Australian Journal of Advanced Nursing 39(2) • 2020.392.505

Management of bleeding in trauma victims by Portuguese nurses in prehospital setting

AUTHORS

MAURO AL MOTA PhD, RN[1,2,3,4,5]
MARGARIDA REIS SANTOS PhD, RN[6,7]
EDUARDO JF SANTOS PhD, RN[2,3]
ANDREA FIGUEIREDO MSN, RN[5]
FILIPE MELO MSN, RN[5,8,9]
SARA ALBUQUERQUE MSc, MD[10]
MADALENA CUNHA PhD, RN[2,3]

1. Abel Salazar Institute of Biomedical Sciences, University of Porto, Porto, Portugal
2. Health School of the Polytechnic Institute of Viseu, Portugal
3. Health Sciences Research Unit: Nursing (UICISA: E), Nursing School of Coimbra (ESEnfC), Portugal
4. Hospital Nossa Senhora da Assunção, Local Health Unit of Guarda, Seia, Portugal
5. INEM – National Institute of Medical Emergency. Portugal
6. Nursing School of Porto, Porto, Portugal
7. CINTESIS – Center for Health Technology and Services Research, University of Porto, Porto, Portugal
8. Hospital de Faro. University Hospital Center of Algarve. Faro, Portugal
9. ABC – Algarve Biomedical Centre. Faro, Portugal
10. Group of Health Centers – Greater Porto VII – Gaia, USF Nova Salus, Gaia, Portugal

CORRESPONDING AUTHOR

MAURO AL MOTA Health School of the Polytechnic Institute of Viseu, 3500-843 Viseu, Portugal.
Email: maurolopesmota@gmail.com

ABSTRACT

Introduction: External bleeding is the leading preventable cause of death from traumatic injuries. Implementation of guidelines for its control have been associated with a significant reduction in mortality. The objectives of this study were to provide a characterisation of trauma patients with external bleeding and to compare the outcomes from specific autonomous interventions applied by nurses in prehospital care.

Methods: A non-randomised prospective study was conducted in the Immediate Life Support Ambulances in Portugal, from 1 March 2019 to 30 April 2020. Patients were divided into two groups according to whether external bleeding was controlled or not on their arrival at the emergency room.

Results: A total of 189 patients were included in this study (73.0% men; mean age of 53.6 years). Among these patients, 140 (74.1%) had their external bleeding controlled by prehospital nurse's intervention. The average time of assistance at the incident site was 31.5 min. Patients with uncontrolled bleeding had a higher average rescue time (30.8 ±15.2 vs 33.7 ±13.0). Cryotherapy was administered to 15.9% of all patients and 93.3% of these patients arrived at the emergency room with controlled bleeding (p=0.01).

Discussion: Despite the substantial reduction in the number of patients who keep bleeding after prehospital care, it was observed that one fifth of patients have external bleeding on arrival at the emergency room. Cryotherapy has been shown to be effective in controlling external bleeding. Failure to use haemostatic agents may explain the ineffective control of more complex external bleeding.

Contribution to Emergency Nursing Practice: The current literature on management of bleeding in trauma patients is scarce and contradictory, especially in terms of interventions provided by

 https://doi.org/10.37464/2020.392.505

prehospital teams led by a registered nurse. In addition, interventions vary from country to country.

This article increases awareness of autonomous interventions implemented by prehospital nurses to manage external bleeding.

Key implications for emergency nursing practice identified in this study suggest greater fluid therapy appears harmful while cryotherapy achieved the best results (control of the bleeding on emergency room arrival). This may contribute to the review of institutional algorithms and training in this area.

Keywords: Trauma; Patient Care Team; Prehospital Care; Haemorrhage; Nursing.

INTRODUCTION

Severe trauma is an international primary cause of death, with more than five million worldwide deaths each year.[1] Bleeding is the leading preventable cause of death from trauma injuries.[2,3] The implementation of specific guidelines to control external bleeding has been associated with a significant reduction in the number of deaths.[4]

The treatment of internal and external bleeding depends on the use of more specialised medical equipment.[5] To achieve a rapid surgical intervention to control bleeding, a short scene time, rapid response and rapid application of control methods provided by the prehospital services is required.[6] Interventions often used to control external bleeding may involve simple methods such as direct pressure, elevation of the injured area or cryotherapy (which decreases mucosal blood flow and helps haemostasis),[7] but also complex ones such as haemostatic dressings (contain agents to improve blood clotting),[8] or torniquet (a "life-saving" intervention).[9]

An essential task carried out by the rescue team is to minimise intervention and transportation time until the final and definitive treatment is administered.[10] The prehospital period is defined as the time elapsed between the injury and the admission to the emergency room. Out-of-hospital scene times greater than or equal to 20 minutes are associated with higher odds of mortality in patients with penetrating traumatic injuries, and it is for this reason that it is recommended that minimal time be spent in the out-of-hospital setting, allowing only essential procedures to be performed.[11] Therefore a systematic assessment, targeted hemodynamic management and rapid transportation to a trauma centre is crutial.[12] Therefore, it is essential to implement a model of trauma care delivery based on solid evidence-based principles within the healthcare system that are applied in all phases of care delivery.[13]

Prehospital nurses play an essential role, as they are responsible for the initial resuscitation, management and prevention of further bleeding and the avoidance of hypoxemia. Further, their care model includes diagnosis, monitoring and immediate bleeding control. Additionally, they are also responsible for further investigation of any unidentified source of bleeding, restricted volume replacement, and core temperature control.[14] However, these interventions are still understudied in the prehospital setting.[15]

STUDY OBJECTIVES

The objectives of this study were to: (1) characterise trauma patients with external bleeding, who are managed in the prehospital environment by a team composed of a registered nurse (leader) and an emergency technician; and (2) to evaluate the factors associated with the effectiveness of interventions applied by nurses to patients with external bleeding.

METHODS

This study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[16]

STUDY DESIGN

This was a non-randomised prospective study, conducted in Portugal. Data were prospectively collected from 1 March 2019 to 30 April 2020.

SETTING

The study was conducted in all (n=41) Immediate Life Support Ambulances (ASIV) operating in mainland Portugal. National Institute of Medical Emergency (INEM) is responsible for the coordination of the Integrated Medical Emergency System in mainland Portugal, providing prehospital emergency care to trauma victims and acute medical patients. INEM´s ambulances are able to provide assistance in place and during transport to the emergency room. There are two types of ambulances, basic life support ambulances, with a team of two emergency technicians and ASIV, with a team of nurse (team leader) and emergency technician.

PARTICIPANTS

Since we included the entire accessible population during a given time period, without specific sampling criteria, the study used convenience sampling. The sample included all trauma patients who fulfilled the following inclusion criteria: aged 18 years or older; with (suspected) injuries from blunt, penetrating, or blast mechanisms and; with active external bleeding. Patients were excluded if they show (suspected) injuries from heat or cold.

VARIABLES

The following clinical characteristics of the patients were collected by the registered nurses: day and time of incident, age, gender, physical location of trauma, type of trauma, mechanism of trauma, scene time, transportation time, vital signs, Shock Index (SI), Revised Trauma Score (RTS) and type of interventions implemented. External bleeding treatment implemented by ASIV nurses followed INEM institutional algorithms. INEM supervises all prehospital practices in Portugal. Interventions administered included: rewarming measures, immobilisation, elevation of the injured area, oxygen therapy, fluid therapy and hands-on therapies such as direct pressure, pressure/wound dressings, and cryotherapy. Cryotherapy involves the application of a cold substance, such as ice, on the skin, which promotes immediate vasoconstriction, reducing vascular spasms and slowing blood flow.[17]

DATA SOURCES

A data collection tool (Prehospital Rescued Victim's Clinical File) specifically designed by researchers for this purpose was used in order to describe the hemodynamic status of the trauma patients rescued, the interventions implemented, the time elapsed during the rescue and the time elapsed between the moment they left the incident site and the arrival at the reference emergency room. Prior to its application and to ensure data consistency, the principal investigator conducted specific training for all ASIV nurses so that they could fill in the questionnaire with information about the treatment given to trauma patients.

STATISTICAL METHODS

Continuous variables included mean and standard deviations (SD) while categorical variables included frequencies and percentages. To compare demographic data, clinical characteristics, and interventions employed by burses to control active bleeding, we used the McNemar test (paired nominal data – to compare results with similar injuries with and without bleedin g control), Student's t-test (continuous variables) and the χ^2 test or Fisher's exact test (categorical variables).[18] All interventions administered to control bleeding were included in stepwise multivariate logistic regression (Forward Conditional analysis), with bleeding controlled on arrival at the emergency room as a dependent variable. Previously, all assumptions (normality, multicollinearity, among others) were met. A 2-sided $p<0.05$ was considered statistically significant. All analyses were performed using SPSS statistical software- version 23.0 (IBM Corp).

ETHICAL CONSIDERATIONS

This study was approved by INEM as part of the project "Evidências para Não Arriscar MaisVidas: do pré-hospitalar ao serviço de urgência e a alta (MaisVidas)", with the reference: PROJ/UniCISE /2017/000.1 Additionally, the study received ethical approval from the Tondela Viseu Hospital Centre Ethics Committees. The exemption from the obligation to obtain the consent of patients was granted.

RESULTS

A total of 627 trauma patients were rescued by ASIV teams in Portugal during the period it took to conduct this study. However, only 189 (30.1%) trauma patients met the inclusion criteria, 19 patients were excluded because they died before arriving at the emergency room and 419 patients because they showed no active external bleeding. The patients were mostly men (73.0%; n=138) with a mean age of 53.6 (±19.1) years. 74.1% (n=140) of trauma patients arrived at the emergency room unit with controlled bleeding ($p<0.001$). Trauma patients with active external bleeding, on arrival at the emergency room, were slightly older than those with bleeding controlled (56.5±20.6 vs 52.6±19.1), however the difference was not statistically significant. The most frequent type of trauma with external bleeding was blunt force trauma (53.4%; n=101), followed by penetrating trauma (36.0%; n=68). External bleeding in blunt trauma was controlled in 49.3% (n=69) of the patients, whereas in cases involving penetrating trauma, external bleeding control was achieved in 37.1% (n=52) of the cases ($p<0.05$). As for the physical location of trauma, cranioencephalic trauma was the most common (56.6%; n=107), followed by lower limb trauma (46.0%; n=87). The average time it took the teams to provide assistance at the incident site was longer for patients whose bleeding was not controlled, with a higher mean value of approximately three minutes; however, it was observed that transport to the reference emergency room unit took longer for patients with controlled external bleeding. It was also noted that trauma situations were more common in autumn and summer, however, there was no relationship between seasons and the control of external bleeding (Table 1).

Patients with uncontrolled external bleeding, after the intervention of ASIV teams, show higher mean values of respiratory rate than patients with controlled external bleeding (18.27±4.2 vs 17.12±2.62; $p<0.05$). The initial mean systolic blood pressure, respiratory rate, and heart rate of patients with external bleeding and without active external

TABLE 1: DIFFERENCES IN DEMOGRAPHIC AND CLINICAL CHARACTERISTICS BETWEEN PATIENTS WITH CONTROLLED AND ACTIVE BLEEDING ON ARRIVAL AT THE EMERGENCY ROOM (N=189)

	Active bleeding before the ASIV nurses' intervention	Controlled bleeding on arrival at the emergency room	Active bleeding on arrival at the emergency room	p[a]
n (%)	189 (100)	140 (74.1)	49 (25.9)	<0.001[b]
Age, years	53.6 (19.5)	52.6 (19.1)	56.5 (20.6)	0.48
Gender, n (%)				
Male	138 (73)	101 (72.1)	37 (75.5)	0.64
Female	51 (27)	39 (27.9)	12 (24.5)	
Season, n (%)				
Winter	33 (17.5)	26 (18.6)	7 (14.3)	0.79
Spring	32 (16.9)	22 (15.7)	10 (20.4)	
Summer	62 (32.8)	47 (33.6)	15 (30.6)	
Autumn	62 (32.8)	45 (32.1)	17 (34.7)	
Location of trauma, n (%)				
Cranioencephalic	107 (56.6)	77 (55)	30 (61.2)	0.44
Neck	33 (17.5)	28 (20)	5 (10.2)	0.12
Thoracic	44 (23.3)	37 (26.4)	7 (14.3)	0.08
Abdominal	32 (16.9)	24 (17.1)	8 (16.3)	0.89
Pelvic	30 (15.9)	20 (14.3)	10 (20.4)	0.31
Upper limbs	67 (35.4)	54 (38.6)	13 (26.5)	0.12
Lower limbs	87 (46)	64 (45.7)	23 (46.9)	0.88
Spinal-cord	41 (21.7)	32 (22.9)	9 (18.4)	0.51
Type of trauma, n (%)				
Blunt	101 (53.4)	69 (49.3)	32 (65.3)	0.03[b]
Penetrating	68 (36)	52 (37.1)	16 (32.7)	
Blunt and penetrating	20 (10.6)	19 (13.6)	1 (2.0)	
On-site rescue elapsed time, minutes	31.5 (14.6)	30.7 (15.1)	33.7 (13.0)	0.49
Transportation time from incident site to emergency room, minutes	40 (25.3)	40.8 (25.6)	37.8 (24.3)	0.08
Vital parameters				
Initial Systolic Blood Pressure, mmHg	131.9 (27.5)	129.9 (27.2)	137.1 (27.6)	0.11
Final systolic blood pressure, mmHg	130.5 (22.6)	129 (22.6)	133.8 (21.5)	0.20
Initial respiratory rate	18.8 (3.5)	18.7 (3.5)	19.2 (3.3)	0.44
Final respiratory rate	17.3 (3.1)	17.1 (2.6)	18.2 (4.2)	0.02[b]
Initial heart rate	85.6 (17.1)	84.8 (16.0)	87.2 (19.6)	0.38
Final heart rate	82.2 (15.0)	81.3 (14.0)	83.9 (17.7)	0.35
Initial axillary temperature	36 (0.6)	36 (0.6)	36.0 (0.5)	0.87
Final axillary temperature	36 (0.4)	36.1 (0.4)	36.0 (0.3)	0.11
Initial Oxygen Saturation	97 (2.9)	97.1 (2.8)	96.9 (3.0)	0.60
Final Oxygen Saturation	98 (2.1)	97.4 (8.5)	97.6 (3.1)	0.83
Severity indices				
MGAP	23.7 (3.4)	23.6 (3.5)	24.3 (3.2)	0.23
Initial Shock Index	0.6 (0.1)	0.6 (0.1)	0.6 (0.1)	0.83
Final Shock Index	0.6 (0.1)	0.6 (0.1)	0.6 (0.1)	0.96
Initial Revised Trauma Score	7.6 (0.5)	7.6 (0.5)	7.6 (0.4)	0.54
Final Revised Trauma Score	7.7 (0.4)	7.6 (0.5)	7.7 (0.4)	0.86

[a] p values indicate differences between patients with controlled and active bleeding on arrival at the emergency room based on the results of a McNemar test, Student's t-test, χ^2 test, or Fisher exact test.

[b] Statistically significant.

MGAP (Mechanism, Glasgow coma scale, Age, and arterial Pressure)

TABLE 2: DIFFERENCES IN INTERVENTIONS IN PATIENTS WITH CONTROLLED AND ACTIVE BLEEDING ON ARRIVAL AT THE EMERGENCY ROOM (N=189)

	Active bleeding before the ASIV nurses' intervention n=189	Controlled bleeding on arrival at the emergency room n=140	Active bleeding on arrival at the emergency room n=49	p[a]
Rewarming measures, n (%)	157 (83.1)	119 (85.0)	38 (77.6)	0.34
Removing wet clothes	39 (20.6)	29 (20.7)	10 (20.4)	0.96
Drying the patient's body	26 (13.8)	18 (12.9)	8 (16.3)	0.54
Isothermal blanket	122 (64.6)	90 (64.3)	32 (65.3)	0.89
Blankets	26 (13.8)	20 (14.3)	6 (12.2)	0.72
Increasing ambient temperature	100 (52.9)	73 (52.1)	27 (55.1)	0.72
Heating pads	3 (1.6)	3 (2.1)	0 (0.0)	0.56
Warmed intravenous fluid	56 (29.6)	39 (27.9)	17 (34.7)	0.36
Immobilisation, n (%)	150 (79.4)	110 (78.6)	40 (81.6)	0.64
Elevation of the injured area, n (%)	18 (9.5)	13 (9.3)	5 (2.6) 10.2)	0.85
Oxygen therapy, n (%)	70 (37)	50 (35.7)	20 (40.8)	0.52
Volume of fluid therapy, n (%)				
0 ml	29 (15.3)	24 (17.1)	5 (10.2)	0.55
1 to 500 ml	106 (56.1)	79 (56.4)	27 (55.1)	
501 to 1000 ml	39 (20.6)	27 (19.3)	12 (24.5)	
1001 to 1500 ml	13 (6.9)	9 (6.4)	4 (8.2)	
1501to 2000 ml	2 (1.1)	1 (0.7)	1 (2.0)	
Physical measurements, n (%)				
Direct pressure	39 (20.6)	33 (23.6)	6 (12.2)	0.09
Wound dressing	91 (48.1)	70 (50.0)	21 (42.9)	0.38
Cryotherapy	30 (15.9)	28 (20.0)	2 (4.1)	0.01[b]

[a] p values indicate differences between patients with controlled and active bleeding on arrival at the emergency room according to the results of a χ^2 test, or Fisher exact test.

[b] Statistically significant.

bleeding tend to decrease after the nurses' intervention, and the SpO2 values increase in both groups of patients.

Based on the interventions administered to all trauma patients, the differences between patients with controlled and active bleeding on arrival in the emergency room are shown in Table 2.

The data show a significant association between cryotherapy and external bleeding control. Cryotherapy was administered to 15.9% (n=30) of the patients. 93.3% (n=28) of them arrived at the emergency room with controlled bleeding (p=0.01). This trend was also reinforced by the multivariate analysis which included all the interventions implemented and found that only cryotherapy was associated with bleeding control (p=0.02) (Table 3). According to this model, cryotherapy alone is responsible for an explained percentage of variance of 73.9%.

TABLE 3: ODDS RATIO FOR BLEEDING CONTROL IN PATIENTS WITH TRAUMA BASED ON CRYOTHERAPY INTERVENTION (N=189)

	OR	95% CI	p
Cryotherapy	5.93	1.35-25.90	0.02

OR: Odds Ratio; CI: confidence interval; p: statistically significant.

DISCUSSION

Among the 189 cases included in this prospective study, one fifth was still experiencing severe bleeding when they got to the emergency room. The interventions that were most frequently administered were rewarming measures (83.0%) (especially the use of isothermal blanket and increasing ambient temperature) and immobilisation (80.0%). Oxygen therapy and elevation of the injured area were also applied, as was warm fluid therapy. None of these measures revealed statistically significant differences for the two groups of patients, i.e., with controlled versus non-controlled bleeding on arrival at the emergency room. Physical interventions were also applied, namely wound dressing (48.0%), direct pressure (21.0%) and cryotherapy (16.0%). This last measure proved to be the only therapy with statistical significance, both in univariate and multivariate analyses. Patients who underwent cryotherapy were almost six times more likely to arrive at the emergency room with bleeding under control. Even so, it was found that cryotherapy was administered to only 16% of victims. Its application may not always be affordable or easy to implement in trauma victims, which may explain its reduced use as a bleeding control measure. Cryotherapy is a safe, non-invasive procedure,[19] although

supervision by healthcare professionals is required to avoid unnecessary skin damage.[20]

Age and gender were statistically similar between the two groups, and so were the values of systolic blood pressure, heart rate, MGAP and shock index. These results support the evidence found by other studies that point to the fact that vital signs are poor indicators of physiological compromise,[21-23] even though traditional vital signs (systolic blood pressure, heart rate and respiratory rate) are commonly highly valued during the initial evaluation of traumatised patients.[24,25] However, this study shows that there have been significant differences in respiratory rate, between patients with and without controlled bleeding, which may indicate an important relationship between hemodynamic compromise and the respiratory rate in patients whose bleeding has not yet been controlled. Understanding altered initial physiological outcomes may prove useful to predict outcome in trauma patients.[26]

The significant reduction in the number of patients with active external bleeding (74.1%, n=140; p<0.001) seems to demonstrate that the management of bleeding as a whole is more consistent than the sum of all available interventions. This is because the inability to demonstrate the effectiveness of each intervention contrasts with the overall capacity of all interventions to reduce the number of bleeding patients. It is the set of interventions that seems to improve this clinical condition and not the implementation of an isolated measure.[27] This research has shown that cryotherapy has contributed significantly to the control of bleeding and its use is associated with a decrease in the number of patients with active external bleeding. Despite the results observed with the application of cryotherapy to trauma patients, it is not possible to find evidence that prove its clinical efficacy.[28] This study obtained important results regarding to this measure, but more methodologically robust studies, such as clinical trials are needed to assess the risks, benefits and feasibility of cryotherapy as an intervention used by nurses in the pre-hospital setting to control bleeding. Although cryotherapy is the only statistically significant one, we should point out that direct pressure, although not significant, seems to be a simple, easy, immediate intervention with good results in controlling external bleeding.

It is important to recognise that not all the haemostatic options used for this purpose are available in ASIV in Portugal. This is the case, for instance, of haemostatic dressings, haemostatic agents, or anti-haemorrhagic pharmacological options like tranexamic acid, an important and recommended pharmacological option to control bleeding.[14, 29] Several studies have demonstrated the effectiveness of haemostatic dressings,[30-32] and haemostatic agents,[33, 34] in controlling bleeding. Other studies have also shown that direct compression itself increases its effectiveness when associated with topical haemostatic agents.[4] The use of tourniquets is also indicated in the control of uncontrolled external limb bleeding.[28] This measure is available in ASIV ambulances in Portugal, but this intervention wasn't used by nurses in any situation in our research (data not shown), even though almost half of the patients with active bleeding on arrival at the emergency room had experienced lower limb trauma injuries and one fourth of the patients experienced the same sort of trauma in the upper limbs. There have been concerns that the effectiveness of the tourniquet obtained in military settings may not be directly extrapolated to civilian patients due to differences in the pattern and severity of the injuries.[35] The existing civilian experience with tourniquet use has not been systematically assessed,[36,37] so it is important to understand whether the rescue teams have adequate training and experience in the application of turnstiles, and if this limitation may explain the difficulty in implementing this technique.

Rescue time management remains a critical variable that should be considered during prehospital assistance.[14,38] Surgical intervention is the necessary and definitive treatment for patients with uncontrolled bleeding trauma but is only available in trauma centers.[39] Therefore, prehospital care should consider not only the administration of the necessary interventions, but also the management of the assistance time itself.[14,28] Many factors affect prehospital transport time, like the distance from a trauma centre and specific patient-related factors.[39] We believe that the timely management of interventions can increase the patients' probability of survival, however, this research was unable to find results to assess this phenomenon. On the other hand, it was observed that patients with uncontrolled external bleeding on arrival at the emergency room have an average rescue time at the incident site of approximately 33.7 minutes, three minutes more than patients with controlled bleeding. Other studies have shown a mean response time of less than 20 min.[39,40] They also proved that every additional minute in prehospital scene time independently correlates with a 1% increase in mortality.[39]

Trauma models are currently used by different countries to provide pre-hospital professionals with decision support during field triage. These models seek to outline the best methodology to be used to improve clinical decisions.[41] In addition, a multidisciplinary approach with clinical guidelines can ensure a uniform standard of care and thus improve outcomes for the patient with severe bleeding trauma.[14] Therefore, we believe that a model of trauma care adjusted to the pre-hospital reality can support providers not only in triage decisions, but also in clinical decision making to improve patient outcomes, particularly in bleeding control.

LIMITATIONS

Our study has some limitations. First, the number of events with confirmed active external bleeding was relatively low, despite the inclusion of a high number of trauma patients (608), which did not allow for more consistent conclusions. This lack of homogeneity may have affected the power of the statistical tests. Second, the impossibility to assess all the means usually used for active external bleeding control in trauma victims, since the ASIV in Portugal are not equipped with all the anti-haemorrhagic devices that are available in other contexts and countries. Finally, the conclusions of this investigation should be interpreted considering the outcomes found at emergency room arrival. More solid conclusions could be achieved using intra-hospital results.

IMPLICATIONS FOR EMERGENCY NURSING

The management of external bleeding is a priority in prehospital care for trauma patients. This study suggests that nurses should consider the following options in their clinical practice: (1) higher respiratory rate values seem to be an important predictor of hemodynamic instability resulting from uncontrolled active external bleeding; (2) cryotherapy has been proven to be successful in controlling external bleeding; (3) overall success may be explained with the concerted implementation of several types of interventions, and not with the isolated administration of specific interventions; (4) Haemostatic options should become part of the ASIV's protocols in the future. The approach to trauma patients remains controversial, so the rescue of each patient should depend on the articulation between the assessment of available evidence and the type of treatment available in each rescue ambulance.

CONCLUSION

This study shows that a significant number of patients continue to arrive at the emergency room with active external bleeding. More complicated haemorrhages require more effective interventions, so providing ambulances with more differentiated pharmacological and non-pharmacological options is a priority. Cryotherapy has been associated with high control of external bleeding, so evaluating its effectiveness in new investigations is also a priority.

Conflicts of interest: The authors have nothing to disclose.

Acknowledgments: The authors gratefully acknowledge the support of the Health Sciences Research Unit: Nursing (UICISA: E), hosted by the Nursing School of Coimbra (ESEnfC) and funded by the Foundation for Science and Technology (FCT). Furthermore, we would like to thank the Instituto Politécnico de Viseu for their support.

REFERENCES

1. Naghavi M, Abajobir AA, Abbafati C, Abbas KM, Abd-Allah F, Abera SF, et al. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet*. 2017;390(10100):1151-210. Available from: https://doi.org/10.1016/S0140-6736(17)32152-9.
2. Davenport RA, Guerreiro M, Frith D, Rourke C, Platton S, Cohen M, et al. Activated Protein C drives the hyperfibrinolysis of acute traumatic coagulopathy. *Anesthesiology*. 2017;126(1):115-27. Available from: https://doi.org/10.1097/ALN.0000000000001428.
3. Gurney D. Emerging trauma trends: where is your practice? *J Emerg Nurs*. 2018;44(3):305-7. Available from: https://doi.org/10.1016/j.jen.2018.01.020.
4. Bulger EM, Snyder D, Schoelles K, Gotschall C, Dawson D, Lang E, et al. An evidence-based prehospital guideline for external hemorrhage control: american college of surgeons committee on trauma. *Prehosp Emerg Care*. 2014;18(2):163-73. Available from: https://doi.org/10.3109/10903127.2014.896962.
5. Gaston E, Fraser JF, Xu ZP, Ta HT. Nano- and micro-materials in the treatment of internal bleeding and uncontrolled hemorrhage. *Nanomedicine*. 2018;14(2):507-19. Available from: https://doi.org/10.1016/j.nano.2017.11.007.
6. Seamon MJ, Fisher CA, Gaughan J, Lloyd M, Bradley KM, Santora TA, et al. Prehospital procedures before emergency department thoracotomy: "scoop and run" saves lives. *J Trauma*. 2007;63(1):113-20. Available from: https://doi.org/10.1097/TA.0b013e31806842a1.
7. Berry D, Carlson JN, Singletary E, Zideman DA, Ring J. Use of cryotherapy for managing epistaxis in the first aid setting: a scoping review. *Cureus*. 2021;13(5):e14832. Available from: https://doi.org/10.7759/cureus.14832.
8. Boulton AJ, Lewis CT, Naumann DN, Midwinter MJ. Prehospital haemostatic dressings for trauma: a systematic review. *Emerg Med J*. 2018;35(7):449-57. Available from: https://doi.org/10.1136/emermed-2018-207523.
9. Kragh JF Jr, Walters TJ, Baer DG, Fox CJ, Wade CE, Salinas J, et al. Survival with emergency tourniquet use to stop bleeding in major limb trauma. *Ann Surg*. 2009;249(1):1-7. Available from: https://doi.org/10.1097/SLA.0b013e31818842ba.
10. Tiel Groenestege-Kreb D, van Maarseveen O, Leenen L. Trauma team. *Br J Anaesth*. 2014;113(2):258-65. Available from: https://doi.org/10.1093/bja/aeu236.
11. McCoy CE, Menchine M, Sampson S, Anderson C, Kahn C. Emergency medical services out-of-hospital scene and transport times and their association with mortality in trauma patients presenting to an urban Level I trauma center. *Ann Emerg Med*. 2013;61(2):167-74. Available from: https://doi.org/10.1016/j.annemergmed.2012.08.026.
12. Eastridge BJ, Hardin M, Cantrell J, Oetjen-Gerdes L, Zubko T, Mallak C, et al. Died of wounds on the battlefield: causation and implications for improving combat casualty care. *J Trauma*. 2011;71(1 Suppl):S4-8. Avalable from: https://doi.org/10.1097/TA.0b013e318221147b.
13. Moore K. Injury prevention and trauma mortality. *J Emerg Nurs*. 2016;42(5):457-8. Available from: https://doi.org/10.1016/j.jen.2016.06.015.
14. Spahn DR, Bouillon B, Cerny V, Duranteau J, Filipescu D, Hunt BJ, et al. The European guideline on management of major bleeding and coagulopathy following trauma: fifth edition. *Crit Care*. 2019;23(1):98. Available from: https://doi.org/10.1186/s13054-019-2347-3.

15. Eastridge BJ, Holcomb JB, Shackelford S. Outcomes of traumatic hemorrhagic shock and the epidemiology of preventable death from injury. *Transfusion*. 2019;59(S2):1423-8. Available from: https://doi.org/10.1111/trf.15161.
16. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP, et al. Strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *BMJ*. 2007;335(7624):806-8. Available from: https://doi.org/10.1136/bmj.39335.541782.AD.
17. Thacoor A, Sandiford NA. Cryotherapy following total knee arthroplasty: what is the evidence? *J Orthop Surg*. 2019;27(1):2309499019832752. Available from: https://doi.org/10.1177/2309499019832752.
18. du Prel JB, Rohrig B, Hommel G, Blettner M. Choosing statistical tests: part 12 of a series on evaluation of scientific publications. *Dtsch Arztebl Int*. 2010;107(19):343-8. Available from: https://doi.org/10.3238/arztebl.2010.0343.
19. El-Deen DS, Youssef NFA. The effect of cryotherapy application before versus after subcutaneous anticoagulant injection on pain intensity and hematoma formation: a quasi-experimental design. *Int J Nurs Sci*. 2018;5(3):223-9. Available from: https://doi.org/10.1016/j.ijnss.2018.07.006.
20. Walczuk I, Eertmans F, Rossel B, Cegielska A, Stockfleth E, Antunes A, et al. Efficacy and safety of three cryotherapy devices for wart treatment: a randomized, controlled, investigator-blinded, comparative study. *Dermatol Ther* (Heidelb). 2018;8(2):203-16. Available from: https://doi.org/10.1007/s13555-017-0210-5.
21. Johnson MC, Alarhayem A, Convertino V, Carter R 3rd, Chung K, Stewart R, et al. Compensatory reserve index: performance of a novel monitoring technology to identify the bleeding trauma patient. *Shock*. 2018;49(3):295-300. Available from: https://doi.org/10.1097/SHK.0000000000000959.
22. Nadler R, Convertino VA, Gendler S, Lending G, Lipsky AM, Cardin S, et al. The value of noninvasive measurement of the compensatory reserve index in monitoring and triage of patients experiencing minimal blood loss. *Shock*. 2014;42(2):93-8. Available from: https://doi.org/10.1097/SHK.0000000000000178.
23. Fligor SC, Hamill ME, Love KM, Collier BR, Lollar D, Bradburn EH. Vital signs strongly predict massive transfusion need in geriatric trauma patients. *Am Surg*. 2016;82(7):632-6.
24. Bruijns SR, Guly HR, Bouamra O, Lecky F, Wallis LA. The value of the difference between ED and prehospital vital signs in predicting outcome in trauma. *Emerg Med J*. 2014;31(7):579-82. Available from: https://doi.org/10.1136/emermed-2012-202271.
25. Bruijns SR, Guly HR, Bouamra O, Lecky F, Lee WA. The value of traditional vital signs, shock index, and age-based markers in predicting trauma mortality. *J Trauma Acute Care Surg*. 2013;74(6):1432-7. Available from: https://doi.org/10.1097/TA.0b013e31829246c7.
26. Bhandarkar P, Munivenkatappa A, Roy N, Kumar V, Samudrala VD, Kamble J, et al. On-admission blood pressure and pulse rate in trauma patients and their correlation with mortality: cushing's phenomenon revisited. *Int J Crit Illn Inj Sci*. 2017;7(1):14-7. Available from: https://doi.org/10.4103/2229-5151.201950.
27. Josse F, Stohr A, Lechner R, Helm M, Hossfeld B. Prehospital strategies to stop the bleeding. *Anasthesiol Intensiv med Notfallmed Schmerzther*. 2020;55(10):603-19. Available from: https://doi.org/10.1055/a-0967-1586.
28. Charlton NP, Swain JM, Brozek JL, Ludwikowska M, Singletary E, Zideman D, et al. Control of severe, life-threatening external bleeding in the out-of-hospital setting: a systematic review. *Prehosp Emerg Care*. 2020:1-33. Available from: https://doi.org/10.1080/10903127.2020.1743801.
29. Ramirez RJ, Spinella PC, Bochicchio GV. Tranexamic acid update in trauma. *Crit Care Clin*. 2017;33(1):85-99. Available from: https://doi.org/10.1016/j.ccc.2016.08.004.
30. Singletary EM, Charlton NP, Epstein JL, Ferguson JD, Jensen JL, MacPherson AI, et al. Part 15: First Aid: 2015 American Heart Association and American Red Cross guidelines update for first aid. *Circulation*. 2015;132(18 Suppl 2):S574-89. Available from: https://doi.org/10.1161/CIR.0000000000000269.
31. Zideman DA, De Buck ED, Singletary EM, Cassan P, Chalkias AF, Evans TR, et al. European resuscitation council guidelines for resuscitation 2015 Section 9. First aid. *Resuscitation*. 2015;95:278-87. Available from: https://doi.org/10.1016/j.resuscitation.2015.07.031.
32. Hatamabadi HR, Asayesh Zarchi F, Kariman H, Arhami Dolatabadi A, Tabatabaey A, Amini A. Celox-coated gauze for the treatment of civilian penetrating trauma: a randomized clinical trial. *Trauma Mon*. 2015;20(1):e23862. Available from: https://doi.org/10.5812/traumamon.23862.
33. Schauer SG, April MD, Naylor JF, Maddry JK, Arana AA, Dubick MA, et al. Prehospital application of hemostatic agents in Iraq and Afghanistan. *Prehosp Emerg Care*. 2018;22(5):614-23. Available from: https://doi.org/10.1080/10903127.2017.1423140.
34. Grissom TE, Fang R. Topical hemostatic agents and dressings in the prehospital setting. *Curr Opin Anaesthesiol*. 2015;28(2):210-6. Available from: https://doi.org/10.1097/ACO.0000000000000166.
35. Schroll R, Smith A, McSwain NE Jr, Myers J, Rocchi K, Inaba K, et al. A multi-institutional analysis of prehospital tourniquet use. *J Trauma Acute Care Surg*. 2015;79(1):10-4. Available from: https://doi.org/10.1097/TA.0000000000000689.
36. Kauvar DS, Dubick MA, Walters TJ, Kragh JF Jr. Systematic review of prehospital tourniquet use in civilian limb trauma. *J Trauma Acute Care Surg*. 2018;84(5):819-25. Available from: https://doi.org/10.1097/TA.0000000000001826.
37. Duignan KM, Lamb LC, DiFiori MM, Quinlavin J, Feeney JM. Tourniquet use in the prehospital setting: are they being used appropriately? *Am J Disaster Med*. 2018;13(1):37-43. Available from: https://doi.org/10.5055/ajdm.2018.0286.
38. Hargestam M, Lindkvist M, Jacobsson M, Brulin C, Hultin M. Trauma teams and time to early management during in situ trauma team training. *BMJ Open*. 2016;6(1):e009911. Available from: https://doi.org/10.1136/bmjopen-2015-009911.
39. Nasser AAH, Nederpelt C, El Hechi M, Mendoza A, Saillant N, Fagenholz P, et al. Every minute counts: the impact of pre-hospital response time and scene time on mortality of penetrating trauma patients. *Am J Surg*. 2020;220(1):240-4. Available from: https://doi.org/10.1016/j.amjsurg.2019.11.018.
40. Mahama MN, Kenu E, Bandoh DA, Zakariah AN. Emergency response time and pre-hospital trauma survival rate of the national ambulance service, Greater Accra (January – December 2014). *BMC Emerg Med*. 2018;18(1):33. Available from: https://doi.org/10.1186/s12873-018-0184-3.
41. van der Sluijs R, Debray TPA, Poeze M, Leenen LPH, van Heijl M. Development and validation of a novel prediction model to identify patients in need of specialized trauma care during field triage: design and rationale of the GOAT study. *Diagn Progn Res*. 2019;3:12. Available from: https://doi.org/10.1186/s41512-019-0058-5.