Title: Factors Influencing Adherence to Standard Infection Control Precautions Among Pre-Hospital Emergency Personnel

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Abstract

Background: The rising incidence of healthcare-associated infections underscores the need for strict adherence to standard precautions. The pre-hospital emergency service is the initial contact point for patients, where infection risks can start. This study was conducted with aim to evaluate the factors influencing adherence to standard precautions among pre-hospital emergency personnel.

Materials and Methods: This descriptive-analytical cross-sectional study was conducted in 2023. Data were collected using a demographic questionnaire and the Compliance with Standard Precautions Scale (CSPS). Statistical analysis was performed using SPSS (version 25) and Kolmogorov-Smirnov, Chi-square, and Fisher's exact tests, and Spearman correlation. $P<0.05$ was considered statistically significant.

Results: This study of 206 pre-hospital emergency personnel in Tehran found low compliance with standard precautions (mean score: 13.27 ± 3.38), Standard precaution compliance was significantly and positively associated with marital status, history of health check-ups, history of exposure to body fluids, and the quality of personal protective equipment, with higher compliance observed among individuals possessing these characteristics. No significant links were found with base type (urban/rural) or PPE access. Weak, non-significant correlations were observed with age ($r = -0.031$, $p = 0.668$) and work experience ($r = -0.075$, $p = 0.292$).

Discussion: Given the low compliance with standard precautions among pre-hospital emergency personnel and the rise of emerging and antibiotic-resistant infectious diseases, developing specialized infection control policies and strategies tailored to pre-hospital emergency care is imperative.

Conclusion: Improving adherence to standard precautions among pre-hospital emergency personnel is crucial. Strengthening the factors influencing adherence can enhance infection control from the initial stage of medical service delivery.

Key words: Emergency Medical Services, Standard Precautions, Occupational Hazards, Infection Control, Compliance, Personal Protective Equipment, Healthcare-Associated Infections.

Background

Pre-hospital emergency personnel are exposed to various occupational hazards due to the nature of their work (1). These include complex patient conditions, logistical interruptions, health risks, interpersonal and interprofessional conflicts, and legal challenges (2). Direct contact with patients and victims who may carry known or unknown pathogens places these personnel at risk of transmitting infectious diseases to themselves, others, and the environment, often unknowingly (3, 4). Additionally, they face risks such as injuries from sharp instruments and exposure to bodily fluids, which increase the likelihood of contracting diseases like hepatitis, HIV, and respiratory infections (5). In rare cases, emergency deliveries occur in ambulances before reaching medical centers, further complicating infection control (6). All these factors make pre-hospital emergency settings a potential source of infection within the healthcare system.

Each year, approximately 3 million healthcare workers are at risk of contracting blood-borne and fluid-transmitted diseases worldwide. In response to this growing concern, the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) introduced the concept of "Standard Precautions" (7). These measures include hand hygiene, use of personal protective equipment (PPE), and safe handling of sharp instruments. They represent the minimum infection prevention strategies applicable to all patients at all times, regardless of diagnosis (8).

In modern healthcare systems, it is assumed that every patient may be infectious or colonized with microorganisms capable of transmission. Therefore, it is essential for pre-hospital emergency personnel to consistently apply standard precautions and infection control measures to themselves, their equipment, and the care environment to minimize infection risks (9). Studies have shown that ambulances and emergency equipment may harbor infectious microorganisms such as Staphylococcus aureus, Enterobacter, and methicillin-resistant bacteria (10). Recognizing the level of adherence to standard precautions among pre-hospital emergency personnel, and identifying the factors influencing their implementation, is crucial for infection prevention and control (11).

According to the Ministry of Health and Medical Education, the rate of healthcare-associated infections (HAIs) in Iran in 2020 was 26.57 per 1000 people, with regional variation. For instance, a 2022 study in eastern provinces reported a rate of 17.1 per 1000, while the global rate was 0.14% in the same year (12). These infections are directly linked to prolonged hospitalization, delayed recovery, increased mortality, and higher healthcare costs. Given the importance of infection

control, it is vital to identify critical points for prevention and the individual factors influencing adherence to standard precautions (13). Moreover, pre-hospital emergency personnel play a key role in disaster and epidemic response, often facing challenges such as lack of PPE, which can negatively impact their mental health and professional well-being (14).

Most studies have focused on hospitals and hospital staff. However, given that the starting point of healthcare services is the pre-hospital emergency setting, it is essential to assess the level of adherence to standard precautions and identify the factors influencing their implementation. Tehran, as the capital and most populous city of Iran, has a dense network of pre-hospital emergency bases and faces frequent traffic congestion, high accident rates, and increased exposure to infectious risks. These factors make it a critical setting for evaluating adherence to standard precautions and infection control practices.

Therefore, this study aimed to answer the following research questions:

1. What is the level of adherence to standard precautions among pre-hospital emergency personnel in Tehran?
2. Which individual and contextual factors are associated with adherence to these precautions?

Method

This descriptive-analytical cross-sectional study was conducted from September to February 2023 on 215 personnel from the pre-hospital emergency operations unit in Tehran. The study population includes all operational staff of the pre-hospital emergency services in Tehran, and the study environment encompasses all pre-hospital emergency bases in Tehran, including both urban and road bases.

The subjects were selected through convenient sampling based on inclusion criteria, following informed consent and awareness of the study's objectives. The inclusion criteria were as follows: a minimum of 6 months of recent work experience in the pre-hospital emergency service, employment in the operational unit of the pre-hospital emergency service, possession of an associate degree or higher, and membership in the emergency staff (motor ambulance, ambulance, or bus ambulance). The exclusion criterion was failure to complete more than 10% of the questionnaire. Incomplete questionnaires exceeding this threshold were excluded from the

analysis. For partially missing data within accepted questionnaires, listwise deletion was applied, assuming the data were missing completely at random (MCAR).

The G*power v 3.1 software was used to calculate the sample size considering the minimum correlation of 0.2, which was the weak correlation based on Cohen's effect size (38) and considering this value provided the high sample size, as well as the type1 error of 0.05 and the second type error was calculated as 0.2, or in other words, the power of the test was 80% and sample size of 193 people was calculated in each group. Considering a10% drop in the sample, this amount increased to 215 people.

The data collection instruments included a demographic information questionnaire, which captured details such as educational degree, age, work experience, and type of base, as well as the Compliance with Standard Precautions Scale (CSPS).The CSPS tool, initially developed by the Centers for Disease Control and Prevention (CDC) in 1996, was revised in 2010 by Dr. Simon Ching Lam in Hong Kong based on the WHO guidelines for standard precautions (15). This tool has been translated and utilized in various languages. It consists of 20 items, with 16 positively phrased and 4 negatively phrased. Responses are provided on a four-point Likert scale ranging from "never" to "always." For the 16 positively phrased items, only the "always" response receives a score of 1, while other responses are scored 0. Regarding the 4 negatively phrased items, the "never" response is scored 1, and other responses are scored 0. The total score ranges from 0 to 20, with higher scores indicating greater adherence to standard precautions. The correlation coefficient of 0.2 was selected as the minimum effect size based on Cohen's criteria, which classify an r value of 0.1–0.3 as a small effect size. This threshold was chosen to ensure sufficient statistical power (80%) to detect even weak associations between variables, which are common in behavioral and health sciences.

In Iran, the CSPS tool was first employed in 2021 in a study by Mohammadnejad Ostad et al. (16), where it was translated into Persian and its validity and reliability were assessed. In the present study, the validity and reliability of the tool were re-examined. The validity of the tools was confirmed using the Lawshe method with content validity index (CVI) and content validity ratio (CVR) of 1. The reliability of the tool was determined through Cronbach's alpha ($\alpha = 0.78$).

The study was approved by the ethics committee of Tehran University of Medical Sciences (ethical code: IR.TUMS.FNM.REC.1402.112). After explaining the study objectives, an informed consent was obtained from eligible participants before starting the study. Then, the paper-based

questionnaires were distributed to the research units during their work shifts. Participants completed the forms in the presence of the researcher, who was available to provide clarification if needed. This supervised administration aimed to minimize response bias and ensure accurate data collection. The collected data were analyzed using SPSS software (version 25). Descriptive statistics, including absolute and relative frequencies, mean, and standard deviation, were used to summarize demographic variables.The Kolmogorov-Smirnov test was applied to assess the normality of continuous variables.For categorical variables, the Chi-square test and Fisher's exact test were used to examine associations between demographic factors and compliance with standard precautions.

Spearman's rank correlation was employed to assess relationships between ordinal variables and compliance scores. A significance level of $P<0.05$ was considered statistically significant.

Results

A total of 206 personnel from the pre-hospital emergency operations unit in Tehran participated in this study. The mean age of participants was 33.82 ± 7 years (95% CI: 32.91–34.73). The majority held a bachelor's degree in emergency medical services (59%). The overall mean compliance score with standard precautions was 13.27 ± 3.38 (95% CI: 12.85–13.69), indicating low adherence. Detailed demographic characteristics are presented in Table 1.

Table 1. Demographic characteristics of participants (n = 206)

Variable	Category	n (%)
Age group (years)	20–30	73 (35.4%)
	31–40	97 (41.1%)
	41–50	32 (15.5%)
	51–60	4 (1.9%)
Marital status	Married	137 (66.5%)
	Single	69 (33.5%)
Education level	Associate	62 (30.1%)
	Bachelor	124 (60.2%)
	Master	7 (3.4%)
	Bachelor student	13 (6.3%)
Technician level	First responder	26 (12.6%)
	Basic	6 (2.9%)
	Intermediate	106 (51.5%)
	Paramedic	65 (31.6%)
Employment type	Contracted	108 (52.4%)
	Non-contracted	98 (47.6%)

Significant associations were found between compliance and marital status ($p = 0.034$), history of general health check-ups ($p = 0.004$), experience of exposure to body fluids in the past year ($p = 0.006$), and the quality of personal protective equipment (PPE) available during shifts ($p = 0.006$). For example, married personnel had a higher mean compliance score (13.89 ± 3.21) compared to single personnel (12.45 ± 3.52). Similarly, those with a history of general health check-ups scored higher (14.02 ± 3.18) than those without (12.76 ± 3.41). Factors associated with compliance are summarized in Table 2.

Table 2. Factors associated with compliance with standard precautions

Variable	Category	n (%)	p-value
Quality of PPE	Low	34 (15.5%)	0.006
	Moderate	130 (59.4%)	
	High	42 (25.1%)	
Health check-up history	Yes	122 (59.2%)	0.004
	No	84 (40.8%)	
Body fluid exposure (past year)	Yes	70 (34%)	0.006
	No	136 (66%)	
Sharp object exposure	Yes	99 (48.1%)	0.001
	No	107 (51.9%)	
Type of emergency base	Urban	193 (93.7%)	0.786
	Rural	12 (5.8%)	
PPE access during shifts	Full set	61 (29.6%)	0.526
	Mask and gloves	97 (47.1%)	
	Mask only	6 (2.9%)	
	Gloves only	6 (2.9%)	
	Glasses only	3 (1.5%)	
	None	4 (1.9%)	

No statistically significant relationship was found between compliance and certain demographic characteristics, including the type of emergency base (urban vs. rural, $p = 0.786$) and access to specific types of PPE ($p = 0.526$). PPE availability was categorized based on combinations of items (e.g., gloves only, masks only, full set). However, the type of PPE available did not significantly impact compliance, suggesting that perceived quality may be more influential than quantity. Pearson's correlation test revealed weak negative correlations between compliance and both age ($r = -0.031$, $p = 0.668$) and work experience ($r = -0.075$, $p = 0.292$). According to Cohen's criteria, these effect sizes are considered negligible ($r < 0.1$), indicating no meaningful relationship. Given the number of statistical tests performed, no formal adjustment for multiple comparisons was applied. Therefore, findings should be interpreted with caution regarding potential Type I errors.

Discussion

This study revealed low adherence to standard precautions among pre-hospital emergency personnel in Tehran, consistent with previous findings in Iran (17, 21), Pakistan (18), and Australia (3). For instance, Taylor et al. (3) highlighted inadequate performance among paramedics regarding infection control. Similarly, Mohamad Nejad (17) reported weak compliance among ICU nurses, and Bunduki et al. (18) found poor adherence among physicians.

Vikke et al. (5) reported that only 56.9% of EMS providers arrived wearing gloves, hand hygiene was observed in 27.8% of providers, and reusable equipment disinfection occurred in just 31.6% of opportunities. These findings highlight the need for improved adherence to standard precautions to mitigate the risk of infection transmission.

Alhazmi et al. (1) found that 76% of EMS providers consistently complied with standard precautions, although urban providers reported inconsistent use more frequently than rural ones. This variability underscores the influence of geographic and operational factors.

The significant relationship between marital status and compliance in the present study contrasts with Mehravar et al. (7), who found no such correlation, and Mendes et al. (13), who reported higher adherence among single individuals. These differences may reflect demographic or cultural variations.

Employment status also showed a significant association with compliance. Mehravar et al. (7) found formal nurses had higher adherence, while Khodaveisi et al. (19) reported no correlation. These discrepancies may be due to differences in workplace conditions and job security. The link between health check-ups and compliance is supported by Soltanzadeh et al. (20), who emphasized the impact of shift schedules on metabolic health. Mohamadkhani et al. (21) found low awareness among EMS personnel regarding post-hepatitis B vaccination serology, and Amini et al. (22) highlighted the role of occupational health examinations in injury prevention.

Exposure to body fluids was associated with higher compliance, possibly due to increased risk perception. Moshksar et al. (23) reported that 39.8% of healthcare workers had experienced such exposure, and Khodaveisi et al. (19) concluded that perceived risk enhances adherence.

The quality of PPE was a key determinant of compliance. Marzaleh et al. (24) identified poor-quality gloves as a barrier, and Siam and ALreshidi (25) found high usage rates of gloves and masks among emergency nurses during exposure to body fluids.Sharp object injuries were also linked to adherence. Siam and ALreshidi (25) reported 87.5% compliance during use of disposable

sharps, and Kim et al. (26) emphasized the role of training and supervision in reducing such injuries.This study found weak, non-significant correlations between compliance and both age and work experience. While Brandão et al. (27) reported improved adherence with experience, other studies (19, 25) found no such relationship. These inconsistencies may reflect variations in training, workplace policies, or cultural factors.

This study contributes to the literature by focusing specifically on pre-hospital emergency personnel—a group often overlooked in infection control research (1–4, 6, 11, 14). Given their frontline role and exposure to high-risk environments, targeted interventions for this population are essential.

One of the challenges encountered by the research team in this study was the uneven participation from various operational areas across Tehran. To mitigate this limitation, appropriate statistical tests were applied. It is recommended that future research compare and contextualize the findings of this study with other investigations on standard precautions in prehospital emergency settings.

A primary limitation of this study is the reliance on self-reporting tools, which may introduce response bias. Nonetheless, efforts were made to minimize this bias by clearly explaining the study's purpose to participants and ensuring confidentiality.Additionally, the use of convenience sampling may have introduced selection bias, as participants were recruited based on availability rather than random selection. This could affect the representativeness of the sample and limit the generalizability of the findings. Future studies are encouraged to employ probabilistic sampling methods to enhance the validity and applicability of results.

Conclusion:

Adherence to standard precautions among pre-hospital emergency personnel was found to be suboptimal. To address this issue, specific interventions should be implemented, including regular training on infection control, provision of high-quality PPE, and mandatory health check-ups. Policymakers should prioritize infection prevention strategies in pre-hospital settings, recognizing their critical role in the healthcare system. Strengthening these measures can enhance safety for both healthcare providers and the communities they serve. Future research should investigate the effectiveness of structured educational programs, the role of psychological factors such as perceived vulnerability, and the impact of organizational support on compliance. Longitudinal

studies are also recommended to assess changes in adherence over time and in response to policy interventions or public health emergencies.

Declarations

Ethics approval and consent to participate

The Research Ethics Committee of the Faculty of Nursing and Midwifery at Tehran University of Medical Sciences approved this study (ethical code: IR.TUMS.FNM.REC.1402.112). All participants were informed about the study details, and informed consent was obtained from them.

Consent for publication

Not applicable.

Data availability

All the data are available from the corresponding author upon reasonable request.

Competing interests

None to report.

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Authors' Contributions

The present study was designed by ZAD, and the proposal was prepared by YJ with specialized consultation from MNF and SMS. Data were collected by YJ and analyzed by MNF. The initial draft of the manuscript was prepared by YJ, and the final version was edited by ZAD and MNF. The final manuscript was reviewed and approved by all authors.

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