

Assessment of Environmental Hazards in Emergency Medical Services (EMS): A Scoping Review

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Abstract: *Emergency medical services (EMS) workers provide care to patients in a challenging and dynamic environment. This environment is characterized by a high risk for both harm and errors. Although EMS care plays a vital role in saving lives, the literature on healthcare worker safety in this setting is sparse. The purpose of this study was to assess various environmental hazards affecting the EMS providers, their effects, and what needs to be done to change the situation. The study adopted the scoping review method of study. A total of 13,382 articles were identified for the study. However, after thorough screening, and removal of duplicates and irrelevant studies, only 33 articles were selected and included in the final review. From the results of the review, it was established that EMS workers face physical hazards such as injuries and accidents, psychological hazards, chemical hazards, infectious diseases, and fatigue. These threats lead to morbidity, disabilities, stress, and other impacts among healthcare workers. For them to be addressed, there is a need to promote emergency preparedness and strengthen emergency response efforts. It was concluded that promoting healthcare worker safety in the EMS setting requires a multi-disciplinary approach involving teams from other fields of medicine. This can help to provide a novel understanding of how to deal with the environmental threats that EMS personnel get exposed to.*

Keywords: Environmental hazards, Emergency Medical Services, EMS providers, healthcare workers

1. Introduction

1.1 Background

A large portion of global burden of disease is made up of emergency conditions, most of which are potentially addressable by prehospital and emergency medical care (MOH, 2020). Whenever a medical emergency occurs, emergency medical services (EMS) workers play an important role in providing pre-hospital care. Their services are critical to survivors of accidents, persons who experience heart attacks, and those who need other forms of urgent medical attention (Maguire & Smith, 2013). These healthcare providers deliver care services in high-risk, stressful, and unpredictable environments compared to their counterparts that give other types of care. Emergency medical responders (EMR), Emergency medical technicians (EMT) and Paramedics often work without sufficient personal protective equipment. Hand washing among these healthcare providers is in most cases limited when they provide emergency services outside the health facilities. Due to the nature of their work, and work environment, EMS providers tend to face serious challenges. They are exposed to motor-vehicle accidents, infectious materials, extreme temperatures, assaults, long working hours, and psychological and physical stressors (Taylor et al., 2015). These risks increase their vulnerability to injuries and ill health.

The volatility of the emergency medical care environment not only jeopardizes the health of healthcare providers, but also that of patients. Patients seeking emergency medical attention sometimes get exposed to infectious diseases, injuries, and other risks (Bigham, Buick & Brooks, 2012; Oyegbile & Brysiewicz, 2020). According to the World

Health Organization (2020), containment of hazardous materials, accessing the extent of infrastructure damage, strengthening disaster management and response plans, and improvement of sanitation facilities can help to minimize the impact of environmental hazards encountered in the EMS setting. Despite being a sensitive area of healthcare, EMS care continues to receive limited attention in the literature about healthcare workforce safety. The purpose of this scoping review was to carry out a systematic review of the literature available on the environmental hazards that EMS providers are exposed to.

1.2 Objectives

The main objective of the review was to identify and map available evidence on threats to healthcare worker safety in EMS care. The review also aimed at examining the effect of the hazards and determining the strategies that can be used to address them. This information can be used to inform healthcare policy and educate EMS operators.

Using the stated objectives, and the participants, interventions, comparisons, outcomes, and study design (PICOS) criterion, the researcher developed the following research questions to guide him in conducting the scoping review:

- What are the common environmental hazards that emergency medical services (EMS) providers face?
- What is the effect of these hazards on the health and wellbeing of the healthcare providers?
- How can environmental hazards in EMS be addressed?

2. Methods

The current scoping review was based on Arksey and O'Malley's framework that was developed further by Levac, Colquhoun, and O'Brien, and Joanna Briggs Institute Framework for Scoping Reviews. It also conformed to the Preferred Reporting Items for Systematic Reviews and meta-analyses (PRISMA-ScR).

2.1 Eligibility Criteria

The review began with the identification of suitable inclusion and exclusion criteria for determining relevant articles for the study. These eligibility criteria are derived from the population, concept, and context (PCC) framework as shown in table 1 below.

Table 1: Eligibility criteria

PCC Framework	Inclusion	Exclusion
Population	EMS healthcare workers (Emergency Medical Technicians, Emergency Medical Responders, and Paramedics)	Other healthcare workers who do not serve in the prehospital and emergency medical departments
Concept	Environmental hazards (scene of injury or illness, during transport, emergency department)	Other types of hazards that are not associated with the emergency medical environment
Context	Emergency medical services/emergency medical care	Other forms of healthcare services that are not part of emergency medical care

2.2 Information Sources

Both peer-reviewed and non-peer-reviewed journal articles and pieces of grey literature were considered for the study. Three credible databases (PubMed, CINAHL, and Emerald) were initially searched. These databases were last searched after the year 2016. The databases were identified with the help of subject-specific librarians and various experts were mainly drawn from the emergency medical department. After the initial search, a comprehensive search followed. Some of the keywords and phrases that were used for the search include "hazards," "environmental hazards," "health hazards," "health risks," "health threats," "threats to health worker safety," "threats to healthcare providers," "threats in emergency medical services," "threats in EMS," "emergency medical services," "emergency care," "critical care," and "pre-hospital care" (see appendix A for an example).

During the data search, the researcher never limited himself to specific articles. All types of articles containing relevant information on environmental hazards applicable in the EMS were considered. These included articles deriving from qualitative, quantitative, and mixed methods of research. However, it is important to note that the researcher placed some limits in the areas of the subject matter of the review, language of publication, and publication date of the articles. Articles containing irrelevant information, articles not published in the English language, and articles published before the year 2016 were not considered.

Apart from databases, reference lists and bibliographies of the articles included in the study were also searched to identify more relevant articles. Some articles considered for the review were obtained through the process of hand searching. This process was necessary because some important studies published in journals may not necessarily be accessed using electronic databases. Some may not contain the search terms used in this review in their abstracts and titles. After the search, duplicate studies were removed from the list of considerations.

2.3 Study Selection

To select relevant articles for the review, specific search criteria were applied to each database. Abstracts and titles of different articles that met the eligibility criteria were subjected to screening using the lead author. In cases where it was not easy to determine the exclusion and inclusion criteria using titles and abstracts, it was necessary to source full articles. In situations where bibliography or reference list searches were used to identify article titles as potentially relevant, their abstracts were accessed and screened using the set criteria above. The process of selecting articles that were relevant to the study was conducted independently by way of involving two reviewers. Emerging disagreements were resolved through dialogue and further consultations. In the process, all the necessary amendments were made.

2.4 Data Collection Process

Data for the review was extracted from the selected articles using certain study characteristics. It was then charted using a standardized form that had been developed by the researcher during a pilot study. The following study characteristics were recorded: author(s), date of publication, purpose, objectives, method, sample, interventions, outcomes, and findings and conclusion. This information was filled in the charting form that was presented in form of a charting table.

For the study objectives and questions to be answered, a narrative synthesis of the review results was conducted. The process involved: (i) numerical and descriptive synthesis; (ii) examples of environmental hazards, and characteristics of emergency departments; (iii) strategies that can be used to minimize environmental hazards in EMS. The findings of the outcome measures were collated and treated separately using population sub-groups (paramedics, emergency medical technicians, and emergency medical responders). The reviewers also summarized and reported the findings of the measures based on the study quality context. This undertaking enabled them to gauge the strength of the available evidence and bias risk.

3. Results

3.1 Selection of Studies

The search yielded a total of $n = 13,382$ articles (PubMed $n = 10,232$, CINAHL $n = 2937$, and Emerald $n = 213$). Out of these, 3,091 were found to be duplicates. 9110 articles were excluded from the study at the abstract or title screening

stage due to their irrelevance. From the remaining 1,181 articles, only 76 entered the full-text screening stage. At this stage, 7 articles were again excluded due to irrelevance. In general, only 33 articles met the set eligibility criteria for the

review. The study selection process is demonstrated in figure 1 below.

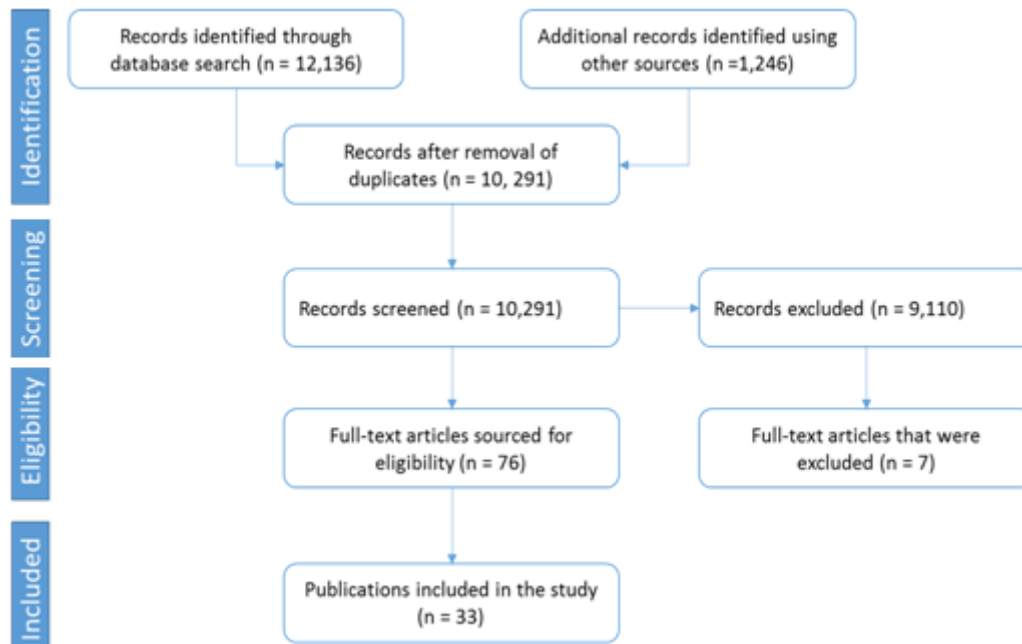


Figure 1: Presentation of the study selection results using the PRISMA chart

3.2 Study Characteristics

The selected articles were published between 2016 and 2020 and were based on studies conducted in the United States, England, Canada, and Australia. The studies mainly focused on EMS workers and the environmental hazards they grapple with. However, they also contained information on health hazards facing other healthcare workers who do not serve in the emergency medical departments. This information was important for comparison purposes. Interventions varied widely, but they involved prevention measures, emergency preparedness, and disaster response plans. Just like interventions, outcomes also varied. While these measures worked for most EMS healthcare workers, they did not work for some. It is also important to note that the selected studies, mainly journal articles (81.8%), were based on various research designs, including quasi-experimental, cross-sectional, longitudinal, case studies, and pretest-posttest designs from the health sector (69.7%). Table 2 below summarizes the features of the selected studies.

Table 2: Features of the selected studies

Table 1. Features of articles included for reviews (n = 33).		
Features	Number (n = 33)	Percent (%)
<i>Year of publication</i>		
2016	7	21.21
2017	8	24.24
2018	3	9.09
2019	9	27.27
2020	6	18.18
<i>Type of publication</i>		
Journal	27	81.8
Conference paper	4	12.12

State or international organization report	2	0.06
<i>Sector</i>		
Health	23	69.7
Health and Social sciences	6	18.2
Social sciences	3	0.09
Other	1	0.03
<i>Scoping terminology</i>		
Scoping review	23	0.52
Scoping study	3	0.09
Systematic mapping	1	0.03
Evidence mapping	3	0.09
Rapid review	1	0.03
Scoping exercise	1	0.03
Other	1	0.03
<i>Study length (mean; range)</i>	6.15 months	2 weeks to 23 months

Most studies consulted were based on a published framework (90.9%), with information sourced from electronic databases (75.8%), and clear inclusion and exclusion criteria (66.7%). These characteristics are highlighted in the table below.

Table 3: Methodological features of articles included in the reviews (n = 33)

Methodological Features	Number (n=33)	Percent (%)
Methodology		
Application of the published framework	30	90.9
Conducted quality assessment	3	9.09
Search scheme		
Electronic database(s)	25	75.8
Reference list of relevant articles	3	9.09
Manual searching	3	9.09
Internet search/websites	2	6.06
Study selection		

Defined inclusion/exclusion criteria	22	66.7
Screening of titles and abstracts by ≥ 2 reviewers	4	12.1
Screening of full-text articles by ≥ 2 reviewers	3	9.09
No limits on study design	2	6.06
Limited to controlled trials only	1	3.03
No limits on publication type	0	0
Limited to peer-reviewed articles	1	3.03
Limited to journal articles (peer and non-peer-reviewed)	0	0
Data charting		
Data extraction by one reviewer	28	84.8
Data extraction by one reviewer, responses verified by another reviewer	3	9.09
Data extraction by ≥ 2 reviewers	1	3.03
Use of a standardized form	1	3.03
Data Analysis		
Number of articles included (min, max)	30	90.09
Descriptive narrative summary	2	6.06
Formal qualitative analysis	1	3.03
Meta-analysis	0	0

(Table adopted from Pham, Mai T., Andrijana Rajić, Judy D. Greig, Jan M. Sargeant, Andrew Papadopoulos, and Scott A. McEwen. "A scoping review of scoping reviews: advancing the approach and enhancing the consistency", Research Synthesis Methods, 2014).

4. Discussion

4.1 Environmental Hazards in EMS

The main goal of this review was to identify various environmental hazards in an EMS setting. From the findings of the study, it was found that about 90% of the articles that made it into the final list of selection contained enough information on environmental hazards in an EMS setting (Chen et al., 2019; Chong, Henderson & Lewis, 2016; Kuek, 2019; Leszczyński et al., 2019; Levac, Venesoja et al., 2020; Wimalaratne et al., 2017; World Health Organization, 2020; Phillips, 2016; Gormley et al., 2016; Beyramijam et al., 2020; Taylor et al., 2016; Mitchell, Maguire & Guidotti, 2016; Lo et al., 2017; Howard et al., 2017; Juliá-Sanchis et al., 2019; Maguire & O'Neill, 2017; Maguire et al., 2018; Pourshaikhian, 2016; Ramacciati et al., 2016; Reichard et al., 2017; Berry & Perera, 2019; Dropkin et al., 2019; Reuter & Camba, 2017; Oyegbile, & Brysiewicz, 2020; Misasi & Keebler, 2019; Boujema et al., 2018; Shin & Lee, 2020; Moya, Carrasco & Hoz, 2017; Brice et al., 2019; Patterson et al., 2018). The EMS environmental hazards were grouped into five broad categories: physical hazards, accident hazards, psychological aspects, chemical hazards, and biological hazards.

4.1.1 Accident Hazards

Accident hazards that EMS personnel struggle with include motor vehicle accidents, needle injuries, fire accidents, slips, and falls (Chong, Henderson & Lewis, 2016; Hughes et al., 2017; Lo et al., 2017; Maguire & O'Neill, 2017; Wimalaratne et al., 2017; Berry & Perera, 2019; Chen et al., 2019; Shin & Lee, 2020; Venesoja et al., 2020).

4.1.2 Physical Hazards

Physical hazards include assaults from patients, workplace violence, and exposure to noise from emergency horns (Gormley et al., 2016; Phillips, 2016; Pourshaikhian, 2016; Taylor et al., 2016; Howard et al., 2017; Lo et al., 2017; Reichard et al., 2017; Reuter & Camba, 2017; Leszczyński et al., 2019; Oyegbile, & Brysiewicz, 2020; Venesoja et al., 2020; World Health Organization, 2020).

4.1.3. Chemical Hazards

Chemical hazards comprise exposure to toxic chemicals and poisons, and the potential of getting sensitized to latex (Henderson & Lewis, 2016; Wimalaratne et al., 2017; Maguire et al., 2018; Berry & Perera, 2019; Kuek, 2019; Misasi & Keebler, 2019; Beyramijam et al., 2020; World Health Organization, 2020).

4.1.4 Biological Hazards

Biological hazards entail exposure to contagious diseases and blood-borne infections, conjunctiva exposure, back pain, and fatigue (Henderson & Lewis, 2016; Mitchell, Maguire & Guidotti, 2016; Ramacciati et al., 2016; Patterson et al., 2018; Chen et al., 2019; Dropkin et al., 2019; Leszczyński et al., 2019; Misasi & Keebler, 2019; Beyramijam et al., 2020).

4.1.5 Psychological Aspects

Psychological hazards include work-related stress, workplace stress, traumatic experiences, and verbal abuse (Phillips, 2016; Lo et al., 2017; Moya, Carrasco & Hoz, 2017; Boujema et al., 2018; Chen et al., 2019; Kuek, 2019; Brice et al., 2019; World Health Organization, 2020).

4.2 Effect of Environmental Hazards on EMS Personnel

The scoping review also aimed at looking for information on the effect of the environmental hazards on EMS providers. From the study findings, it was established that more than three-quarters of the articles included in the review contained information on the effects (Boujema et al., 2018; Beyramijam et al., 2020; Howard et al., 2017; Brice et al., 2019; Juliá-Sanchis et al., 2019; Mitchell, Maguire & Guidotti, 2016; Oyegbile & Brysiewicz, 2020; Patterson et al., 2018; Pourshaikhian, 2016; Reuter-Oppermann, van den Berg & Vile, 2017; Moya, Carrasco & Hoz, 2017; Phillips, 2016; Carrasco & Hoz, 2017; Misasi & Keebler, 2019; Wimalaratne et al., 2017; Ramacciati et al., 2016; Berry & Perera, 2019; Reichard et al., 2017; Chen et al., 2019; Kuek, 2019; Chong, Henderson & Lewis, 2016; Maguire et al., 2018; Dropkin et al., 2019; Venesoja et al., 2020; Hughes et al., 2017; Shin & Lee, 2020). The major effects that were put forward include physical injuries, stress, low productivity, disabilities, morbidity, and mortality.

4.2.1 Physical Injuries

EMS providers experience various forms of injuries, including strains, sprains, musculoskeletal injuries, and wounds (Hughes et al., 2017; Maguire et al., 2018; Brice et al., 2019). These injuries are mainly due to excessive physical effort, repetitive movements, and awkward posture at work (Phillips, 2016; Hughes et al., 2017).

4.2.2 Low Productivity

EMS personnel get exposed to long working hours in busy environments (Chong, Henderson & Lewis, 2016; Dropkin et al., 2019). Many of them become less productive due to fatigue (Ramacciati et al., 2016; Shin & Lee, 2020).

4.2.3 Alcohol and Drug Use

Since EMS personnel work in a stressful environment most of the time, some resort to drug and alcohol abuse (Boujemaa et al., 2018; Oyegbile & Brysiewicz, 2020). These substances tend to have a negative impact on their health (Mitchell, Maguire & Guidotti, 2016; Venesoja et al., 2020).

4.2.4 Disabilities

Exposure to injuries causes disabilities among EMS providers (Pourshaikhian, 2016; Patterson et al., 2018; Juliá-Sanchis et al., 2019). Disabled providers find it difficult to cope with the demanding EMS environment (Carrasco & Hoz, 2017; Beyramijam et al., 2020).

4.2.5 Morbidity

EMS providers risk getting infected by contagious and infectious diseases (Moya, Carrasco & Hoz, 2017; Reuter-Oppermann, van den Berg & Vile, 2017). These include HIV/AIDS, and other blood-borne diseases (Howard et al., 2017; Juliá-Sanchis et al., 2019).

4.2.6 Mortality

Some EMS personnel end up losing their lives in the process of providing emergency services to patients (Kuek, 2019; Misasi & Keebler, 2019). These include those who sustain serious injuries (Wimalaratne et al., 2017; Berry & Perera, 2019).

4.3 How to Address the Environmental Hazards Facing EMS Personnel

The findings of the review also showed that the selected studies contained information about how the effects of environmental hazards can be addressed within the EMS context. Over half of the articles contained this information (Boujemaa et al., 2018; Brice et al., 2019; Dropkin et al., 2019; Juliá-Sanchis et al., 2019; Oyegbile & Brysiewicz, 2020; Shin & Lee, 2020; Patterson et al., 2018; Moya, Carrasco & Hoz, 2017; Venesoja et al., 2020; Pourshaikhian, 2016; Reuter-Oppermann, van den Berg & Vile, 2017; Mitchell, Maguire & Guidotti, 2016; Berry & Perera, 2019; Ramacciati et al., 2016; Phillips, 2016; Hughes et al., 2017; Howard et al., 2017). The remedies were dominated by strategies such as emergency response, emergency preparedness, prevention measures, and recovery measures.

4.3.1 Emergency Response

The environmental hazards that EMS workers face can be addressed through effective quick emergency response plans (Ramacciati et al., 2016; Howard et al., 2017). These may include accessing infrastructural damage, and containing all hazardous materials (Pourshaikhian, 2016; Moya, Carrasco & Hoz, 2017).

4.3.2 Emergency Preparedness

It is necessary to be prepared for emergencies (Howard et al., 2017; Oyegbile & Brysiewicz, 2020; Shin & Lee, 2020). This can be achieved by developing effective response plans, and strengthening disaster management policies (Reuter-Oppermann, van den Berg & Vile, 2017s; Juliá-Sanchis et al., 2019).

4.3.3 Prevention Measures

There is need to put in place functional prevention measures (Mitchell, Maguire & Guidotti, 2016; Boujemaa et al., 2018; Dropkin et al., 2019). These include creating community awareness, issuing early warning signs, and constructing disaster-prone kind of health facilities (Berry & Perera, 2019; Brice et al., 2019).

4.3.4 Recovery Measures

EMS environmental hazards can also be curbed through recovery measures (Phillips, 2016; Patterson et al., 2018). These include reconstructing resilient sanitation and water infrastructure (Hughes et al., 2017).

4.4 Study Limitations

The review has some limitations. Most studies on environmental hazards that EMS healthcare providers have to deal with mainly report physical hazards such as motor vehicle crashes, and injuries. This demonstrates biases in reporting other events such as near-miss events that are usually underreported. The review is also limited by the fact that some of the relevant studies included could not be completely retrieved. They contained titles and abstracts only. The researcher found it difficult to access the information contained in such articles. There is as well the limitation of excluding studies not published in the English language. Through this publication bias, the researcher was likely to miss important and relevant information published in other languages.

5. Conclusion and Recommendation

This scoping review was conducted to identify relevant articles containing information on environmental hazards within the EMS settings, their effects on healthcare providers, and how possible to curb them. From the findings of the study, it was established that healthcare workers who give out EMS are threatened by physical hazards, accident hazards, psychological hazards, chemical hazards, and biological hazards. These hazards result in stress, injuries, morbidity, disabilities, and other effects. The environmental hazards can be addressed by putting in place appropriate emergency preparedness plans, and emergency response strategies.

EMS policymakers can use the information provided by the review to advocate for a modified scope of practice that is appropriate to different groups of EMS personnel. The undertaking will help to ensure that these healthcare providers are protected against potential environmental hazards that are likely to interfere with their work. The information can also be used to improve the quality of emergency services to ensure that the patient is well protected against the hazards.

While this review of the literature yielded important research data, it is clear that it only addresses the plight of healthcare workers in the EMS setting. Yet the environmental hazards that threaten care in this setting affect not only healthcare providers but also patients. There is a need for more rigorous research that covers both the service providers and users. It is also important for future researchers to apply the existing healthcare worker safety knowledge from other medical fields in the EMS. This can help to generate a new understanding of how to deal with the safety of healthcare workers in this setting.

References

- [1] Berry, L., & Perera, T. B. (2019). *EMS, Hazardous Waste Response*. In StatPearls [Internet]. StatPearls Publishing.
- [2] Beyramijam, M., Khankeh, H. R., Farrokhi, M., Ebadi, A., Masoumi, G. & Aminizadeh, M. (2020). Disaster Preparedness among Emergency Medical Service Providers: A Systematic Review Protocol. *Emergency Medicine International*.
- [3] Boujemaa, R., Jebali, A., Hammami, S., Ruiz, A., & Bouchriha, H. (2018). A stochastic approach for designing two-tiered emergency medical service systems. *Flexible Services and Manufacturing Journal*, 30(1-2), 123-152.
- [4] Brice, J. H., Cyr, J. M., Hnat, A. T., Wei, T. L., Principe, S., Thead, S. E., ... & Forrest, E. E. (2019). Assessment of Key Health and Wellness Indicators Among North Carolina Emergency Medical Service Providers. *Prehospital Emergency Care*, 23(2), 179-186.
- [5] Chen, X. Q., Liu, Z. F., Zhong, S. K., Niu, X. T., Huang, Y. X., & Zhang, L. L. (2019). Factors influencing the emergency medical service response time for cardiovascular disease in Guangzhou, China. *Current medical science*, 39(3), 463-471.
- [6] Chong, K. C., Henderson, S. G., & Lewis, M. E. (2016). The vehicle mix decision in emergency medical service systems. *Manufacturing & Service Operations Management*, 18(3), 347-360.
- [7] Dropkin, J., Power, P., Rasul, R., Moline, J., & Kim, H. (2019). Effect of resiliency and age on musculoskeletal injuries and lost workdays in emergency medical service personnel. *International journal of industrial ergonomics*, 69, 184-193.
- [8] Gormley, M. A., Crowe, R. P., Bentley, M. A. & Levine R. (2016). A national description of violence toward emergency medical services personnel. *Prehosp Emerg Care*, 20 (4), 439-447.
- [9] Howard, I. L., Bowen, J. M., Al Shaikh, L. A. H., Mate, K. S., Owen, R. C., & Williams, D. M. (2017). Development of a trigger tool to identify adverse events and harm in emergency medical services. *Emergency Medicine Journal*, 34(6), 391-397.
- [10] Hughes, A. M., Patterson, P. D., Weaver, M. D., et al. (2017). Teammate familiarity, teamwork, and risk of workplace injury in emergency medical services teams. *J Emerg Nurs*, 43,339-346.
- [11] Juliá-Sanchis, R., Richart-Martínez, M., García-Aracil, N., José-Alcaide, L., Piquer-Donat, T., & Castejón-de-la-Encina, M. E. (2019). Measuring the levels of burnout syndrome and empathy of Spanish emergency medical service professionals. *Australasian emergency care*, 22(3), 193-199.
- [12] Kayano, R., Chan, E. Y., Murray, V., Abrahams, J., & Barber, S. L. (2019). WHO thematic platform for health emergency and disaster risk management research network (TPRN): Report of the Kobe expert meeting. *International journal of environmental research and public health*, 16(7), 1232.
- [13] Kuek, B. J., Li, H., Yap, S., Ng, M. X., Ng, Y. Y., White, A. E., & Ong, M. E. (2019). Characteristics of frequent users of emergency medical services in Singapore. *Prehospital Emergency Care*, 23(2), 215-224.
- [14] Leszczyński, P., Panczyk, M., Podgórski, M., Owczarek, K., Gałazkowski, R., Mikos, M., ... & Gotlib, J. (2019). Determinants of occupational burnout among employees of the Emergency Medical Services in Poland. *Annals of Agricultural and Environmental Medicine*, 26(1), 114-119.
- [15] Lo, S. T. T., Chan, Y.Y., Chan , G. K. W. et al. (2017). Health emergency and disaster risk management (health-EDRM): developing the research field within the Sendai framework paradigm. *International Journal of Disaster Risk Science*, 8 (2), 145-149.
- [16] Maguire, B. J. & O'Neill, B. J. (2017). Emergency Medical Service Personnel's Risk From Violence While Serving the Community. *Am J Public Health*, 107 (11): 1770-1775. doi: 10.2105/AJPH.2017.303989
- [17] Maguire, B. J., O'Meara, P., O'Neill, B. J., & Brightwell, R. (2018). Violence against emergency medical services personnel: a systematic review of the literature. *American journal of industrial medicine*, 61(2), 167-180.
- [18] Misasi, P., & Keebler, J. R. (2019). Medication safety in emergency medical services: approaching an evidence-based method of verification to reduce errors. *Therapeutic advances in drug safety*, 10, 2042098618821916.
- [19] Mitchell, C. S., Maguire, B. J. & Guidotti, T. L. (2016). Worker health and safety in disaster response. In: Ciottone G, editor. *Disaster Medicine*. Philadelphia, PA: Elsevier.
- [20] Moya, P. N., Carrasco, M. G., & Hoz, E. V. (2017). Psychosocial risk and protective factors for the health and well-being of professionals working in emergency and non-emergency medical transport services, identified via questionnaires. *Scandinavian Journal of Trauma, Resuscitation, and Emergency Medicine*, 25(1), 88.
- [21] Oyegbile, Y. & Brysiewicz, P. (2020). Measuring patient experience in the emergency department: A scoping review. *African Journal of Emergency Medicine*. DOI: 10.1016/j.afjem.2020.07.005
- [22] Patterson, P. D., Runyon, M. S., Higgins, J. S., Weaver, M. D., Teasley, E. M., Kroemer, A. J., ... & Bizhanova, Z. (2018). Shorter versus longer shift durations to mitigate fatigue and fatigue-related risks in emergency medical services personnel and related shift workers: a systematic review. *Prehospital Emergency Care*, 22(sup1), 28-36.

- [23] Phillips, J. P. (2016). Workplace violence against health care workers in the United States. *N Engl J Med.*, 374 (17), 1661–1669.
- [24] Pourshaikhian, M., Gorji, H. A., Aryankhesal, A., Khorasani-Zavareh, D., & Barati, A. (2016). A systematic literature review: workplace violence against emergency medical services personnel. *Archives of trauma research*, 5(1).
- [25] Ramacciati, N., Ceccagnoli, A., Addey, B., Lumini, E., & Rasero, L. (2016). Interventions to reduce the risk of violence toward emergency department staff: current approaches. *Open access emergency medicine: OAEM*, 8, 17.
- [26] Reichard, A. A., Marsh, S. M., Tonozzi, T. R., Konda, S., & Gormley, M. A. (2017). Occupational injuries and exposures among emergency medical services workers. *Prehospital emergency care*, 21(4), 420-431.
- [27] Reuter, E., & Camba, J. D. (2017). Understanding emergency workers' behavior and perspectives on design and safety in the workplace. *Applied Ergonomics*, 59, 73-83.
- [28] Reuter-Oppermann, M., van den Berg, P. L., & Vile, J. L. (2017). Logistics for emergency medical service systems. *Health Systems*, 6(3), 187-208.
- [29] Shin, K., & Lee, T. (2020). Emergency medical service resource allocation in a mass casualty incident by integrating patient prioritization and hospital selection problems. *IISE Transactions*, 1-15.
- [30] Taylor, J.A., Barnes, B., Davis, A. L., Wright, J., Widman, S. & LeVasseur, M. (2016). Expecting the unexpected: a mixed methods study of violence to EMS responders in an urban fire department. *Am J Ind Med.*, 59 (2), 150–163.
- [31] Venesoja, A., Castrén, M., Tella, S., & Lindström, V. (2020). Patients' perceptions of safety in emergency medical services: an interview study. *BMJ Open*, 10(10), e037488.
- [32] Wimalaratne, K., Lee, J. I., Lee, K. H., Lee, H. Y., Lee, J. H., & Kang, I. H. (2017). Emergency medical service systems in Sri Lanka: problems of the past, challenges of the future. *International journal of emergency medicine*, 10(1), 10.
- [33] World Health Organization. (2020). *Managing environmental health risks in emergencies*. Retrieved on November 12, 2020, from <https://www.who.int/activities/managing-environmental-health-risks-in-emergency>

serviceS [tiab] OR EMS [tiab] or emergency department [tiab] or emergency services [tiab].

Appendices

Appendix A: Search Strategy for PubMed

PubMed

Date searched: 13th November 2020

Records indentified: 10,232

'ENVIRONMENT'

#1 Environment [Mesh] OR environment [tiab] OR environmental [tiab]

'HAZARD'

#2 Hazard [tiab] OR hazards [tiab] OR risks [tiab] OR threats

'EMERGENCY MEDICAL SERVICE'

Emergency medical service [tiab] OR Emergency medical