Trauma Mon. 2019 July; 24(4):e88412. doi: 10.5812/traumamon.88412.

Published online 2019 March 9. **Review Article**

Root Causes of Preventable Prehospital Deaths in Road Traffic Injuries: A Systematic Review

Adel Eftekhari [1], Abbasali Dehghani Tafti [1,*], Davoud Khorasani-Zavareh [2], Khadijeh Nasiriani [3], Majid Hajimaghsoudi [4] and Hossein Falahzadeh [5]

[1] Department of Health in Emergencies and Disasters, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[2] Safety Promotion and Injury Prevention Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[3] Department of Nursing, School of Nursing and Midwifery, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[4] Trauma Research Center, Shahid Rahnemoon Hospital, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[5] Department of Biostatistics and Epidemiology, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

[*] *Corresponding author*: Department of Health in Emergencies and Disasters, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran. Tel: +98-3533123000. Email: aadtafti@yahoo.com

Received 2018 December 29; **Accepted** 2019 January 05.

Abstract

Context: The prehospital care system depends on many factors. If all factors contributing to prehospital care are handled correctly, many fatalities occurring in this phase will be prevented.
Objectives: We aimed to identify root causes and factors contributing to preventable deaths in the prehospital phase of road traffic injuries.
Data Sources: In this study, a systematic review was performed on the Web of Science, Scopus, and PubMed databases, as well as Google Scholar Search Engine, using keywords "preventable mortality/fatality", "road traffic injuries", "prehospital" and a combination of them to find papers published from May 10, 2018, to August 30, 2018. The quality of the finally retrieved papers was investigated by two researchers independently and in the case of any disparities, a third researcher explored the papers. The PRISMA checklist was used to analyze the quality of the papers.
Study Selection: All documents and papers were included in the initial investigation regardless of the type of the paper. If a paper dealt with preventable fatalities of road traffic injuries in both prehospital and hospital phases, only were the prehospital phase results analyzed.
Results: Based on the findings, 14 articles and records were included in the review. The precise assessment of the papers using content analysis resulted in the emergence of three themes, six subthemes, and 45 codes. The main themes including "systemic deficiencies, human errors, and patient's clinical condition," and the subthemes including "educational deficiencies, managerial deficiencies, errors/delay in diagnosis, therapeutic deficiencies, technical deficiencies, and trauma types" were extracted.
Conclusions: Various factors were rendered effective in preventable fatalities of road traffic injuries in the prehospital phase. The identification of these factors and resolving the identified problems can reduce the fatalities of road traffic injuries.

Keywords: Preventable Fatalities/Mortalities, Prehospital, Road Traffic Injuries, Systematic Review

1. Context

Traffic accidents that constitute a considerable portion of unintentional incidents are of utmost importance around the world (1, 2). Almost 80% of accident fatalities occur in developing and underdeveloped countries (3, 4). According to recent reports in 2017, traffic accidents were the fourth leading cause of death in the youth aged 15 - 49-years-old around the globe so that there were 18.41 traffic accident fatalities for every 100,000 population (5). According to statistics on road accident victims, 31.9% of road accident casualties require emergency care in the prehospital phase (6). The prehospital phase encompasses the distance from the occurrence of the event and the appearance of symptoms until the arrival of the injured person at a suitable healthcare center. Hospital services are provided in response to call for emergency care for the assessment of medical needs of victims, delivery of healthcare in the field, and transport of patient or casualty to the suitable healthcare facility (7). The prehospital emergency medical service (EMS) is a health management system with a community-based approach coordinated with the whole healthcare system. The EMS centers are the cornerstones of healthcare provision in all countries. The

most important goal of this system is the provision of satisfactory services in the shortest time possible based on global up-to-date scientific standards (8). Since 30 - 60% of fatal road traffic injuries occur during the patient transport p.hase (9), the provision of care for victims who need immediate emergency care is of utmost significance (10). A study by Bakke and Wisborg (11) reported that 86% of mortalities among victims of road traffic injuries occur in the prehospital phase. However, there is a considerable reduction in fatalities attributed to road traffic injuries in developed countries, to some extent, due to achievements in the successful planning of prehospital care provision (12, 13). In recent years, approaches toward prehospital emergency care services have changed so that the WHO has rendered the prehospital emergency care as an indispensable component of any effective healthcare system (14). The prehospital healthcare system consists of elements such as information communication, transport, pathfinding, integration, and type of human expertise in ambulances, and communicative devices like wireless systems (15). Many fatalities/mortalities are preventable in the prehospital phase provided that all the factors contributing to prehospital care are correctly and effectively implemented. The preventable fatality was first introduced by Rutstein et al. (16) in the 1970s. It is used as an innovative method of determining and analyzing preventable mortality as a functional index to measure healthcare quality. Identifying the factors contributing to preventable fatalities in the prehospital phase enables professionals to create near-standard conditions at the time of accidents through prognosis, reduce fatalities as well as the number and severity of handicaps and crippling due to accidents and consequently, increase life expectancy via decreasing mortalities and burnout. All these would lead to diminished care costs and improved continuous rehabilitation of victims.

2. Objectives

Due to the importance of the issue and the curious lack of a comprehensive study to classify all factors contributing to the therapeutic and managerial aspects of fatal road traffic injuries, the current survey investigated all studies that have dealt with these factors.

3. Data Sources

3.1. Study Design

The present study was conducted as a systematic review.

3.2. Search Strategy and Inclusion Criteria

The main research question was "What factors can affect the preventable fatal road traffic injuries in the prehospital phase?" The keywords used in the electronic search included "death, fatality, mortality, casualty", "injury, trauma", "preventable, avoidable, unexpected", "incident, accident, event, road traffic", and "prehospital, pre-hospital, pre hospital, out of hospital". The keywords required for exploring the research question were selected based on Mesh terms. The use of Mesh term search enhances access to suitable, accurate keywords according to standards. Moreover, the opinions of experts, faculty members, and keywords of related articles were used in this process. The selected keywords were searched in the Web of Science, Scopus, and PubMed databases, as well as Google Scholar search engine. The search strategy was determined based on the characteristics of each database. The manual search was also used through surveying the references of all related papers. The database search covered the period from May 10, 2018, to August 30, 2018.

3.2.1. Search Strategy in PubMed

((Death* [Title/abstract] OR fatalit* [Title/abstract] OR mortalit* [Title/abstract] OR casualty* [Title/abstract] OR injur* [Title/abstract] OR trauma* [Title/abstract]) AND (preventable* [Title/abstract] OR Avoidable* [Title/abstract] OR Unexpected* [Title/abstract]) AND (incident* [Title/abstract] OR accident* [Title/abstract] OR event* [Title] OR Road traffic [Title] OR "pre hospital*"[Title] OR prehospital* [Title] OR prehospital OR "out of hospital" [Title])).

4. Study Selection

All documents and papers regardless of their type (original paper, short communication, letter to editor, RCT, systematic review) and books, conference papers, and international congress papers related to the topic were examined in the study. If a paper reported preventable fatal road traffic injuries in both hospital and prehospital phases, only the results of the prehospital phase entered the analysis. Papers addressing preventable fatalities of non-traffic accidents, as well as papers with no access to their full text, were excluded from the study. The selection of articles was done using the PRISMA checklist (17, 18). This 27-item tool has three choices for each item: Not applicable, not reported, and reported. This checklist investigates the method of presentation of title, abstract, introduction, methodology, results, discussion, and funding.

5. Data Extraction

We extracted the necessary information about studies using a form that included the title of study, author(s) name, study method, objectives, research type, measurement tool, research place, and factors affecting preventable mortality.

5.1. Analysis

All the searched papers and documents were imported to EndNote X8 and duplicates were excluded. Then, the studies that were not in line with the research question, regarding title and abstract, were omitted. Next, the full texts of all papers were investigated by two researchers independently and the irrelevant ones were excluded based on criteria. Subsequently, the full texts of the remaining papers were explored using the standard PRISMA checklist (17, 18). The quality of papers was explored by two researchers independently. In the case of any disparity between the research project supervisor and the student as the main researcher, a third researcher (research advisor) settled the dispute.

6. Results

A total number of 7247 papers were obtained from the mentioned databases. In addition, 1902 duplicated papers were excluded. Overall, 5355 titles and abstracts were examined and 218 full-text papers were explored of which, 12 were finalized for analysis. The rest of the papers were omitted, as they were irrelevant or did not observe the inclusion criteria. Two more articles entered the study after examining the reference lists. Ultimately, 14 relevant papers were analyzed. The results are displayed in Figure 1.

6.1. Descriptive Analysis

The results showed that of 14 papers studied, seven (50%) pertained to Australia and 28% were related to Asian countries. All the selected papers were original articles. Most of them, i.e., 12 (88%) papers, were retrospective in design. The descriptive statistics of the papers are presented in Table 1.

6.2. Analytical Analysis

The precisely detailed assessment of the papers based on content analysis resulted in three themes, six subthemes, and 45 codes. The main themes were "systemic deficiencies" with the subthemes of "educational deficiencies" and "managerial deficiencies", the "human errors" theme with the subthemes of "errors in diagnosis" and "latency in diagnosis", "therapeutic deficiencies", and "technical deficiencies", and the theme of "patient's clinical condition" with the subtheme of "trauma type" (Table 2).

7. Discussion

Many factors can affect the preventable fatal road traffic injuries in the prehospital phase. The identification of these parameters can help reduce the associated mortalities. The results obtained from the finally retrieved papers in this study demonstrated that some factors directly or indirectly affect the variable under study. Systemic, managerial, and technical deficiencies, and latency and errors in diagnosis were among the factors that influenced the preventable traffic accident mortalities in the prehospital phase (19, 20, 22-24, 28-32). It appears that the retrieved studies lacked a comprehensive attitude toward all factors affecting the preventable road traffic injuries in the prehospital phase. Nevertheless, the present systematic review disclosed the role of factors such as systemic deficiencies, human errors, and patient's clinical condition in terms of educational and managerial deficiencies, therapeutic, diagnostic, and technical errors, and trauma type.

Systemic deficiencies include insufficient equipment and facilities and/or deficiency of the workforce. The correct performance of various parts of the prehospital care system leads to the quick dispatch of an ambulance to the patient in the accident scene and prevention of death and disability. The success of this system depends on many factors including the high capacity of the responsible staff, trained personnel, sufficient and suitable equipment, and prompt and effective coordination and communication (33, 34).

In this study, the managerial and educational deficiencies were the indicators of systemic deficiencies. The shortage of trained personnel with medical and paramedical skills and insufficient level of skills in prehospital emergency staff were identified as educational deficiencies. Furthermore, the inappropriate admission of patients by the official personnel, lack of direct contact of prehospital personnel with the physician, lack of sufficient documents, shortage of pertinent consultants of trauma like neurosurgeons, and lack of appropriate triage services for patients were among the managerial deficiencies in the category of systemic deficiencies. It should be noted that in this study, the time of prehospital care provision was found prolonged due to issues related to the selection of the right path for reaching the patient at the traffic accident scene in the prehospital phase. This time was affected by factors such as delayed arrival of an ambulance or delayed arrival of the victim at the hospital or delayed admission and even delayed contact with the police, fire station, and EMS personnel. Rautji et al. (22) and Omoke et al. (21) referred to the insufficient number of trained medical staff and lack of accessibility of sufficiently skilled personnel of prehospital acre, especially ALS in the ambulance, as factors that

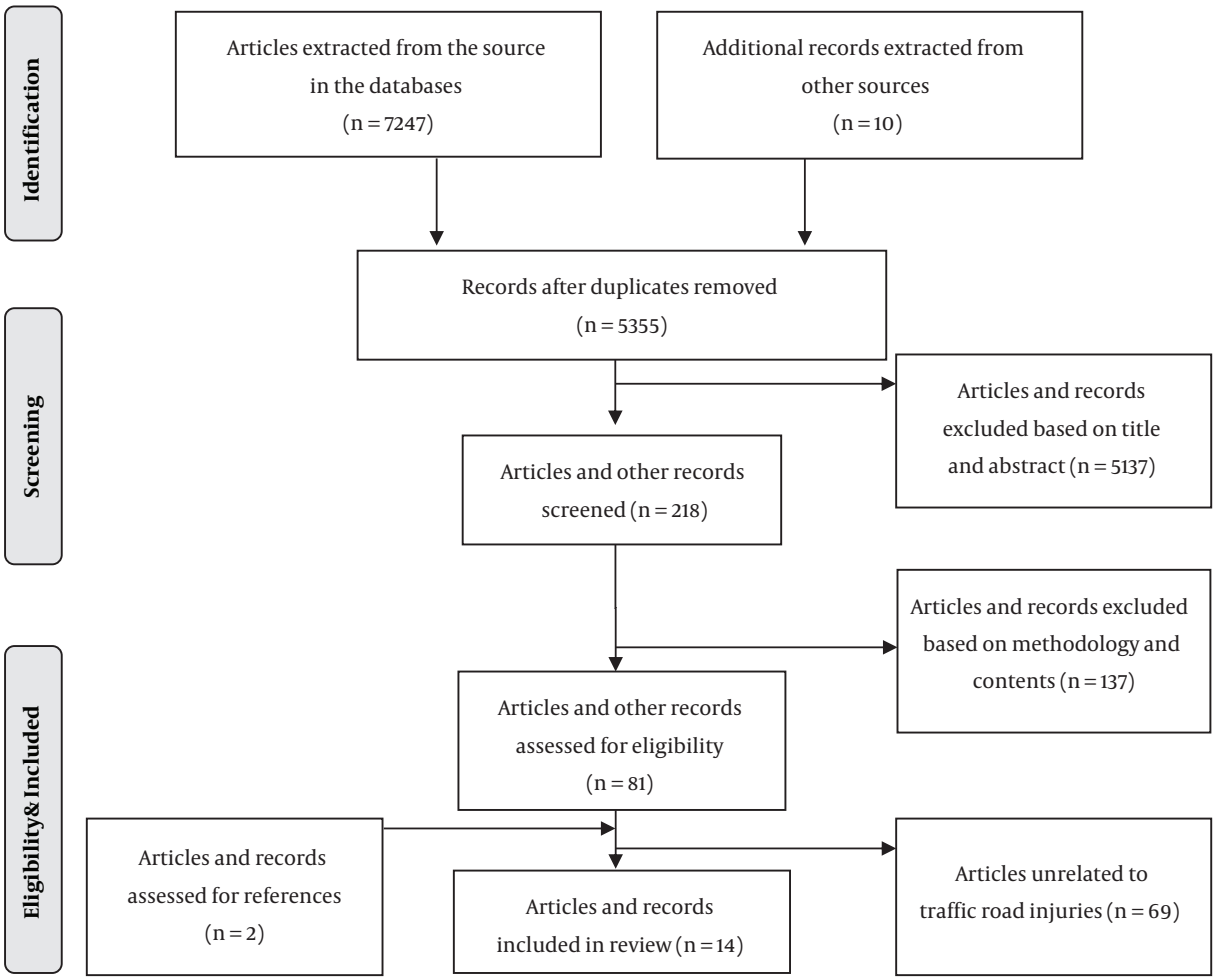

Figure 1. Flowchart diagram of paper search and selection

influenced the prevention of fatal road traffic injuries. In addition, McDemott et al. (31) stated that increased training and tactfulness of the personnel engaged in prehospital care are among the most important factors in managing traumatized victims. This is consistent with our findings. The time interval between ambulance arrival at the scene and victim's arrival at the healthcare facility is very important and this response time should be, according to gold standards, less than 8 min (35, 36). Concerning the response time reduction in prehospital care as an important factor in diminishing fatalities in this study, another study cited modern equipment like EMS helicopters as a factor that contributes to fatality reduction due to the use of suitable means and tactful trained personnel while the speed of patient transport was less important (37). This parallels the need for skilled personnel found in our study, yet inconsistent with care provision time in our findings.

Another important factor was the component of human errors. Our study identified diagnostic, therapeutic, and technical errors as affecting factors in this category. A diagnostic error is defined as a type of error that leads to incorrect diagnosis due to misunderstanding, physician's disqualification and incompetency, lack of medical examination, or a wrong diagnostic method. With technical error, we mean an error that occurs during a diagnostic or therapeutic method or procedure (23). An inappropriate intervention in prehospital care may predispose traffic accident victims to disability, crippling, or death while accurate wise measures of prehospital EMS workforce can aid in reducing mortalities (23).

This study identified the following as diagnostic errors: Insufficient inspection and observation of victims, undi-

Table 1. Details of Analyzed Papers Pertaining to Factors Affecting Preventable Pre-Hospital Deaths in Road Traffic Injuries

No.	Author and year (Ref.)	Objective	Type of Research	Setting	Design/Instrument
1	McDermott et al. (2005) (19)	Identifying prehospital care system and management deficiencies and preventable deaths	Original research	Australia	Retrospective study/prehospital and hospital records, autopsy findings and peer group review with a multidisciplinary discussion
2	Michiue et al. (2008) (20)	Investigating the severity of injury in traffic accidents and evaluating the associated mortality	Original research	China	Retrospective study/autopsy records and trauma severity score (AIS, ISS, TRISS)
3	Omoke et al. (2012) (21)	Early consequences of road traffic injuries in the emergency room	Original research	Nigeria	Prospective study/questionnaires
4	Rautji (2006) (22)	The use of traumatic injury scoring methods in traffic accident autopsies	Original research	India	Prospective study/autopsy records and trauma severity score (AIS, ISS)
5	Rivara et al. (1989) (23)	evaluating the effectiveness of 1) systems used in traumatic care and 2) the benefits of the evaluation tool in identifying preventable mortality	Original research	United States	Retrospective study/autopsy records and trauma severity score (ISS)
6	Rosenfeld et al. (2000) (24)	Investigating organizational and clinical defects and their role in mortality and evaluation of mortality prevention capabilities	Original research	Australia	Retrospective study/records including ambulance documentation, hospital and police records, and results of autopsies
7	Sahdev et al. (1994) (25)	Determining injuries and deaths prevented by appropriate use of resources	Original research	India	Retrospective study/autopsy records and trauma severity score (ISS, AIS)
8	Ryan et al. (2004) (26)	Surveying injuries in motorcyclist crash in the prehospital phase	Original research	Australia	Retrospective study/Police and autopsy records and trauma severity score (ISS, AIS)
9	Ray et al. (2016) (27)	Studying the causes of deaths of motorcyclists and assessing whether these deaths were potentially preventable.	Original research	United States	Retrospectively study/medical examiner records
10	McDermott et al. (1996) (28)	Identifying problems in the management of road fatalities and preventable deaths	Original research	Australia	Retrospective study/reports of hospitals, the police, the coroner, and autopsies
11	McDermott et al. (1997) (29)	Identifying problems in the management of traffic fatalities	Original research	Australia	Correlation analysis between the observed amount and the opinions of the committees with the statistical Kappa test
12	Motomura et al. (2014) (30)	Detection of mortality that is completely or relatively preventable	Original research	Japan	The police, fire stations, prehospital, hospital, forensic medicine, and autopsy records and trauma severity score
13	McDemott et al. (2001) (31)	Detecting errors in clinical and organizational affairs in traffic accident casualties	Original research	Australia	Retrospective study/ambulance, hospital and autopsy (TRISS) records, trauma severity score (TRISS) evaluated by a multidisciplinary committee.
14	McDemott et al. (1997) (32)	Identification of managerial problems in traffic accident losses for their role in preventive deaths	Original research	Australia	Retrospective study/prehospital, hospital, and autopsy records and trauma severity score (AIS, ISS, TRISS)

agnosed tension pneumothorax, intestinal rupture, fracture of ribs or sternum, subdural hematoma, hypovolemic shock, flail chest, pulmonary failure, aortic rupture, pelvic fracture, and hepatic rupture.

The therapeutic errors emerged in this study included insufficient medical care such as inadequate first-aid in the scene, faulty use of medicines or their dosages, excessive use of narcotics and analgesics, improper airway management like delayed intubation, insufficient respiratory ventilation, unsuitable monitoring of oxygen therapy, lack of hemostasis, insufficient CPR, insufficient monitoring of blood transfusion such as delayed fluid infusion or inadequate fluid replacement, improper phlebotomy and venipuncture, improper chest tube placement, and lack of performing blood tests. The EMS personnel must perform a series of interventions according to international protocols when they face victims at the scene. For traumatized patients, these interventions include stabilizing spinal column, bleeding control at the scene, compression dressing, the use of angiocatheter, phlebotomy of the peripheral ves-

Table 2. Effective Factors of Preventive Fatal Road Traffic Injuries in Pre-Hospital Phase Based on Content Analysis of Systematic Review

Theme/Subtheme	Codes	Studies
Systemic deficiencies		
Educational deficiencies	(1) insufficient number of medically trained personnel; (2) availability of consultant medical staff and the ALS training of ambulance officers; (3) personnel without paramedic skills and medical escort; (4) inadequate skill levels of prehospital emergency staff	Omoke et al. (2012) (21), Rautji et al. (2006) (22), McDemott et al. (2001) (29)
Managerial deficiencies	(1) inappropriate reception by junior staff; (2) no call for doctor delivery system; (3) inadequate Documentation; (4) lack of neurosurgical consultation; (5) inappropriate triage category; (6) Inappropriate (transfer) destination; (7) delay in the time of call (to paramedic, the police, fire department, dispatch of emergency medical services) and unduly prolonged time at the scene; (8) delay in the time of arrival of an ambulance to the accident scene and arrival at hospital (Long time interval between accident time and hospital admission); (9) prolonged total time of prehospital care	Rautji et al. (2006) (22), McDermott et al. (1996) (28), Rosenfeld et al. (2000) (24), McDermott et al. (1997) (29), McDemott et al. (2001) (31), McDermott et al. (2005) (19), Rivara et al. (1989) (23), Michiue et al. (2008) (20), Motomura et al. (2014) (30), McDermott et al. (1997) (32)
Human errors		
Errors/latency in diagnosis	(1) inadequate abdominal assessment; (2) inadequate observations; (3) missed or delayed diagnosis; (4) tension pneumothorax; (5) hypovolemic shock; (6) fractured (ribs, bilateral flail chest/sternum, pelvis); (7) respiratory failure; (8) severe hypoxia (treated with morphine instead of oxygen); (9) subdural/extradural hematoma; (10) cerebral swelling; (11) hemothorax; (12) liver laceration; (13) ruptured aorta; (14) adult respiratory distress syndrome (ARDS); (15) thoracic aorta; (16) intra-abdominal hemorrhage	Rautji et al. (2006) (22), McDermott et al. (1996) (28), Rosenfeld et al. (2000). (24), McDermott et al. (1997) (29), McDemott et al. (2001) (31), McDermott et al. (2005) (19), Rivara et al. (1989) (23), Michiue et al. (2008) (20), Motomura et al. (2014) (30), McDermott et al. (1997) (32)
Therapeutic deficiencies	(1) insufficient medical care such as simple first-aid measures at the scene of the crash; (2) inadequate resuscitation in patients with ruptured liver and spleen leading to brain death; (3) failure to provide appropriate drugs (inappropriate drugs/dosage, sedation/medication inappropriateness, sedation for intubation and excessive sedation); (4) lack of proper airway management (no intubation, inadequate ABG or O_2 monitoring, respiratory/ventilator resuscitation, delayed intubation/definitive airway); (5) inadequate external hemorrhage control; (6) inappropriate cardiopulmonary; (7) respiratory resuscitation; (8) inadequate hematology; (9) inadequate perfusion monitoring (no or delayed second intravenous line, no IV access, delayed IV fluids, insertion of only one IV line); (10) inadequate management of hypothermia; (11) no or delayed chest decompression; (12) no intercostal catheter	Omoke et al. (2012) (21), Rivara et al. (1989) (23), McDemott et al. (1997) (29), McDemott et al. (2001) (31), McDemott et al. (2005) (19), McDermott et al. (1996) (28), McDermott et al. (1997) (32), Ryan et al. (2004) (26)
Technical deficiencies	(1) failed intubation; (2) failed IV access; (3) misplaced endotracheal tube (esophageal or right main bronchus intubation); (4) failure to intubate comatose patients; (5) failure to apply or properly fit a cervical collar; (6) absent or not-poorly fitted C-collar	Rautji et al. (2006) (22), McDermott et al. (1996) (28), Rosenfeld et al. (2000) (24), McDermott et al. (1997) (29), McDemott et al. (2001) (31), McDermott et al. (2005) (19), Rivara et al. (1989) (23), Michiue et al. (2008) (20), Motomura et al. (2014) (30), McDermott et al. (1997) (32)
Patient's clinical condition		
Trauma type	(1) hemorrhage/hypovolemic shock; (2) head injury; (3) hypoxia; (4) tension pneumothorax; (5) massive retroperitoneal hemorrhage; (6) lung laceration hemothorax; (7) purulent peritonitiss; (8) massive anterior mediastinal hematoma; (9) fracture (rib, pelvis); (10) intra-abdominal bleeding; (11) hemorrhage; (12) injuries to lung, kidney, spleen, chest, extremities, abdomen, spinal, face, head, and neck; (13) neurological injury (epidural, subdural, subarachnoid, and intracerebral hemorrhage, laceration, diffuse axonal injury, brain swelling, contusion, the fractured base of the skull, brain stem injury)	Michiue et al. (2008) (20), Raut et al. (2006) (22), Sahdev et al. (1994) (25), Ray et al. (2016) (27), McDermott et al. (1997) (29), Motomura et al. (2014) (30), McDemott et al. (1997) (32), McDemott et al. (2001) (31)

sel on victim transport, administration of 50% glucose to patients with impaired consciousness, and other relevant interventions depending on the condition of the victim of the road traffic injuries. Obviously, the vital signs of these patients ought to be taken and they must be transferred quickly to modern equipped facilities (38-40). If any mis-

take occurs during these procedures, any mistake is committed by the personnel, or a correct procedure is completed in a delayed manner, all these would lead to victim's death in the road traffic injuries; however, these cases are easily preventable.

Technical errors comprised another category of errors that included inappropriate intratracheal intubation, lack of setting up an IV line, delayed intratracheal intubation, and failed intratracheal intubation. These errors were committed by prehospital caregivers in road traffic injuries leading to many preventable fatalities.

The patient's clinical condition in terms of the type of trauma was stated as another influential factor in preventable fatalities of road traffic injuries. In this study, the type of trauma to be considered by prehospital personnel to avoid mortalities included hemorrhage, pelvic fracture, spleen rupture, epidural hematoma, pulmonary injury, renal injury, hemothorax, pressure pneumothorax, retroperitoneal bleeding, abdominal bleeding, neurological injuries, hemorrhagic and hypovolemic shock, head trauma, and hypoxia that had led to victim's death due to delayed intervention or delayed correction of these trauma. McDermott et al. (19) enumerated bleeding and hypovolemic shock as the most important factors that could be prevented through prompt prehospital intervention and diagnosis. Sahdev et al. (25) estimated the severity of body trauma and mentioned trauma to the head and neck as injuries that could be prevented by prompt intervention. In addition, Ryan et al. (26) referred to head and chest trauma as the most frequent injuries that could be managed to avoid preventable fatalities.

Our electronic and manual search demonstrated that the full texts of some papers were not accessible. This was resolved by sending Emails to the authors or via inter-university links. Another limitation was searching English-only papers and documents and excluding other languages.

8. Conclusions

Numerous factors were extracted at the managerial and therapeutic levels in the reviewed studies. The identification and management of these factors can reduce fatal road traffic injuries through beforehand preparation for responding at the scene. It appears that a few studies have explored the preventable fatal road traffic injuries in the prehospital phase. A need assessment should be done to determine the importance of prioritizing this issue in future research.

Acknowledgments

This paper was derived from a Ph.D. research project at Shahid Sadoughi University of Medical Sciences with the ethics code of IR.SSU.SPH.REC.1397.038 approved by the Ethics Committee in Human Research at the university. The authors give their special thanks to all those who assisted in carrying out the project.

Footnotes

Authors' Contribution: Adel Eftekhari searched the databases; Khadijeh Nasiriani and Adel Eftekhari removed the unrelated articles. Davoud Khorasani-Zavareh, Adel Eftekhari, and Majid Hajimaghsoudi selected articles and evaluated their quality. Hossein Falahzadeh participated as a statistical advisor in extracting the data of the tools used in the selected articles. All authors participated in drafting of the manuscript

Conflict of Interests: The authors did not declare any conflicts of interest.

Funding/Support: This article is derived from a Ph.D. thesis funded by Shahid Sadoughi University of Medical Sciences, in Yazd, Iran.

References

1. Jat AA, Khan MR, Zafar H, Raja AJ, Hoda Q, Rehmani R, et al. Peer review audit of trauma deaths in a developing country. *Asian J Surg*. 2004;**27**(1):58–64. doi: 10.1016/S1015-9584(09)60247-5. [PubMed: 14719518].
2. Varghese M, Sasser S, Kellermann A, Lormand JD; World Health Organization. *Prehospital trauma care systems*. Geneva: World Health Organization; 2005.
3. Arreola-Risa C, Mock C, Herrera-Escamilla AJ, Contreras I, Vargas J. Cost-effectiveness and benefit of alternatives to improve training for prehospital trauma care in Mexico. *Prehosp Disaster Med*. 2004;**19**(4):318–25. [PubMed: 15645628].
4. Carr BG, Caplan JM, Pryor JP, Branas CC. A meta-analysis of prehospital care times for trauma. *Prehosp Emerg Care*. 2006;**10**(2):198–206. doi: 10.1080/10903120500541324. [PubMed: 16531377].
5. IHME. *Global Burden of Disease 2017*. 2018. Available from: https://vizhub.healthdata.org/gbd-compare.
6. Rezaei S, Arab M, Karami Matin B, Akbari Sari A. Extent, consequences and economic burden of road traffic crashes in Iran. *J Inj Violence Res*. 2014;**6**(2):57–63. doi: 10.5249/jivr.v6i2.191. [PubMed: 24045158]. [PubMed Central: PMC4009170].
7. Caceres JA, Adil MM, Jadhav V, Chaudhry SA, Pawar S, Rodriguez GJ, et al. Diagnosis of stroke by emergency medical dispatchers and its impact on the prehospital care of patients. *J Stroke Cerebrovasc Dis*. 2013;**22**(8):e610–4. doi: 10.1016/j.jstrokecerebrovasdis.2013.07.039. [PubMed: 24075587].
8. Amin SN, Mahmoud NM, Farzaneh MM. [Identify stressful factors causing dissatisfaction in pre-hospital emergency personnel in Kerman]. *Payavard Salamat*. 2013;**6**(6):489–97. Persian.

9. Khankeh H, Khorasani-Zavareh D, Masoumi G. Why the prominent improvement in prehospital medical response in Iran couldn't decrease the number of death related road traffic injuries. *J Trauma Treat*. 2012;**1**(4):2167. doi: 10.4172/2167-1222.1000e103.
10. Lossius HM, Roislien J, Lockey DJ. Patient safety in pre-hospital emergency tracheal intubation: A comprehensive meta-analysis of the intubation success rates of EMS providers. *Crit Care*. 2012;**16**(1):R24. doi: 10.1186/cc11189. [PubMed: 22325973]. [PubMed Central: PMC3396268].
11. Bakke HK, Wisborg T. Rural high north: A high rate of fatal injury and prehospital death. *World J Surg*. 2011;**35**(7):1615–20. doi: 10.1007/s00268-011-1102-y. [PubMed: 21538190]. [PubMed Central: PMC3140949].
12. Jacobs GD, Aeron-Thomas A. *A review of global road accident fatalities*. RoSPA Road Safety Congress; 1999.
13. World Health Organization. *Violence, injuries and disability: Biennial report 2010-2011*. Geneva, Switzerland: World Health Organization; 2012.
14. Al-Shaqsi S. Models of international emergency medical service (ems) systems. *Oman Med J*. 2010;**25**(4):320–3. doi: 10.5001/omj.2010.92. [PubMed: 22043368]. [PubMed Central: PMC3191661].
15. Institute for Rational Living; Institute for Rational-Emotive Therapy (New york). *Mental health*. New York: Rational living; 1934.
16. Rutstein DD, Berenberg W, Chalmers TC, Child CG 3rd, Fishman AP, Perrin EB. Measuring the quality of medical care. A clinical method. *N Engl J Med*. 1976;**294**(11):582–8. doi: 10.1056/NEJM197603112941104. [PubMed: 942758].
17. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Sys Rev*. 2015;**4**(1):1. doi: 10.1186/2046-4053-4-1.
18. Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: Elaboration and explanation. *BMJ*. 2015;**350**:g7647. doi: 10.1136/bmj.g7647. [PubMed: 25555855].
19. McDermott FT, Cooper GJ, Hogan PL, Cordner SM, Tremayne AB. Evaluation of the prehospital management of road traffic fatalities in Victoria, Australia. *Prehosp Disaster Med*. 2005;**20**(4):219–27. doi: 10.1017/S1049023X00002570. [PubMed: 16128469].
20. Michiue T, Ishikawa T, Quan L, Zhu BL, Maeda H. Forensic pathological evaluation of injury severity and fatal outcome in traffic accidents: Five illustrative autopsy cases of clinically unexpected death. *Forensic Sci Med Pathol*. 2008;**4**(3):153–8. doi: 10.1007/s12024-007-9025-5. [PubMed: 19291453].
21. Omoke NI, Chukwu CO, Madubueze CC, Oyakhiolme OP. Outcome of road traffic injuries received in the emergency room of a teaching hospital, Southeast Nigeria. *Trop Doct*. 2012;**42**(1):18–22. doi: 10.1258/td.2011.110030. [PubMed: 22290108].
22. Rautji R, Bhardwaj DN, Dogra TD. The abbreviated injury scale and its correlation with preventable traumatic accidental deaths: A study from South Delhi. *Med Sci Law*. 2006;**46**(2):157–65. doi: 10.1258/rsmmsl.46.2.157. [PubMed: 16683471].
23. Rivara FP, Maier RV, Mueller BA, Luna GA, Dicker BG, Herman CM, et al. Evaluation of potentially preventable deaths among pedestrian and bicyclist fatalities. *JAMA*. 1989;**261**(4):566–70. doi: 10.1001/jama.1989.03420040104028. [PubMed: 2909799].
24. Rosenfeld JV, McDermott FT, Laidlaw JD, Cordner SM, Tremayne AB. The preventability of death in road traffic fatalities with head injury in Victoria, Australia. The Consultative Committee on Road Traffic Fatalities. *J Clin Neurosci*. 2000;**7**(6):507–14. doi: 10.1054/jocn.1999.0694. [PubMed: 11029231].
25. Sahdev P, Lacqua MJ, Singh B, Dogra TD. Road traffic fatalities in Delhi: Causes, injury patterns, and incidence of preventable deaths. *Accid Anal Prev*. 1994;**26**(3):377–84. doi: 10.1016/0001-4575(94)90011-6. [PubMed: 8011050].
26. Ryan M, Stella J, Chiu H, Ragg M. Injury patterns and preventability in prehospital motor vehicle crash fatalities in Victoria. *Emerg Med Australas*. 2004;**16**(4):274–9. doi: 10.1111/j.1742-6723.2004.00622.x. [PubMed: 15283713].
27. Ray JJ, Meizoso JP, Satahoo SS, Davis JS, Van Haren RM, Dermer H, et al. Potentially preventable prehospital deaths from motor vehicle collisions. *Traffic Inj Prev*. 2016;**17**(7):676–80. doi: 10.1080/15389588.2016.1149580. [PubMed: 26890273].
28. McDermott FT, Cordner SM, Tremayne AB. Evaluation of the medical management and preventability of death in 137 road traffic fatalities in Victoria, Australia: An overview. Consultative Committee on Road Traffic Fatalities in Victoria. *J Trauma*. 1996;**40**(4):520–33. discussion 533-5. doi: 10.1097/00005373-199604000-00003. [PubMed: 8614029].
29. McDermott FT, Cordner SM, Tremayne AB. Reproducibility of preventable death judgments and problem identification in 60 consecutive road trauma fatalities in Victoria, Australia. Consultative Committee on Road Traffic Fatalities in Victoria. *J Trauma*. 1997;**43**(5):831–9. doi: 10.1097/00005373-199711000-00016. [PubMed: 9390497].
30. Motomura T, Mashiko K, Matsumoto H, Motomura A, Iwase H, Oda S, et al. Preventable trauma deaths after traffic accidents in Chiba Prefecture, Japan, 2011: Problems and solutions. *J Nippon Med Sch*. 2014;**81**(5):320–7. doi: 10.1272/jnms.81.320. [PubMed: 25391701].
31. McDermott FT, Cordner SM, Tremayne AB; Consultative Committee on Road Traffic Fatalities. Road traffic fatalities in Victoria, Australia and changes to the trauma care system. *Br J Surg*. 2001;**88**(8):1099–104. doi: 10.1046/j.0007-1323.2001.01835.x. [PubMed: 11488796].
32. McDermott FT, Cordner SM, Tremayne AB. Management deficiencies and death preventability in 120 Victorian road fatalities (1993-1994). The Consultative Committee on Road Traffic Fatalities in Victoria. *Aust N Z J Surg*. 1997;**67**(9):611–8. doi: 10.1111/j.1445-2197.1997.tb04608.x. [PubMed: 9322697].
33. Zeraatchi A, Rostami B, Rostami A. [Time indices of emergency medical services; a cross-sectional study]. *Iran J Emerg Med*. 2017;**5**:8. Persian.
34. Sabouri E, Naderi MM, Saburie O, Mohammadi Y, Tavakkoli F. [The evaluation of prehospital emergency performance indicators in birjand, 2015]. *Iran J Emerg Care*. 2017;**1**(1):61–8. Persian.
35. Hatamabadi HR, Vafaee R, Haddadi M, Abdalvand A, Soori H. Necessity of an integrated road traffic injuries surveillance system: A community-based study. *Traffic Inj Prev*. 2011;**12**(4):358–62. doi: 10.1080/15389588.2011.566656. [PubMed: 21823944].
36. Roudsari BS, Shadman M, Ghodsi M. Childhood trauma fatality and resource allocation in injury control programs in a developing country. *BMC Public Health*. 2006;**6**:117. doi: 10.1186/1471-2458-6-117. [PubMed: 16670023]. [PubMed Central: PMC1471786].
37. Westhoff J, Hildebrand F, Grotz M, Richter M, Pape HC, Krettek C. Trauma care in Germany. *Injury*. 2003;**34**(9):674–83. doi: 10.1016/S0020-1383(03)00147-5. [PubMed: 12951292].
38. Burch JM, Francious RJ, Schwartz SI, Shires GT, Spencer FC. *Principles of surgery*. New York: Mc Graw-Hi; 1999.
39. Delbridge T, Domeier R, Key CB. Prehospital asthma management. *Prehosp Emerg Care*. 2003;**7**(1):42–7. doi: 10.1080/10903120390937076. [PubMed: 12540142].
40. Nicholl JS. Prehospital management of the seizure patient. *Emerg Med Serv*. 1999;**28**(5):71–5. quiz 77. [PubMed: 10537415].