalil M, Alam MM, Arefin MK, Chowdhury MR, Huq MR, Chowdhury JA, et al. Role of personal protective measures in prevention of COVID-19 spread among physicians in Bangladesh: a multicenter cross-sectional comparative study. SN comprehensive clinical medicine. 2020;2(10):1733-9. doi: 10.1007/s42399-020-00471-1.
- 25. Bani-Issa WA, Al Nusair H, Altamimi A, Hatahet S, Deyab F, Fakhry R, et al. Self-Report Assessment of Nurses' Risk for Infection After Exposure to Patients With Coronavirus Disease (COVID-19) in the United Arab Emirates. Journal of Nursing Scholarship. 2021;53(2):171-9. doi: 10.1111/jnu.12625.
- 26. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus—infected pneumonia in Wuhan, China. Jama. 2020;323(11):1061-9. doi: 10.1001/jama.2020.1585.
- 27. Nguyen LH, Drew DA, Graham MS, Joshi AD, Guo C-G, Ma W, et al. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study. The Lancet Public Health. 2020;5(9):e475-e83. doi: 10.1016/S2468-2667(20)30164-X.
- 28. Oh HS, Uhm D. Occupational exposure to infection risk and use of personal protective equipment by emergency medical personnel in the Republic of Korea. American journal of infection control. 2016;44(6):647-51. https://doi.org/10.1016/j.ajic.2015.12.022
- 29. Hoseinabadi TS, Kakhki S, Teimori G, Nayyeri S. Burnout and its influencing factors between frontline nurses and nurses from other wards during the outbreak of Coronavirus Disease-COVID-19-in Iran. Investigacion y educacion en enfermeria. 2020;38(2). 10.17533/udea.iee.v38n2e03
- 30. Adeleye OO, Adeyemi A, Oyem J, Akindokun S, Ayanlade J. Rational use of personal protective equipment (PPE) among health workes in COVID-19 frontline. Eur J Pharm Med Res. 2020;7:445-51. https://www.researchgate.net/publication/274584398
- 31. Murphy DL, Barnard LM, Drucker CJ, Yang BY, Emert JM, Schwarcz L, et al. Occupational exposures and programmatic response to COVID-19 pandemic: an emergency medical services experience. Emergency Medicine Journal. 2020;37(11):707-13. doi: 10.1136/emermed-2020-210095.
- 32. Chow-In Ko P, Chen WJ, Huei-Ming Ma M, Chiang WC, Su CP, Huang CH, et al. Emergency medical services utilization during an outbreak of severe acute respiratory syndrome (SARS) and the incidence of SARS-associated coronavirus infection among emergency medical technicians. Academic emergency medicine. 2004;11(9):903-11. https://doi.org/10.1197/j.aem.2004.03.016