Trauma Monthly 2020;25(5): 200-206
10.30491/TM.2020.233780.1130
Trauma Monthly
Original Article

Audit on in-Hospital Mortality of Trauma Patients: EMS Management and Mismanagement

Pir-Hossein Kolivand [1,2], Babak Mahshidfar [3,4], Peyman Saberian [1,5]*, Nader Tavakoli [3], Parisa Hasani-Sharamin [6], Atefeh Abdollahi[1,7]

[1] Prehospital and Hospital Emergency Research Center, Tehran University of Medical Sciences, Tehran, Iran
[2] Shefa Neuroscience Research Center, Khatam-al-Anbya Hospital, Tehran, Iran
[3] Trauma and Injury Research Center, Iran University of Medical Sciences, Tehran, Iran
[4] Department of Emergency Medicine, Rasool-e-Akram Hospital, Iran University of Medical Sciences, Tehran, Iran
[5] Anesthesiology Department, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran
[6] Tehran Emergency Medical Service Center, Tehran, Iran
[7]Department of Emergency Medicine, Sina Hospital, Tehran University of Medical Sciences, Tehran, Iran

*** Corresponding Author:** Peyman Saberian, Anesthesiology Department, Imam Khomeini Hospital Complex, Tehran, Iran.
Email: peymansaberian61@gmail.com

Received June 8, 2020; **Accepted** August 28, 2020; **Online Published** September 01, 2020

Abstract

Background: The investigation of trauma-related mortality is one of the key components in trauma studies and it is used as a performance index and measure of health care quality.

Objectives: The present study aimed to evaluate the performance of pre-hospital interventions and identify possible mismanagements in dealing with trauma patients transferred by emergency medical services (EMS) to the hospital and died.

Methods: This study was conducted in 2019, in Tehran, Iran. All trauma patients who were transferred to the emergency department (ED) of three main referral hospitals, by Tehran EMS and died at the hospital within 24 hours of admission, were studied retrospectively. The required information was collected from the EMS and the hospital records. A panel of experts was asked to identify possible errors based on standards for each patient.

Results: During the one-year study period, almost 14000 trauma patients were transported by Tehran EMS to the studied hospitals. Of them, a total of 197 deaths were recorded. The most and least provided services were breathing management (87.3%) and intravenous (IV) fluid therapy (12.2%), respectively. Needle thoracostomy, IV fluids therapy, life supports (basic and advanced cardiac), and airway management had the highest percentage of mismanagement among provided services. Bleeding control and resuscitation were consistent with the recommended standard.

Conclusion: In the current study, bleeding control and immobilization was performed appropriately. Needle tracheostomy was not performed at all. Airway management and life supports of the victims were not performed properly.

Keywords: Advanced Trauma Life Support Care, Emergency Medical Services, Death, Management Audit, Multiple Trauma.

Introduction

Trauma is one of the leading causes of mortality in the world, accounting for over five million deaths globally each year that most occur in young people. As a result, it causes a significant loss of productivity and serious social and economic damage to the family and society.[1,2] The investigation of trauma-related mortality is one of the key components in trauma studies and it is used as a performance index and measure of health care quality.[3-5] Statistical systems are often used to record the causes of trauma-related mortality and its changes over time, so trauma registry systems have been established in many countries in this regard.[6,7] However, most of these systems focus on in-hospital care and have generally overlooked the valuable information of the pre-hospital phase.[8,9] Although the pre-hospital emergency system in some countries are still used solely for the transfer of patients to medical centers. While in most parts of the world, numerous care at different levels are provided to trauma patients in the pre-hospital phase.[10] It is expected that as care becomes more accurate and faster in this phase, the rates of mortality and disability resulting from accidents are decreased.[11-13] However, the lack of practical data on the effectiveness of pre-hospital trauma interventions remains a serious problem and it seems necessary to evaluate the pre-hospital processes of traumatic patients' management based on standards.[14-16] In Iran, as in many countries, emergency medical services (EMS) is responsible for providing pre-hospital services to traumatic patients, and emergency medical technicians (EMTs) provide basic and advanced services at various levels for such

patients. In spite of all these actions, some patients die before or after reaching the hospital, which may be preventable in some instances and can be instructive in assessing the process of dealing with them. Despite of some published research on this topic in some parts of the world, to the best of our knowledge, no studies have been conducted on this issue in Iran.[17,18] Therefore, this study aimed to evaluate the performance of pre-hospital interventions and identify possible mismanagement cases in traumatic patients who were transferred by Tehran EMS to the hospital and died there.

Materials and Methods

Study setting

This audit was conducted during the year 2019 in Tehran, Iran. Census sampling was carried out retrospectively. All trauma patients who were transferred to the emergency department (ED) of Rasoul Akram, Haft-e-Tir and Firoozgar hospitals, Tehran, Iran by Tehran EMS from 1-1-2019 until 31-12-2019 and died after admission in the hospital, were studied. At scene deaths (those who not referred to the hospital) and cases with incomplete information were excluded from the study.

Data collection

A researcher-made checklist was used to gather the needed data. The required information was collected by reviewing the data available in both EMS and the hospital records of the patients. Pre-hospital data includes primary vital signs recorded at the scene and secondary vital signs if repeated, time of call with EMS dispatch, the arrival time of EMTs at the scene, time of leaving the scene by EMTs, arrival time of EMTs at the hospital, services provided by EMTs during the transfer, and results of the scene assessment. The services provided in the pre-hospital setting by EMT were categorized into airway management (basic and advanced), breathing management (oxygen therapy and ventilator-assisted or bag-valve-mask breathing), intravenous (IV) fluid therapy (the type of fluid used and its amount), bleeding control (direct pressure, compression bandage, and tourniquet), immobilization (head and neck immobilizing by a collar or hand, spine immobilization with immobilizing devices such as long backboard or Kendrick extrication device (KED), and limb immobilization), life supports (basic and advanced cardiac), and needle thoracostomy. Hospital data included vital signs recorded on the admission to the ED, diagnostic processes performed and results of clinical and paraclinical tests. The Mechanism-GCS-Age-Arterial Pressure (MGAP) score was also calculated according to the information recorded at the scene.

Definition

MGAP score was validated by Sartorius et al.[19] in 2010 as a simple prehospital triage score to predict the in-hospital mortality of trauma patients. Table-1 shows the details of MGAP score calculation in which based on this scoring system, patients receive a score between 3 and 29, and those with 3-17, 18-22 and 23-29 are categorized as high risk (>50%), medium risk (5-50%) and low risk (<5%), respectively.

Table-1. The details of MGAP score calculation

Variable	Score
Mechanism of injury (Blunt trauma vs. Penetrating trauma)	+4
Glasgow coma scale	3-15
Age <60 years	+5
Systolic blood pressure >120mmHg	+5
Systolic blood pressure 60-120mmHg	+3
Systolic blood pressure <60mmHg	0

Evaluating EMS management in dealing with traumatic patients

For this purpose, a panel of experts consisting of three emergency medicine specialists, one anesthesiologist, and two experienced EMTs was formed, while none of them were involved in providing patient care services. Based on "Guidelines for trauma quality improvement programs"[20] and the standards presented in the book entitled "PHTLS: Prehospital Trauma Life Support",[21] appropriate indicators of trauma patients management in the pre-hospital phase were extracted by the investigators.[22-24] In the panel's first session, the evaluation indicators were discussed and divided into two groups: "the errors related to time" and "management and performed intervention errors". In the following five sessions, all the registered information of the enrolled patients (vital signs, hospital diagnostic processes, and results of clinical and paraclinical tests) were provided to the panel members, and they were asked to identify possible errors for each patient. After reviewing the pre-hospital and hospital records of the case by the panel members, and

comparing the services performed with the standards, the deficiencies were identified in two formats including the cases who have not received the required services and are placed in the not-performed layer, and the cases who have received the service inadequately or incompletely and are placed in the inappropriate layer.

Data analysis

The recorded data were analyzed using IBM SPSS Statistics V21.0, at the 0.05 confidence interval. The percentage and mean were used for the expression of descriptive date. Moreover, for the inferential parts, the Chi-square and Fisher exact tests were used to determine the relationship between the variables.

Ethical consideration

Anonymous information was used to commit the confidentiality principle at all stages of this study. Required permission was obtained from the Ethics Committee of Iran University of Medical Sciences (Code: IR.IUMS.REC.1397.955) and Tehran EMS center.

Results

During the one-year study period, almost 13982 trauma patients were transported by Tehran EMS to the ED of the three studied hospitals. Of them, a total of 197 deaths were recorded. The mean age of the subjects was 45.15 years with a standard deviation of 21.27. Table-2 presents the baseline information of the patients. According to the results, most of the cases (86.8%) were male. Regarding the types of trauma, motor-vehicle-collisions (MVCs) with 152 (77.2%) cases were more common than other causes. Regarding the anatomical location of the trauma, spine had the highest frequency (57.4%). Based on the data recorded at the scene, the severity of trauma was calculated based on the MGAP score, and the high-risk group with 94 cases (47.8%) had the highest frequency.

Findings of the variable of vital signs in the pre-hospital phase and on admission to the ED are reported in Table-3. According to the findings, the mean of pulse rate and level of consciousness of the patients in the pre-hospital phase were significantly different from that of the time of admission in the ED.

Table-2. Baseline characteristics of study patients

Variable	Number (%)
Sex	
Male	171 (86.8)
Female	26 (13.2)
Type Trauma	
Motor vehicle collisions	152 (77.2)
Not Accident	45 (22.8)
Anatomy	
Head and neck	45 (22.8)
Spine	113 (57.4)
Chest	9 (4.6)
Abdomen	4 (2.0)
Upper limbs	10 (5.1)
Lower limbs	19 (9.6)
Pelvic	6 (3.0)
MGAP score	
High	94 (47.8)
Moderate	84 (42.6)
Low	19 (9.6)

Table-3. The mean±SD of patients' vital sign in prehospital and hospital phase

Vital sign	Pre hospital		Hospital		P-value
	mean	S.D	mean	S.D	
Pulse rate	88.69	20.33	81.8	23.43	0.01
Respiratory rate	16.76	5.15	16.82	5.21	0.41
Systolic blood pressure	108.75	22.04	107.89	29.3	0.75
Diastolic blood pressure	70.85	12.65	69.4	18.3	0.45
Glasgow coma scale	10.12	4.56	5.93	3.47	<0.001

Table-4 presents the services provided by EMTs and detected mismanagement. Overall, the most and least services provided by the EMTs were breathing management (87.3%) and IV fluid therapy (12.2%), respectively. Needle thoracostomy, although required, was not performed at all. Needle thoracostomy and intravenous fluid therapy in the not-performed layer, and also life supports and airway management in the inappropriate layer, had the highest

percentage of errors among services provided by the EMTs in dealing with the studied trauma patients. On the other hand, bleeding control, immobilization and breathing management were the most appropriate provided services, which were consistent with the standards.

The duration from call time to the arrival time at the patient's location (response time) in 26 critical cases (13.2%) and the duration from arrival time at the scene to leaving the scene time (scene time) in 22 critical cases (11.2%) were more than 10 min, and the duration from the call time to delivering the patient to the hospital time (total time) was more than 1 hour in 25 cases (12.7%). Response time in noncritical cases was more than 20 min in 19 cases (9.6%). Table-5 shows the relationship between the inappropriate taken interventions with the MGAP score of the study patients. According to the results, the inappropriateness of interventions according to the MGAP score was different. This differences was more observed in the airway and breathing control, IV fluid therapy, which the response time and scene time in critical cases were more than 10 min ($p<0.05$). Most of them were found in the high-risk group: Twenty-one out of 30 (70%) cases of inappropriate IV fluid therapy, 16 out of total 25 (64.0%) cases of inappropriate breathing management were in the high-risk group. Twenty out of 33 (60.6%) cases of airway management were also included. Twenty-one out of 26 (80.8%) critical cases for response time more than 10 min and 18 out of 22 (81.8%) critical cases were scene time more than 10 min.

Table-4. Frequency of management and mismanagement performed by EMTs dealing with study trauma patients

Intervention	Performed		Not-performed	Total required
	Appropriate	Inappropriate		
			Number (%)	
Airway management	52 (61.2)	17 (20.0)	16 (18.8)	85 (100.0)
Breathing management	153 (85.9)	19 (10.7)	6 (3.4)	178 (100.0)
External bleeding control	107 (97.3)	0 (0.0)	3 (2.7)	110 (100.0)
Intravenous fluid therapy	19 (35.2)	5 (9.3)	30 (55.5)	54 (100.0)
Immobilization	161 (92.0)	10 (5.7)	4 (2.3)	175 (100.0)
Cardiopulmonary resuscitation	30 (73.2)	11 (26.8)	0 (0.0)	41 (100.0)
Needle thoracostomy	0 (0.0)	0 (0.0)	9 (100.0)	9 (100.0)

Discussion

In the present study, among the 197 cases of trauma-related deaths registered in hospitals that their pre-hospital procedures were reviewed by an expert panel, 68 required interventions were not performed, and 62 required interventions were performed inappropriately. Most failures were related to essential interventions in IV fluid therapy and airway control, respectively. The most inappropriate performance was related to the essential interventions in breathing and airway control, respectively. In contrast, it is worth noting that most of the necessary interventions in controlling external bleeding and immobilization were appropriately conducted.

Previous studies have shown that most errors in dealing with preventable trauma death in the pre-hospital phase are primarily attributed to delayed treatment, followed by management and medication errors.[25] In this study, according to the defined standards, 13.2% of the response time and 11.2% of the scene time, and 12.7% of the total time in critical cases had a delay. However, the role of time should be examined from several aspects because interventions are generally time-consuming and may inevitably be interpreted as "delays". In contrast, rushing to the hospital for injuries may be accompanied by a failure to perform or impair pre-hospital care.

Airway and breathing management are among the most common errors reported in trauma patients. According to the previous studies, 66-85% of the preventable deaths are caused by airway obstruction, which may be prevented by interventions in pre-hospital care.[26] In our study, there were medication errors in the airway management of 33 cases (16.75%). Although basic airway interventions such as maneuvers and bag-valve-mask with oxygen therapy are often performed for most patients with airway disorders, in some patients, basic interventions may be inadequate, and hence the advanced airway management is necessary before being transferred to another hospital.[27,28]

Table 5. The relationship between the inappropriate interventions taken with the MGAP score

Intervention	inappropriateness	MGAP score			Total	P value
		High	Moderate	Low		
Airway management	Yes	20 (60.6)	10 (30.3)	3 (9.1)	33	0.24
	No	74 (45.1)	74 (45.1)	16 (9.8)	164	
Breathing management	Yes	16 (64.0)	7 (28.0)	2 (8.0)	25	0.21
	No	78 (45.3)	77 (44.8)	17 (9.9)	172	
Intravenous fluid	Yes	23 (65.7)	8 (22.9)	4 (11.4)	35	0.031
	No	71 (43.8)	76 (46.9)	15 (9.3)	162	
External bleeding	Yes	2 (66.7)	0 (0.0)	1 (33.3)	3	0.14*
	No	92 (47.4)	84 (43.3)	18 (9.3)	194	
Immobilization	Yes	6 (42.9)	7 (50.0)	1 (7.1)	14	0.83
	No	88 (48.1)	77 (42.1)	18 (9.8)	183	
Cardiopulmonary resuscitation	Yes	9 (81.8)	1 (9.1)	1 (9.1)	11	0.042*
	No	85 (45.7)	83 (44.6)	18 (9.7)	186	
Needle thoracostomy	Yes	6 (66.7)	3 (33.3)	0 (0.0)	9	0.52*
	No	88 (46.8)	81 (43.0)	19 (10.2)	188	
Response time in critical cases > 10 min	Yes	21 (80.8)	2 (7.7)	3 (11.5)	26	<0.001
	No	73 (42.7)	82 (48.0)	16 (9.3)	171	
Response time in non-critical cases > 20 min	Yes	8 (42.1)	9 (47.4)	2 (10.5)	19	0.87
	No	86 (48.3)	75 (42.1)	17 (9.6)	178	
Scene time in critical cases > 10 min	Yes	18 (81.8)	4 (18.2)	0 (0.0)	22	0.003
	No	76 (43.4)	80 (45.7)	19 (10.9)	175	
Total time > 60 min	Yes	8 (32.0)	14 (56.0)	3 (12.0)	25	0.24
	No	86 (50.0)	70 (40.7)	16 (9.3)	172	

* Exact Fisher test

Inappropriate IV fluid therapy is one of the major errors in the pre-hospital phase of dealing with traumatic patients, which was observed in 17.76% of cases in the current study. Making decisions in the pre-hospital setting is crucial for IV fluid therapy. In hypotensive traumatic victims, IV fluid administration in the pre-hospital phase has been associated with the reduced probability of shock in ED, and IV fluid is recommended to maintain a patient's blood pressure of approximately 80 mmHg.[23,24,29-31] Moreover, bleeding control is one of the most common errors in pre-hospital care of trauma patients.[24,32] This error was only observed in 2.7% of the studied cases in the present study (it was not done only in 3 cases), and the EMT prioritizes patient transfer to the hospital, and due to the limited number of technicians, airway management was preferred.

In order to improve the quality of trauma care, it is essential to investigate clinical errors in dealing with injuries. Because these experiences can distinguish preventable deaths and decrease mortality rates in future similar cases.[24,33-35] In this regard, in the current study, we tried to take action on these issues. Our study showed that the quality of pre-hospital emergency services in dealing with trauma cases varied in different aspects. Basic interventions to manage traumatic injuries such as bleeding control and immobilization were appropriately performed in the pre-hospital setting. However, in some cases requiring more advanced interventions such as needle tracheostomy or airway management of a traumatic patient (which is often difficult), the interventions were inappropriate, and hence advanced skill training is necessary. One of the reasons for not doing advanced interventions may be legal issues. In some ambulances, the absence of a paramedic and EMT-Intermediate technician is an obstacle to perform advanced interventions, such as endotracheal intubation or finding the central venous line for IV fluid therapy in a patient with a shock that finding peripheral veins is impossible. On the other hand, the association of error with high-risk patients indicates that the greater number of required interventions and the more severe injury can result in a higher rate of errors. Another reason may be attributed to the limited

number of ambulance staff that missions are carried out by two EMTs, and hence performing all interventions is impossible. Therefore, the EMTs have to prioritize and select.

It is expected that the results of this study be useful in solving the existing problems by the relevant organization. In this regard, it is better to classify the mismanagements. In our point of view, there were two distinct categories of mismanagements including those who need advanced interventions that EMTs were not trained for them; so proper workshop or training course are required to be considered for this purpose. The other category of mismanagements is related to carelessness and individual mistakes. In these cases, the relevant EMT must be called for obtaining additional explanations, and his mistakes should be noted.

Some previous studies have distinguished preventable deaths based on the findings of panel experts and autopsy results. Therefore, it seems that the lack of autopsy results is one of the limitations mentioned in the present study. Also, our study did not investigate the out-of-hospital trauma-related deaths due to the inaccessibility of relevant information. Given that the study design was retrospective and based on registered data, there was the likelihood of missing data. Those items that had not been recorded were considered as no intervention. The provided emergency care, the total number of transferred traumatic patients, and the mortality rate in each hospital were not assessed separately in the current study, which could be an important confiding factor.

Conclusions

In the current study, bleeding control and immobilization were performed appropriately. In contrast, the procedure of needle tracheostomy was not performed at all, and interventions related to the airway management and life supports of the victims were not performed properly. IV fluid therapy was the most not-performed required intervention.

Acknowledgments

We would like to express our obligations to the Pre-hospital and Hospital Emergency Research Center affiliated to Tehran University of Medical Sciences.

Authors' Contribution

The conception and design of the work by PHK, PS, BM, and NT; Data acquisition by PHS and AA; Analysis and interpretation of data by PS, PHS, and AA; Drafting the work by PHS, BM and AA; Revising it critically for important intellectual content by PHK, PS and NT; All the authors approved the final version to be published; AND agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work.

Conflict of Interests

The authors declared no potential conflict of interests with respect to the research, authorship, and/or publication of this article.

Funding/Support

This study was funded with a grant from Tehran EMS Center.

References

1. Rahmati F, Doosti M, Bahreini M. The cost analysis of patients with traffic traumatic injuries presenting to emergency department; a cross-sectional study. Adv J Emerg Med. 2019;3(1):e2.
2. Baratloo A, Mirbaha S, Bahreini M, Banaie M, Safaie A. Outcome of trauma patients admitted to emergency department based on full outline of unresponsiveness score. Adv J Emerg Med. 2017;1(1):e2.
3. Teixeira PG, Inaba K, Hadjizacharia P, Brown C, Salim A, Rhee P, et al. Preventable or potentially preventable mortality at a mature trauma center. Journal of Trauma and Acute Care Surgery. 2007;63(6):1338-47. doi:10.1097/TA.0b013e31815078ae
4. Oliver GJ, Walter DP. A call for consensus on methodology and terminology to improve comparability in the study of preventable prehospital trauma deaths: a systematic literature review. Academic emergency medicine. 2016;23(4):503-10. doi:10.1111/acem.12932
5. Saberian P, Farhoud AR, Hasani-Sharamin P, Moghaddami M, Keshvari F. Epidemiological Features of Injured Patients Examined by Tehran Emergency Medical Service Technicians. Adv J Emerg Med. 2019;3(4):e40-e.
6. Gabbe BJ, Lyons RA, Fitzgerald MC, Judson R, Richardson J, Cameron PA. Reduced population burden of road transport-related major trauma after introduction of an inclusive trauma system. Annals of surgery. 2015;261(3):565. doi:10.1097/SLA.0000000000000522
7. Cameron PA, Gabbe BJ, Cooper DJ, Walker T, Judson R, McNeil J. A statewide system of trauma care in Victoria: effect on patient survival. Medical Journal of Australia. 2008;189(10):546-50. doi:10.5694/j.1326-5377.2008.tb02176.x
8. Beck B, Smith K, Mercier E, Cameron P. Clinical review of prehospital trauma deaths-The missing piece of the puzzle. Injury. 2017;48(5):971-2. doi:10.1016/j.injury.2017.02.024
9. Ackland HM, Pilcher DV, Roodenburg OS, McLellan SA, Cameron PA, Cooper DJ. Danger at every rung: epidemiology and outcomes of ICU-admitted ladder-related trauma. Injury. 2016;47(5):1109-17. doi:10.1016/j.injury.2015.12.016
10. Sohimi MB, Abbas WFB, editors. The prioritization factors of Enterprise Application Integration (EAI) adoption in Malaysian e-Government. 2011 International Conference on Research and Innovation in Information Systems; 2011: IEEE.
11. Mock C, Joshipura M, Arreola-Risa C, Quansah R. An estimate of the number of lives that could be saved through improvements in trauma care globally. World J Surg. 2012;36(5):959-63. doi:10.1007/s00268-012-1459-6

12. Henry JA, Reingold AL. Prehospital trauma systems reduce mortality in developing countries: a systematic review and meta-analysis. Journal of Trauma and Acute Care Surgery. 2012;73(1):261-8. doi:10.1097/TA.0b013e31824bde1e
13. Babu BV, Viswanathan K, Ramesh A, Gupta A, Tiwari S, Palatty BU, et al. An interventional study on comprehensive emergency care and trauma registry for road traffic injuries in India: a protocol. Adv J Emerg Med. 2019;3(4):e50.
14. Varghese M, Sasser S, Kellermann A, Lormand J. Organization WH. Prehospital trauma care systems: Geneva: World Health Organization. 2005.
15. Hysong SJ, Smitham K, SoRelle R, Amspoker A, Hughes AM, Haidet P. Mental models of audit and feedback in primary care settings. Implementation Science. 2018;13(1):73. doi:10.1186/s13012-018-0764-3
16. Heydari F, Maghami M-H, Esmailian M, Zamani M. The Effect of Implementation of the Standard Clinical Practice Guideline (CPG) for Management of Multiple Trauma Patients Admitted to an Emergency Department. Adv J Emerg Med. 2017;2(1):e5.
17. Eftekhari A, DehghaniTafti A, Nasiriani K, Hajimaghsoudi M, Fallahzadeh H, Khorasani-Zavareh D. Management of Preventable Deaths due to Road Traffic Injuries in Prehospital Phase; a Qualitative Study. Arch Acad Emerg Med. 2019;7(1):32-.
18. Zhang G-X, Chen K-J, Zhu H-T, Lin A-L, Liu Z-H, Liu L-C, et al. Preventable Deaths in Multiple Trauma Patients: The Importance of Auditing and Continuous Quality Improvement. World J Surg. 2020;44(6):1835-43. doi:10.1007/s00268-020-05423-3
19. Sartorius D, Le Manach Y, David J, Rancurel E, Smail N, Thicoпpй M, et al. Mechanism, glasgow coma scale, age, and arterial pressure (MGAP): a new simple prehospital triage score to predict mortality in trauma patients. Critical care medicine. 2010; 38(3):831-7. doi:10.1097/CCM.0b013e3181cc4a67
20. Organization WH. Guidelines for trauma quality improvement programmes: World Health Organization; 2009.
21. (NAEMT) NAoEMT. PHTLS: Prehospital Trauma Life Support. 8 ed: Jones & Bartlett Learning; 2014.
22. Geeraedts Jr L, Pothof L, Caldwell E, de Lange-de Klerk E, D'Amours S. Prehospital fluid resuscitation in hypotensive trauma patients: do we need a tailored approach? Injury. 2015;46(1):4. doi:10.1016/j.injury.2014.08.001
23. Sapsford W. Should the 'C'in 'ABCDE'be altered to reflect the trend towards hypotensive resuscitation? Scandinavian Journal of Surgery. 2008;97(1):4-11. doi:10.1177/145749690809700102
24. Schoeneberg C, Schilling M, Keitel J, Kauther M, Burggraf M, Hussmann B, et al. Traumanetzwerk, TraumaRegister der DGU®, WeiЯbuch, S3-Leitlinie Polytrauma-ein Versuch der Validierung durch eine retrospektive Analyse von 2304 Patienten (2002-2011) an einem ьberregionalen (Level 1) Traumazentrum. Zentralblatt fьr Chirurgie-Zeitschrift fьr Allgemeine, Viszeral-, Thorax-und GefдЯchirurgie. 2017;142(02):199-208. doi:10.1055/s-0033-1360225
25. Pfeifer R, Halvachizadeh S, Schick S, Sprengel K, Jensen KO, Teuben M, et al. Are Pre-hospital Trauma Deaths Preventable? A Systematic Literature Review. World J Surg. 2019;43(10):2438-46. doi:10.1007/s00268-019-05056-1
26. Christensen EF, Deakin CD, Vilke GM, Lippert FK. Prehospital care and trauma systems. Trauma: CRC Press; 2007. p. 43-58. doi:10.1201/b16040-4
27. Lockey D, Healey B, Crewdson K, Chalk G, Weaver A, Davies G. Advanced airway management is necessary in prehospital trauma patients. British journal of anaesthesia. 2015;114(4):657-62. doi:10.1093/bja/aeu412
28. Sise MJ, Shackford SR, Sise CB, Sack DI, Paci GM, Yale RS, et al. Early intubation in the management of trauma patients: indications and outcomes in 1,000 consecutive patients. Journal of Trauma and Acute Care Surgery. 2009;66(1):32-40. doi:10.1097/TA.0b013e318191bb0c
29. Alimohammadi H, Kianian Y, Zerepoosh FB, Derakhshanfar H, Alavi-Moghadam M, Hatamabadi HR, et al. Accuracy of emergency transfusion score in prediction need for blood transfusion among multiple trauma patients: A cross-sectional study from Iran. International Journal of Critical Illness and Injury Science. 2017;7(4):248. doi:10.4103/IJCIIS.IJCIIS_118_16
30. Hussmann B, Lefering R, Waydhas C, Touma A, Kauther MD, Ruchholtz S, et al. Does increased prehospital replacement volume lead to a poor clinical course and an increased mortality? A matched-pair analysis of 1896 patients of the Trauma Registry of the German Society for Trauma Surgery who were managed by an emergency doctor at the accident site. Injury. 2013;44(5):611-7. doi:10.1016/j.injury.2012.02.004
31. Haut ER, Kalish BT, Cotton BA, Efron DT, Haider AH, Stevens KA, et al. Prehospital intravenous fluid administration is associated with higher mortality in trauma patients: a National Trauma Data Bank analysis. Annals of surgery. 2011;253(2):371-7. doi:10.1097/SLA.0b013e318207c24f
32. Kleber C, Giesecke M, Tsokos M, Haas N, Buschmann C. Trauma-related preventable deaths in Berlin 2010: need to change prehospital management strategies and trauma management education. World J Surg. 2013;37(5):1154-61. doi:10.1007/s00268-013-1964-2
33. Deasy C, Cronin M, Cahill F, Geary U, Houlihan P, Woodford M, et al. Implementing major trauma audit in Ireland. Injury. 2016;47(1):166-72. doi:10.1016/j.injury.2015.07.016
34. Bradley NL, Au S, Widder S. Quality Improvement and Trauma Quality Indicators. Trauma Team Dynamics: Springer; 2016. p. 67-72. doi:10.1007/978-3-319-16586-8_11
35. Lashoher A, Schneider EB, Juillard C, Stevens K, Colantuoni E, Berry WR, et al. Implementation of the World Health Organization Trauma Care Checklist Program in 11 centers across multiple economic strata: effect on care process measures. World J Surg. 2017;41(4):954-62. doi:10.1007/s00268-016-3759-8