Observational Study

Medicine®

OPEN

Revision of the medicolegal assessment criteria in hypovolemic patients

İsmail Özgür Can, MD[a,*], Murat Köker, MD[b], Dilek Solmaz, MD[c], Uğur Kavaklı, MD[a], Başak Bayram, MD[d], Gökmen Karabağ, MD[a], Ümit Ünüvar, MD[e], Yücel Arısoy, MD[a], Erdem Özkara, MD[a]

Abstract

Trauma scoring systems are often used for the determination of the severity level of the lesion and the clinical status in medico-legal assessment of the trauma patient. Trauma scoring systems are used also for the determination of the life-threatening conditions. Blood loss of more than 20% was reported as the only criterion for life-threatening conditions in the acute hypovolemia. The objective of this study was to revise the medico-legal assessment criteria in the patients with acute hypovolemia and to discuss other parameters, which might be used in the determination of the severity level of the clinical status.

The medical reports of the patients with acute hypovolemia due to the trauma, which were sent by the judicial authorities and by other departments of our medical faculty to the department of the forensic medicine between 1999 and 2009, were evaluated. The characteristics such as age, gender, severity of the injury, type of the trauma, history of liquid replacement or blood transfusion, vital signs, type of the physical injury, injured region of the body, presence of any chronic disease were assessed and recorded.

The mean age of the included 155 patients was 34.70 ± 16.08 years (3-87 years). 118 (76%) of patients were males and 37 females (24%). Regarding the event types, road accidents were the most common cause (60.0%) and it was followed by sharp object injuries (18.7%) and firearm injuries (11.6%). 27.7% of the subjects received 2 units blood and blood products transfusion and 21.3% only 1 unit transfusion. According to the results of the medico-legal assessment, 84.5% of the patients had life-threatening conditions.

While evaluating the severity of the clinical conditions in the hypovolemic patients, to report only the losses in percentage causes problems and limitations. Therefore, in respect of the medico-legal assessment of the hypovolemic patients, we believe that it would be more appropriate to use the physiological trauma scoring systems (like Revised Trauma Score) instead of the anatomic scoring systems.

Abbreviations: AIS = Abbreviated Injury Scale, CRAMS = field triage of trauma victims, GCS = Glasgow Coma Scale, ISS = Injury Severity Scale, NISS = New Injury Severity Scale, RTS = Revised Trauma Score, TS = trauma score, TRISS = Trauma Score and Injury Severity Score, TCK = Turkish Penal Code.

Keywords: anatomic scoring scale, hypovolemia, medico-legal assessment, physiological scoring scales, transfusions

1. Introduction

The following scoring systems are used for the determination of the severity of the lesions and clinical status in the trauma patients: Glasgow Coma Scale (GCS), Abbreviated Injury Scale (AIS), trauma score (TS), Revised Trauma Score (RTS), Injury Severity Scale (ISS), New Injury Severity Scale (NISS).[1–6]

In our country, the basic criterion used for the preparation of the medico-legal opinion in forensic patients is the AIS, which is one of the anatomical scoring systems.[2] According to the Turkish Penal Code (TCK), the guideline used for the evaluation of the forensic patients was adapted from AIS. In this guideline, the trauma patients are evaluated as follows:[7]

- Mild injuries (AIS score 1): injuries, which can be treated with simple medical interventions.
- Moderate injuries (AIS score 2): injuries, which cannot be treated with simple medical interventions.
- Other injuries (AIS score 3–6): life-threatening injuries.

As mentioned in TCK, for the determination of the severity of the lesion/clinical status, the severity of the injury (mild, life-threatening, bone fracture) should be reported.[7]

The scoring system for the traumas enables the usage of a common language for the trauma classification, convenience in the transport and triage of the patients and determination of the mortality and morbidity rates due to the trauma.[6,8]

There are anatomical severity scales, which are based on the evaluation of the anatomical regions; physiological severity scales, which are based on the physiological parameters and combined severity scales.[6,8]

1.1. Physiological trauma scales

Consider parameters like heart rate, blood pressure, respiration rate and quality, state of consciousness, body temperature, which are also known as vital signs.[6,8] The most common

Editor: Oguzhan Ekizoglu.

The authors have no conflicts of interest to disclose.

[a] Dokuz Eylül Üniversitesi Tıp Fakültesi, Adli Tıp Anabilim Dalı, [b] İzmir Adli Tıp Kurumu, [c] Katip Çelebi Üniversitesi Tıp Fakültesi, Dahiliye Kliniği, [d] Dokuz Eylül Üniversitesi Tıp Fakültesi, Acil Tıp Anabilim Dalı, İzmir, [e] Mugla Üniversitesi Tıp Fakültesi, Adli Tıp Anabilim Dalı, İstanbul, Turkey.

[*] Correspondence: İsmail Özgür Can, Dokuz Eylul University Faculty of Medicine, Department of Forensic Medicine, Turkey (e-mail: drforensicozgur@gmail.com).

Copyright © 2019 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial License 4.0 (CCBY-NC), where it is permissible to download, share, remix, transform, and buildup the work provided it is properly cited. The work cannot be used commercially without permission from the journal.

Medicine (2019) 98:11(e14799)

Received: 18 November 2018 / Received in final form: 13 February 2019 / Accepted: 14 February 2019

http://dx.doi.org/10.1097/MD.0000000000014799

physiological scoring systems are GCS, TS, RTS, and field triage of trauma victims (CRAMS).[1,3,4,9,10] While GCS is focused on the motor responses to the stimulations, verbal responses, and eye-opening responses, TS evaluates, in addition, systemic blood pressure and respiration rate. RTS includes the parameters, which are revised due to routinely encountered problems. CRAMS takes circulation, respiration, abdomen, motor response and speech into consideration.[8–10]

1.2. Anatomical trauma scoring systems

Determine the severity of the trauma according to the anatomical localization of the injuries.[6,8] AIS, ISS, NISS are among the anatomical scoring systems.[2–5] For the evaluation of the injuries with the anatomical scoring system, the cooperation of the patient is required. However, cooperation cannot be obtained in cranial traumas and alcohol/drug abusers. In penetrating injuries, the depth of the penetration and the damage in the visceral organs cannot be determined with the physical examination. Therefore, it was reported that the anatomical scoring systems were not reliable for trauma triage. It was emphasized that the anatomical scoring systems were usable after the hospital data were collected and advanced investigations are performed.[6,8]

1.3. Combined Trauma Scales

Were developed for the patients, who had the same anatomical and physiological TSs and they take both of the systems into account to determine the prognosis.[6,8] It was reported that the age of the patients affected the prognosis and the mortality and the morbidity rates were much higher in older patients than the younger patients. Trauma Score and Injury Severity Score (TRISS) is a scoring system prepared with the addition of the age and injuring factor (blunt–penetrating) to ISS and RTS.[6,11] A severity characterization of trauma (ASCOT) was developed to increase the accuracy rate of the survival probability and to eliminate the limitations of TRISS.[11–13]

The life-threatening conditions due to the trauma are one of the important issues in the medico-legal assessment of the trauma patients. One of these life-threatening conditions is the hypovolemia.[14,15]

Acute blood loss is one of the most important causes of the mortality and morbidity. It was reported that the type of the injury, vital signs, base deficit, and oxygenation should be taken into the consideration during the management of these patients. The effects of the hypovolemia on the systems, its risks, and irreversible damages are important for the medico-legal assessment along with the clinical diagnosis process.[16,17]

There are several clinical sources regarding the approach to the hypovolemic patients. As the clinical status became persistent in many patients after the trauma, the medico-legal problems came into prominence. The life-threatening characteristics of the different hypovolemia groups are still under discussion in respect of the medico-legal assessment.

According to the guideline of the TCK prepared for the judicial reports, blood loss more than 20% is considered as a life-threatening condition.[7] However, the guideline does not describe the characteristics of this clinical condition. It is not clear; whether it is affected by the individual features and which clinical parameters (hemoglobin, hematocrit, arterial blood pressure, etc) should be taken into the consideration.

In the hypovolemic patients, the concept of the life-threatening condition should be based on objective criteria and measurable and comparable criteria should be determined for the evaluation of the severity of the trauma and the emerging injury.

In this study, the objective was to revise the criteria, which can be used for the medico-legal assessment of the patients with acute hypovolemia and to discuss the parameters, which can be used for the determination of the severity level of the clinical status. Hereby, we discussed the hypovolemic shock and the circulatory shock with its etiology in respect of the medico-legal assessment.

2. Materials and methods

2.1. Study group

This study had an observational and cross-sectional design. Target population consisted of 155 of the forensic patients, who were registered in the department of forensic patients in the University Medical Faculty and were monitored with a diagnosis of hypovolemia between June 2005 and December 2009. The study protocol was approved by the ethics committee of the hospital for the collection of data of human subjects, and the study was conducted in accordance with the ethical standards of the Declaration of Helsinki (Finland).

Medico-legal assessments of these patients were requested by the judicial authorities and by other departments of the medical faculty. The medical records of these patients were included in the study without considering the blood transfusion. The medical records of the patients with medico-legal reports were screened. The trauma patients, who had no hypovolemia and evaluated in respect of invalidity/disability, were excluded.

The following data were investigated: age, gender, type of violence causing the trauma, history of the liquid replacement and blood transfusion, vital signs, type of the physical injury, the injured body part, the presence of chronic diseases. Concepts like shock index, which are used in the clinics, blood pressure, pulse, hemoglobin, hematocrit, urine volume, age, nutritional state, presence of any previous cardiac, renal or hematological disease, the effect of the clinical status on the severity levels were attempted to elucidate. The results of the recorded medico-legal reports were also included in the evaluation.

2.2. The applied trauma scoring systems

RTS (one of the physiological trauma scoring systems), TRISS (one of the combined trauma scoring systems), and Injury Severity Score (one of the anatomical scoring systems).

2.3. Statistical analysis

The data recorded on the evaluation form were analyzed with the Windows SPSS 15.0 software. Continuous variables were calculated with mean and standard deviation, categorical variables with percentages. The normal distribution was analyzed with the Kolmogorov–Smirnov Test. Pairing comparisons were analyzed with Student t test and Mann–Whitney U Test according to the distribution features. For the comparison of the categorical variables, the chi-square test was used in the 4-cell table. The accepted limit of significance was $P < .05$.

The sensitivity, specificity, positive, and negative prediction values (PPV, NPV) were calculated to determine the life-threatening characteristics of the TSs. In addition, the receiver-operating characteristic (ROC) curves, cut-off values, and area-under-the-curve (AUC) calculations and the comparison of the ROC curves were performed with the packaged software Med Calc (v. 9.6.2.0-2008).

Table 1

The demographical and clinical characteristics of the study group.

Age (mean yr ± SD)	34.7 ± 16.0
Age's groups, yr	**n, %**
≤18	18; (11.6)
19–44	102; (65.8)
45–64	29; (18.7)
≥65	6; (3.9)
Gender	**n, %**
Female	37; (23.9)
Male	118; (76.1)
Trauma types	**n, %**
In-vehicle traffic accident	36; (23.2)
Traffic accident	37; (23.9)
Stab wounds	29; (18.7)
Gun shot	18; (11.6)
Motorcycle accident	20; (12.9)
Blunt trauma	12; (7.7)
Burning	3; (1.9)
Clinical status	**mean ± SD**
Transfusion rate	4.1 ± 4.6
Hemoglobin, g/dL	11.3 ± 2.3
Hematocrit, %	32.9 ± 7.1
Systolic blood pressure, mmHg	115 ± 25.2
Diastolic blood pressure, mmHg	71.4 ± 18.0
Respiratory rate/min	21 ± 4.3
Pulse rate/min	95 ± 26.2

SD = standard deviation.

3. Results

The mean age of the included 155 patients was 34.70 ± 16.08 years (3-87 years). The age of most of the patients was between 19 and 44 years. 118 patients (76%) were males and 37 (24%) were females. Traffic accidents were the most common cause of the trauma. The demographical and clinical characteristics were shown in Table 1.

The 51% (n = 79) of the patients received 3 or more units of blood or blood products transfusions, 27.7% (n = 43) received 2 units and 21.3% (n = 339 received 1 unit. There was no significant correlation between the age and transfusion ($P > .05$). The average unit number of blood transfusion compared with age and gender was shown in Figure 1.

The TSs of the patients regarding the different systems were listed in Table 2.

131 (85.1%) patients had life-threatening conditions. Grouping the patients according to the life-threatening conditions did not reveal any correlation with the gender, but the patients with a life-threatening condition were younger (Table 3).

There was no significant difference between these 2 groups in respect of the causes of the trauma ($P > .05$) (Table 4).

Table 2

Trauma scores according to the different trauma systems.

Trauma Score Systems	Mean ± SD
Glasgow Coma Scale	13 ± 3.4
Injury Severity Scale	22 ± 11.6
Revised Trauma Score	7 ± 1.0
TRISS*, blunt	91 ± 14.2
TRISS penetrated	90 ± 16.2

*TRISS = Trauma Score and Injury Severity Score.

Table 3

The demographical and clinical characteristics of the patients with life-threatening and non-life-threatening conditions.

Features	Life-threatening (n:132)	Non life-threatening (n:23)	P
Age (mean ± SD)	33.0 ± 15.5	43.7 ± 16.6	.002
Gender			
Female, n; (%)	30; (22.1)	8; (34.8)	>.05
Male, n; (%)	102; (77.9)	15; (65.2)	
Transfusion rate (mean ± SD)	4.5 ± 4.9	2.0 ± 1.1	.003
Hemoglobin, g/dL (mean ± SD)	11.2 ± 2.4	11.8 ± 1.8	>.05
Systolic pressure, mmHg (mean ± SD)	114 ± 26.5	118 ± 15.8	>.05
Diastolic pressure, mmHg (mean ± SD)	71 ± 19.1	73 ± 10.0	>.05
Respiratory rate/min (mean ± SD)	21 ± 4.5	20 ± 2.9	>.05
Pulse rate/min (mean ± SD)	97 ± 27.5	85 ± 12.9	.014

Table 4

The causes of the trauma in the groups of life-threatening and non-life-threatening conditions.

Trauma types	Life-threatening, n (%)	Non life-threatening, n (%)
In-vehicle traffic accident	31; (22.9)	6; (26.1)
Traffic accident	32; (24.4)	5; (21.7)
Stab wounds	28; (21.4)	1; (4.3)
Gun shot	17; (13.0)	1; (4.3)
Motorcycle accident	13; (9.9)	7; (30.4)
Blunt trauma	9; (6.9)	3; (13)
Burning	2; (1.5)	0
Total	132	23

The GCS, RTS, TRISS blunt, and penetrating TSs were lower in the group with a life-threatening condition and the ISS score was significantly higher in the same group (Table 5).

Evaluation of the TSs in respect of gender and age groups did not display a significant difference ($P > .05$).

There was a sound correlation between the trauma scoring systems (Table 6).

The prediction features of the TSs regarding the life-threatening conditions were investigated with the ROC analysis. The sensitivity and specificity were calculated according to the cut-off values with the ROC analysis (Table 7). Comparison of the ROC curves of the scores did not reveal any significant difference ($P > .05$) (Fig. 1). Taking the score 7, which is used for the life-threatening condition in the GCS, as the cut-off, the sensitivity dropped down to 13.5%. In 93 patients, who had life-

Table 5

Trauma scores in the groups of life-threatening and non-life-threatening conditions.

Trauma Score Systems	Life-threatening (n:132) Mean ± SD	No life-threatening (n:23) Mean ± SD	P
Glasgow Coma Scale	13 ± 3.6	15 ± 0	.013
Injury Severity Scale	24 ± 11.6	13 ± 6.2	<.001
Revised Trauma Score	7 ± 1.0	8 ± 0.2	.028
TRISS blunt	90 ± 15.2	97 ± 3.1	.018
TRISS penetrating	89 ± 17.4	97 ± 2.1	.004

TRISS = Trauma Score and Injury Severity Score.

Table 6

The correlation between the trauma scoring systems.

	ISS		RTS		TRISS blunt		TRISS penetrating	
	P	r	*P*	r	*P*	r	*P*	r
GCS	<.001	−.404	<.001	0.901	<.001	0.774	<.001	0.858
TRISS penetrating	<.001	−.573	<.001	0.886	<.001	0.971		
TRISS blunt	<.001	−.638	<.001	0.794				
RTS	<.001	−.314						

GCS = Glasgow Coma Scale, ISS = Injury Severity Scale, RTS = Revised Trauma Score, TRISS = Trauma Score and Injury Severity Score.

Table 7

The role of the trauma scores in the determination of the life-threatening conditions.

	Cut off	Se	Sp	PPV	NPV	AUC	95% CI
GCS	14	25.0	100	100	–	0.625	0.535–0.709
ISS	18	62.7	86.9	95.4	30.6	0.779	0.704–0.843
RTS	6	30.7	94.7	100	18.1	0.609	0.516–0.697
TRISS blunt	96	41.6	89.5	94.2	22.0	0.672	0.580–0.755
TRISS penetrating	96	45.5	89.5	97.0	22.9	0.709	0.619–0.788

GCS = Glasgow Coma Scale, ISS = Injury Severity Scale, RTS = Revised Trauma Score, TRISS; Trauma Score and Injury Severity Score, Se = Sensitivity, Sp = Specifity, PPV = positive predictive value, NPV = negative predictive value, AUC = Area Under Curve; CI = Confidence Interval.

threatening conditions, the life-threatening condition was not defined if the GCS values were 7 or below 7 (Fig. 2).

There was no significant difference regarding the scores between the non-life-threatening group and 23 patients, which had a life-threatening condition determined only with the volume of the transfusion ($P > .05$) (Table 8).

4. Discussion

In the medico-legal assessment, measurable and comparable criteria should be used for the determination of the severity level of the lesions and clinical status. Anatomical scoring systems like AIS are the basic criterion used for the preparation of the medico-legal opinion in the forensic patients.[2–5]

The current anatomical TSs (ISS, RTS) and physiological scores (TRISS blunt and penetrating) exhibited similar performance in this study. The comparison of the ROC curves did not show any significant difference. If the 7 and a lower score was accepted as the cut-off value - like in other studies for the GCS, sensitivity dropped down to 13.5% and it did not exceed 25% even after taking 14 and lower scores, as it was recommended in the ROC analysis.[11–16] GCS did not seem to be a proper scoring system for the determination of the life-threatening conditions in this group of patients. None of the anatomical and physiological scoring systems proved satisfactory in the patient groups with life-threatening conditions determined by the transfusion volume.[15–18] A new scoring system is necessary for this patient group.

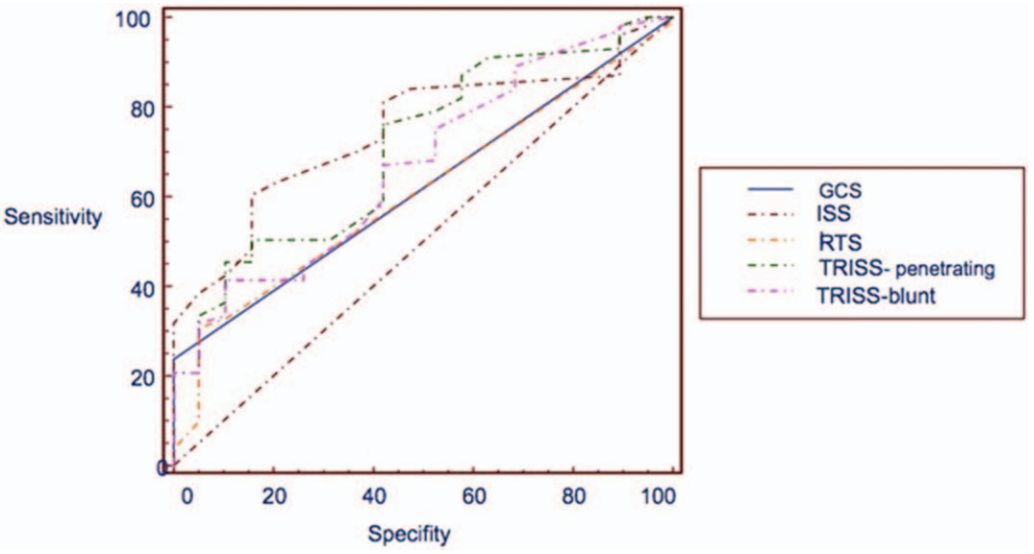

Figure 1. The average unit number of blood transfusion compared with age and gender.

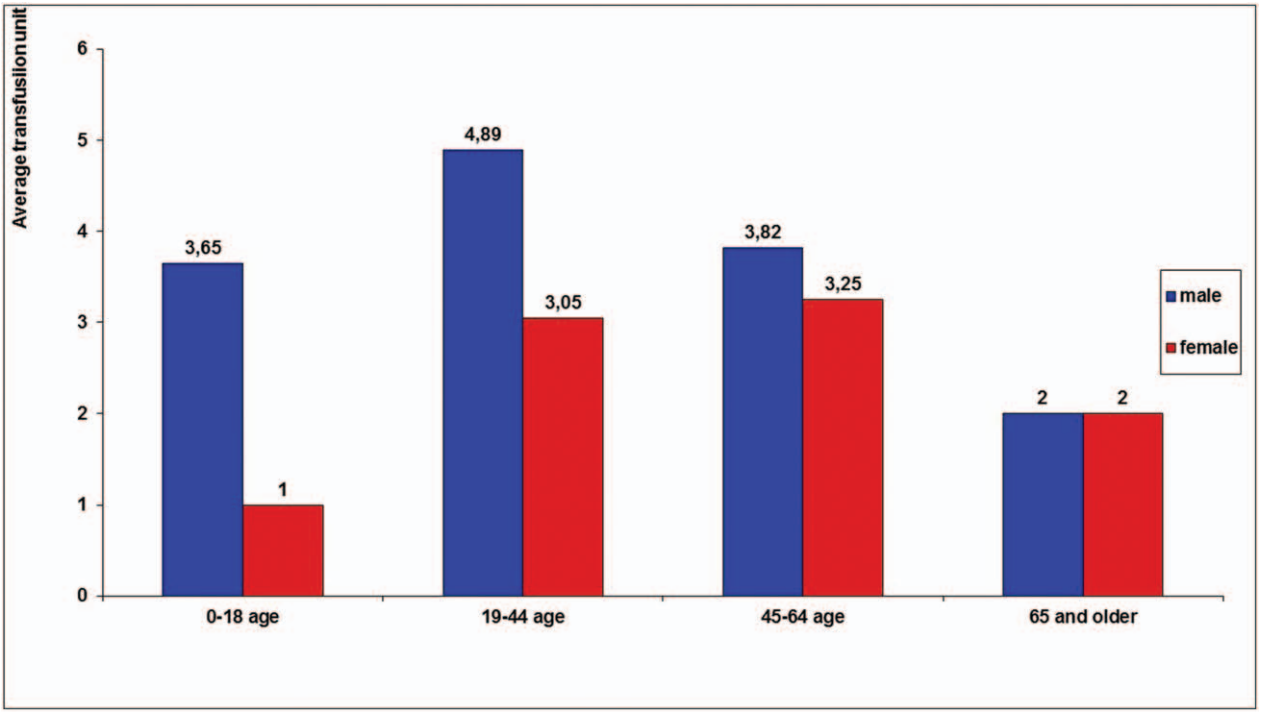

Figure 2. The comparison of the AUC values in respect of the role of the trauma scores in the determination of the life-threatening conditions. AUC = area-under-the-curve.

If only the patients were taken into the consideration, which was classified in the life-threatening condition only due to the blood loss more than 20%, there is no correlation between the anatomical scores (ISS), vital signs and physiological scores. Therefore, we believe that the reliability of the assessment criteria in the guideline currently used as the life-threatening criteria in the patients with acute hypovolemia should be discussed. Especially the significant correlation of the arterial blood pressure, vital signs with the physiological scoring systems indicates to the relevant points in the guideline subject to be changed in respect of the medico-legal assessment of the patients with the acute hypovolemia. This evaluation in the guideline shows the blood loss with a numeric limit and measures only the liquid loss from the intravascular system. We believe that criteria, which can measure the liquid distribution in the intra-/extra-vascular liquid volume, electrolyte balance, and its effects, should replace the criteria mentioned above.

As the decision about the life-threatening conditions is given according to the anatomical scoring in the guideline, the sensitivity of the physiological scoring system seems to be lower than the ISS. Although in the forensic medicine studies, which were focused on all trauma patients, anatomical scoring systems were found reliable and competent, we noticed that the life-threatening conditions were evaluated only with the anatomical scoring systems.[6,8,10]

The vital signs and other characteristics of the patients were usually recorded in the trauma forms used in the emergency unit of our hospital. Therefore, although we had no problem to determine the physiological scoring systems, we observed that these scoring systems were not used at all. It is important to collect data for the physiological scoring systems. The deficiency in the medical records will pose the main challenge for the medico-legal assessment of the forensic patients. We believe that along with the medical record deficiencies, the computer operating systems also prevent the registration of certain parameters in the medical records. In future studies, the use of different score and evaluation criteria could be employed for evaluating forensic cases in different populations. The results should be evaluated and compared with the findings of this and other studies to lay the foundation for a solid methodology for determination of the severity level of the clinical status in the hypovolemic patients.

Table 8

Trauma scores in the patients with a life-threatening condition determined only with the transfusion volume.

Trauma Score Systems	Life-threatening (n:23) Mean ± SD	No life-threatening (n:21) Mean ± SD	*P*
Glasgow Coma Scale	15	15	>.05
Injury Severity Scale	14 ± 7.8	14 ± 6.0	>.05
Revised Trauma Score	7 ± 0.5	8 ± 0.2	>.05
TRISS blunt	97 ± 6.6	97 ± 3.2	>.05
TRISS penetrating	97 ± 5.8	97 ± 2.2	>.05

TRISS = Trauma Score and Injury Severity Score.

5. Conclusion

We believe that the determination of the severity level of the clinical status in the hypovolemic patients only with the loss percentages causes problems and limitations in the medico-legal assessment. The concept of the life-threatening condition should be based on the objective criteria in the hypovolemic patients and measurable and comparable criteria should be developed for the determination of the severity of the trauma and emerging injury.

We recommend the physiological trauma scoring systems like Revised Trauma Scale System along with the clinical findings instead of the anatomical scoring systems in the medico-legal assessment of the hypovolemic patients.

Regarding the medico-legal assessment of the forensic patient with hypovolemia, we believe that:

- the relevant chapter of the guideline for the evaluation of the severity of the trauma prepared for TCK is not satisfactory,
- it is necessary to emphasize the importance of the clinical status with the help of physiological trauma scoring systems like RTS and TRISS,
- there is a need for further studies to evaluate the issues like sensitivity, specificity of the trauma scoring systems.

A part of this study was presented as an oral presentation in the 9th the Forensic Sciences Congress (2010, Izmir)

Author contributions

Conceptualization: Gökmen Karabag.
Data curation: Murat Köker, Dilek Solmaz, Ümit Ünüvar.
Formal analysis: Dilek Solmaz, Uğur Kavaklı, Gökmen Karabag, Ümit Ünüvar.
Investigation: Murat Köker, Uğur Kavaklı, Gökmen Karabag, Ümit Ünüvar.
Methodology: Murat Köker, Dilek Solmaz, Başak Bayram, Gökmen Karabag.
Project administration: Gökmen Karabag.
Resources: Ismail Ozgur Can, Başak Bayram.
Writing – original draft: Ismail Ozgur Can, Başak Bayram, Ümit Ünüvar.
Writing – review & editing: Yücel Arısoy, Erdem Özkara.

References

[1] Glasgow Coma Scale. Available at: http://www.trauma.org/archive/scores/gcs.html [access date April 18, 2016].
[2] Abbreviated Injury Scale. Available at: http://www.trauma.org/archive/scores/ais.html [access date April 16, 2016].
[3] Trauma Score. Available at: http://www.trauma.org/archive/scores/ [access date April 16, 2016].
[4] Revised Trauma Score. Available at: http://www.trauma.org/archive/scores/rts.html [access date April 16, 2016].
[5] Injury Severity Scale. Available at: http://www.trauma.org/archive/scores/iss.html [access date April 16, 2016].
[6] Lavoie A, Moore L, LeSage N, et al. The new injury severity score: a more accurate predictor of in-hospital mortality than the Injury Severity Score. Trauma 2004;56:1312–20.
[7] Yeni Türk Ceza Kanunu'nda tanımlanan yaralama suçlarının adli tıp açısından değerlendirilmesi ve adli rapor tanzimi için rehber. Editörler: Yasemin Günay Balcı, Gürsel Çetin ve Sadullah Güzel, 2005, Revised 2013. Available at: http://www.atk.gov.tr/pdf/tckyaralama24-11-15.pdf [access date March 21, 2016].
[8] Teasdale G, Jennett B. Assessment of coma and impaired consciousness: a practical scale. Lancet 1974;304:81–4.
[9] Günay Y. Trauma scoring and forensic medicine. Bull Forensic Med 1999;4:65–73.
[10] Gormican SP. CRAMS scale: field triage of trauma victims. Ann Emerg Med 1982;11:132–5.
[11] Trauma Score—Injury Severity Score: TRISS. Available at: http://www.trauma.org/archive/scores/triss.html [access date April 16, 2016].
[12] Champion HR, Copes WS, Sacco WJ, et al. Improved predictions from a severity characterization of trauma (ASCOT) over trauma and injury severity score (TRISS): results of an independent evaluation. J Trauma 1996;40:42–9.
[13] Champion HR, Copes WS, Sacco WJ, et al. A new characterization of injury severity. J Trauma 1990;30:539–45.
[14] Richards JB, Wilcox SR. Diagnosis and management of shock in the emergency department. Emerg Med Pract 2014;16:1–22.
[15] National Institute for Health and Care Excellence: Clinical Guidelines. National Clinical Guideline Centre (UK). Major Trauma: Assessment and Initial Management. London: National Institute for Health and Care Excellence (UK); 2016.
[16] Madden B, Phadtare M, Ayoub Z, et al. Hemorrhagic shock from breast blunt trauma. Int J Emerg Med 2015;8:1–4.
[17] Gallimore E. Clinical features and management of haemorrhagic shock. Nurs Stand 2015;30:51–8.
[18] Huber-Wagner S, Qvick M, Mussack T, et al. Working Group on Polytrauma of German Trauma Society (DGU).Massive blood transfusion and outcome in 1062 polytrauma patients: a prospective study based on the Trauma Registry of the German Trauma Society. Vox Sang 2007;92:69–78.