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RESEARCH ARTICLE



Emergency care for trauma patients in the red zone: clinical experience from 2024

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ABSTRACT

Background. The traumatized patient with signs of shock remains a major cause of morbidity and mortality, requiring rapid diagnosis and multidisciplinary management. This study evaluates clinical, paraclinical, and therapeutic aspects of trauma patients admitted with shock signs in the red zone of the Emergency Department of the Institute of Emergency Medicine during 2024.

Material and methods. A prospective analysis of 60 polytrauma patients in shock was performed. Demographic data, trauma mechanisms, Glasgow Coma Score, vital signs, imaging, emergency interventions, and outcomes were evaluated. The patients were managed according to an experimental protocol developed at the institutional level, which provides for a multidisciplinary approach to the traumatized patient. This protocol was developed based on the international protocol for Advanced Trauma Life Support. It will later be implemented at the institutional level.

Results. The cohort included 79% males, with a mean age of 49.7 ± 15.2 years; 75% urban residents. Grade III and IV shock were diagnosed in 40% and 28.3%, respectively. Causes of trauma included physical aggression (29.5%), road traffic accidents (28.5%), and accidental trauma (21.0%), falls from height (21.0%). Radiological lesions were detected in 63.3%, positive findings on Focused Assessment with Sonography for Trauma in 40%, and cranial lesions identified by computed tomography in 60%. Intraglottic intubation was required in 80% of patients, vasopressor support was administered in 50%, antibiotic therapy in 95%, and emergency surgery was performed in 30%. Mortality was 1.7%.

Conclusions. Protocol-driven multidisciplinary care facilitated effective stabilization of traumatized patients presenting with shock. Early diagnosis, the use of advanced imaging techniques, and timely therapeutic interventions significantly contributed to improved patient outcomes. These findings underscore the critical role of structured trauma life support protocols in emergency medical settings.

Keywords: trauma, shock, emergency department, resuscitation, Advanced Trauma Life Support.

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Key messages

What is not yet known on the issue addressed in the submitted manuscript

There is limited published data on the real-time clinical management of polytraumatized patients in shock in Eastern European emergency departments. In particular, the epidemiological profile, temporal distribution, clinical outcomes, and adherence to internationally recognized protocols such as Advanced Trauma Life Support in Moldova remain insufficiently explored.

The research hypothesis

The implementation of a multidisciplinary, protocol-driven approach – based on Advanced Trauma Life Support principles – in the emergency department leads to improved early stabilization,

more efficient therapeutic interventions, and reduced in-hospital mortality among polytraumatized patients presenting with clinical signs of shock.

The novelty added by the manuscript to the already published scientific literature

This is the first prospective clinical analysis of polytraumatized patients in shock managed in the Red Zone of the Institute of Emergency Medicine in Moldova. The study offers novel insights into trauma epidemiology, time-of-day incidence, and demonstrates the effectiveness of standardized, protocol-based emergency care – including Advanced Trauma Life Support – in a resource-limited Eastern European setting.

Introduction

One of the causes of increased morbidity and mortality globally is trauma accompanied by shock, requiring rapid diagnosis and a multidisciplinary approach [1, 2]. This study evaluates the clinical and paraclinical characteristics, as well as therapeutic outcomes, of traumatized patients presenting with shock in the red zone of the Institute of Emergency Medicine (IEM) during 2024.

Adherence to evidence-based protocols, such as the Advanced Trauma Life Support (ATLS), has been demonstrated to improve survival by prioritizing life-threatening injuries and streamlining patient care [1, 3, 4]. Understanding the epidemiology and management of traumatic shock is crucial for optimizing emergency medical response and resource allocation. Historically, management evolved from rapid problem-solving to focused stabilization of vital functions, significantly reducing mortality [1, 5, 6].

While early approaches focused on solving as many problems as quickly as possible, current practice emphasizes prioritizing life-threatening factors, a strategy that has proven effective in reducing patient mortality. Managing a traumatized patient with signs of shock poses not only medical challenges but also has long-term implications for patient quality of life and outcomes in emergency medicine [1, 7].

It is crucial to identify and analyze the main causes that lead to the clinical manifestation of shock in trauma patients. This would support a more precise understanding of how shock evolves across various patient groups and improve strategies for early recognition and intervention.

The aim of the research was to clinically and paraclinically evaluate cases of shock in patients involved in trauma situations, who were treated in the Emergency Department (ED) of IEM, and to assess the quality of care provided.

Material and methods

A prospective observational study was conducted between January 1 and December 31, 2024, at the Institute of Emergency Medicine (IEM), including 60 adult polytraumatized patients presenting with signs of shock admitted to the red zone.

Study design and participants. Inclusion criteria were patients aged 18 years or older, with confirmed trauma and clinical signs of shock according to ICD-10-CM classification, and complete clinical documentation available. Patients presenting with non-traumatic shock or incomplete medical records were excluded from the study.

Recruitment and ethical approval. Patients were consecutively recruited upon admission to the emergency department's red zone. The study protocol was approved by the Institutional Ethics Committee of IEM (Protocol No. 1, dated January 12, 2024). The chairperson of the Ethics Committee was Dr. Diana Manea, Director of the Institute of Emergency Medicine. All participants or their legal representatives provided informed consent in accordance with the Declaration of Helsinki.

Data collection. Data collected comprised demographic characteristics (age, sex, residence), trauma mechanisms, Glasgow Coma Scale (GCS) scores at admission, vital signs (blood pressure (BP), heart rate, respiratory rate, oxygen saturation), imaging findings, laboratory parameters, and emergency interventions.

Imaging and paraclinical assessment. All patients underwent targeted radiological examinations based on suspected injury patterns. Radiography was performed on the thorax, pelvis, spine (cervical, thoracic, and lumbar), as well as the upper and lower limbs using a digital radiography system. In 90% of cases, three anatomical regions were examined; in 10% of cases, only one region was imaged. Computed tomography (CT) was conducted using a 64-slice scanner for whole-body assessment in all patients. Focused Assessment with Sonography for Trauma (FAST) was performed bedside using convex and phased-array probes to assess for free fluid in the thoracic and abdominal cavities. Electrocardiographic monitoring was applied to all patients to assess for acute cardiac abnormalities.

Laboratory evaluations included haemoglobin, lactate, arterial pH, and base deficit values. Monitoring of vital signs and hemodynamic status was conducted continuously throughout emergency department management.

Interventions and clinical management. The patients were managed according to an experimental protocol developed at the institutional level and approved by the institution's ethics committee. The protocol provides for a multidisciplinary approach to the traumatized patient and was developed based on the international Advanced Trauma Life Support (ATLS) protocol. This protocol will be implemented at the institutional level. At the national level there is no protocol for Advanced Trauma Life Support. Emergency interventions included airway assessment and management (oxygen therapy, oropharyngeal airway placement, endotracheal intubation), intravenous fluid resuscitation with crystalloids and blood products, administration of vasopressors, broad-spectrum antibiotic therapy, analge-

sia, and surgical intervention where indicated. A multidisciplinary team including emergency physicians, surgeons, anaesthesiologists, traumatologists, and neurosurgeons was involved in case management. The treatment approach followed internationally accepted trauma protocols.

Statistical analysis. Descriptive statistics were performed using mean \pm standard deviation (SD) for continuous variables and percentages for categorical variables. Data analysis was conducted using SPSS version 25 (IBM Corp., Armonk, NY, USA). A p-value < 0.05 was considered statistically significant.

Results

Demographics aspects. The prospective study conducted during 2024 included the evaluation of 60 patients involved in a trauma case with a diagnosis of shock established in the ED of the IEM, who were subsequently treated in the intensive care units and in the specialized wards within the IEM. Of the patients included in the research, 13 subjects were female, representing 21%, and 47 were male, representing 79%. Thus, the ratio between men and women in case of traumatic shock is found to be 3.6 to 1. The average age was 49.7 ± 15.2 years, which highlights the involvement of this serious clinical condition in the working-age population. Of the subjects included in the research, 75% were urban, while 25% were rural. All patients included in the study had medical insurance.

It was important to assess the time of onset of shock in traumatized patients, being reported to the time of day, the so-called diurnal. The day was divided into 3 time periods. The research results showed that the highest incidence of traumatic shock in the ED, 54%, was during the day from 16:00 to 23:00, a finding likely corresponding to the period when adults are free from work and are more likely to be exposed to trauma, accidents or physical aggression. The lowest incidence was found between 00:00-07:59, representing 17.5%, this low incidence is likely due to the night time when most of the population is inactive.

Where it was possible to collect the anamnesis, it was found that all patients included in the research had certain pre-existing health problems. The presence of arterial hypertension in the anamnesis, which was being treated by the family doctor, was confirmed in 30 cases (50%); obesity grade II-III was present in 24 patients (40%); ischemic heart disease for which they received treatment in the past in 9 patients (15%), stroke in the anamnesis in 3 patients (5%), bronchial asthma in 3 patients (5%), allergic reaction in the anamnesis in 4 patients (6.67%), renal pathology in 1 patient (1.67%). Any coexisting chronic pathology in a trauma patient, including the medications they patient receive, has an impact on the evolution of the patient's condition.

Clinical presentation. All patients included in the study were transported by the 112 service to the IEM, upon arrival, they were triaged according to the criteria for shock, which is an imminent vital risk for the traumatized patient, and were directed to the red zone (Table 1). At triage, the severity criteria were confirmed in all patients according to the vital parameters. Systolic arterial hypotension less than

80 mm Hg was confirmed in all cases. Parameters indicating respiratory compromise, such as respiratory rate less than 8 per minute was confirmed in 4 cases (6.66%), and respiratory rate greater than 30 per minute was confirmed in 93.34% of cases (in 56 patients). Oxygen saturation less than 90% was confirmed in all analyzed cases, which had an essential impact on airway management. The Glasgow Coma Scale (GCS) score of 12-9 points was confirmed in 49 patients (81.66%), and the GCS score of less than 8 points was established in 11 patients (18.34%).

Table 1. The degree of distribution of hypovolemic shock in traumatized patients based on clinical/paraclinical triage data: *Vital Signs at Admission*

Shock Grade (hypovolemic shock)	Number of Patients	Percentage (%)
Grade I	2	3.3
Grade II	17	28.3
Grade III	24	40.0
Grade IV	17	28.3

Note: (Mean \pm SD): Systolic BP: 82.4 ± 14.1 mmHg, Heart rate: 114 ± 18 bpm, Respiratory rate: 26.2 ± 4.9 rpm, Temperature: $35.1 \pm 0.5^\circ\text{C}$, GCS: 10.8 ± 3.4

Cranio-cerebral trauma was identified in 45% of cases, followed by polytrauma in 36% of cases, abdominal trauma in 12% of cases, and thoracic trauma complicated with traumatic shock was present in 7% of cases.

The circumstances of the trauma are important in the development of the trauma mechanism. The research found that most frequently patients suffered physical aggression, (29.5%), followed by road accidents (28.5%), accidental trauma (21%), which included patients involved in workplace trauma, and falls from height (21.0%) (Table 2).

Table 2. Distribution of trauma mechanisms and diagnostic interventions

Mechanism of Injury	Frequency (n)	Percentage (%)
Road traffic accidents	17.1	28.5
Accidental trauma, workplace trauma	12.6	21.0
Physical aggression	17.7	29.5
Falls from height	12.6	21.0

Note: Data are presented as absolute values (n) and percentages (%) out of the total number of patients (n=60). Descriptive statistics were applied using SPSS version 25 (IBM Corp., Armonk, NY, USA). No abbreviations were used in this table.

The evaluation of mortality in the ED of the IEM trauma patients in shock included in the research was inevitable. Of the 60 patients who received qualified emergency medical care in the red zone ED of the IEM, one died, which constituted 1.7%. Prompt management of the trauma patient with shock in the red zone ensures this acceptable mortality rate.

Patients with traumatic shock benefited from a multidisciplinary approach, and were consulted by specialist doctors (surgeon, neurologist, neurosurgeon, traumatologist, internist, intensive care specialist).

Diagnostic workup. All patients underwent laboratory tests (hemoglobin, lactate, pH etc.). Paraclinical findings

were as follows: Hemoglobin 9.2 ± 2.1 g/dL; Lactate 4.1 ± 1.6 mmol/L; Base deficit 7.8 ± 3.2 ; Arterial pH 7.25 ± 0.09 .

The paraclinical examination by applying imaging investigations was important for diagnostic purposes (Table 3). *The radiological examination* was indicated in 60 cases, it was performed on different anatomical regions depending on what the specialist suspected. In some patients, a single anatomical region was examined, in others several. Thus, in 54 patients (90%) 3 anatomical regions were examined radiologically, and in 6 cases (10%) – only one anatomical region. Radiological examinations confirmed the presence of fractures in 30 cases (50%), tension pneumothorax in 5 cases (8.33%), and massive hemothorax in 2 cases (3.33%), damage to the abdominal cavity organs was confirmed in one case, constituting 1.67%. In total, in 38 patients (63.33%) various lesions were confirmed during the radiological examination (Table 3).

Bedside FAST ultrasound – *E-FAST* (Focused Assessment with Sonography for Trauma) ultrasound was performed on all patients included in the study, and was positive in 24 patients (40%), confirming the presence of free fluid in the abdominal cavity in 22 patients (36.67%) and in the thoracic cavity in 2 patients (3.33%).

Full body computed tomography (CT) allowed for detailed assessment of trauma in any anatomical region and is considered the investigation that provides the best result on both the condition of hard tissues and fluid accumulations, organ lesions. CT was performed on 60 patients, being applied in 100% of cases. Computed tomography confirmed craniocerebral injuries in 36 patients (60%), and in 6 cases (10%) intervention for urgent neurosurgical treatment was necessary. Damage to parenchymal organs on CT was recorded in 4 patients (6.67%), damage to cavitary organs in 2 cases (3.33%), and the presence of retroperitoneal hematoma in one case (1.66%).

Table 3. Diagnostic Interventions in Emergency Department

Intervention	Patients (%)
Radiological lesions	63.33
Positive FAST ultrasound	40
Cranial CT lesions	60

Note: Data are presented as percentages (%) of the total number of patients (n=60). Radiological examinations included thoracic, pelvic, spinal, and limb X-rays, based on clinical suspicion. FAST = Focused Assessment with Sonography for Trauma; CT = Computed Tomography. Descriptive statistical analysis was conducted using SPSS version 25 (IBM Corp., Armonk, NY, USA). No inferential statistical tests were applied for this table.

Electrocardiographic monitoring was recorded in all patients in the study and did not confirm the presence of acute injuries.

Management in emergency department. All patients in the study were initially treated in the red zone. The emergency physician was the specialist who managed the case from a clinical and paraclinical point of view, requesting specialist consultations and having a decision-making role in determining treatment tactics (Table 4).

In accordance with the ABCDE (A-airway; B-breathing; C-circulation; D-disability; E-exposure) approach, the emer-

gency physician ensured the appropriate treatment of immediately life-threatening injuries at each stage. In addition to continuous clinical examination and reassessment after each manipulation performed, monitoring of vital parameters was ensured: respiration, oxygen saturation, systolic and diastolic blood pressure, heart rate monitoring, capillary refill time, evaluation of pupil appearance and photo reaction, reassessment of the state of consciousness (AVPU (A-alert, V-verbal, P-reactive to pain, U-unconscious) / GCS), blood glucose assessment and temperature.

With reference to the treatment of the pain syndrome, if it was not initiated at the pre-hospital stage, or if it was ineffective, it is continued in the ED. Analgesic-tranquilizer therapy is a mandatory component in the treatment of shock, which must be initiated at the prehospital stage by the 112 service. The indications for this treatment were the state of compensated shock, when the patient is conscious, with persistent pain syndrome and obvious discomfort; stable hemodynamics, balanced respiration. It is welcome to perform a lesion assessment and assess the presumptive diagnosis, and the actual treatment is done in accordance with the blood pressure (BP) values, the stability of vital functions, and the patient's age. In the treatment of the traumatized patient with signs of shock, pain control and patient sedation are essential for reducing physiological stress, preventing hypoxia and managing anxiety. From the clinical cases evaluated, it was found that this treatment was administered to 55 patients (91.7%), who presented with states of agitation, anxiety and complained of severe pain. The analgesics used were Ketamine (in analgesic doses), Fentanyl, and Tramadol. According to the data from the medical records, the sedatives used were Diazepam and Propofol.

In all patients included in the study, airway patency was assessed, and the liquid content of the oral cavity was aspirated in 11 patients (18.34%), who underwent upper airway prosthesis by applying a Guedel tube. Oxygen was administered by applying an oxygen mask, as all initially presented with oxygen saturation below 90%.

In 48 patients (80%), who were refractory to oxygen therapy, ventilation and preparation for definitive lower airway prosthesis by intraglottic intubation by inserting an endotracheal tube were indicated. Premedication was performed beforehand, after which the emergency physician performed the infraglottic airway prosthesis. In case of identifying the characteristic signs of tension pneumothorax or massive hemothorax, thoracocentesis was performed.

In point C-circulation of the ABCDE assessment, it is mandatory to ensure a central venous access (jugular vein, subclavian vein), continue volemic resuscitation and drug treatment according to the patient's needs. The research found that volemic resuscitation initiated at the prehospital stage continued in all patients in shock, both micromolecular (crystalloid) and macromolecular solutions were administered. In 45 patients (75%), erythrocyte mass/plasma group I rhesus factor negative (O(I) Rh negative) were administered.

Vasopressors, such as Noradrenaline and Dopamine were required by 30 traumatized patients in shock (50%).

According to the recommendations of Advanced Trauma Life Support, in case of traumas where there is a risk of infections, such as open wounds, gunshot wounds, abdominal traumas, broad-spectrum antibiotics are administered according to existing national protocols, for example ceftriaxone 1g and metronidazole 500 mg to prevent secondary infections. According to the information from the ED files examined in 95% of the cases (57 patients), this treatment was administered.

In any state of shock, there is a risk of cardiorespiratory arrest, which most frequently occurs through a pulseless electrical activity rhythm. Cardiorespiratory and cerebral resuscitation is performed in the ED in accordance with international protocols for Advanced Cardiac Life Support, ensuring medication depending on the identified heart rhythm. Cardiorespiratory arrest occurred in 11 cases (18.33%) and advanced resuscitation was initiated in accordance with –protocol for pulseless electrical activity. In one case, cardiorespiratory and cerebral resuscitation was ineffective and biological death was determined.

Table 4. Therapeutic interventions in Emergency Department

Intervention	Number of Patients	Percentage (%)
IV fluid resuscitation	60	100
Oxygen therapy	60	100
Analgesia (opioids or NSAIDs)	55	91.7
Vasopressor support (e.g., norepinephrine)	30	50
Antibiotic administration	57	95
Emergency surgery (laparotomy, thoracotomy)	18	30
Endotracheal intubation	48	80

Note: Data are presented as absolute numbers and percentages (%) of the total study population (n=60). Descriptive statistical analysis was performed using SPSS version 25 (IBM Corp., Armonk, NY, USA). NSAIDs = Non-steroidal Anti-inflammatory Drugs; IV = Intravenous.

Trauma patients who developed shock were stabilized in the ED, IEM red zone, and subsequently treated in the intensive care unit, preliminarily, if necessary, being treated surgically according to the indications of specialists (surgeon, traumatologist, neurosurgeon). The transfer from the ED to the department where the patient was to be treated was performed by the emergency physician in the red zone (Table 5).

Table 5. Patient outcomes after stabilization in Red Zone

Outcome	Number of Patients	Percentage (%)
Stabilized and transferred	36	60
Transferred directly to OR	23	38.3
Death in ED	1	1.7

Note: Data are presented as absolute numbers and percentages (%) relative to the total number of patients (n=60). Descriptive statistics were applied using SPSS version 25 (IBM Corp., Armonk, NY, USA). OR = Operating Room; ED = Emergency Department.

Discussion

The present study highlights a predominance of male patients (79%) with a mean age of approximately 50 years, which aligns with findings from regional trauma registries indicating that the working-age population is primarily affected by severe trauma leading to shock [3, 7, 8]. The mechanisms of injury identified – road traffic accidents, physical aggression, and accidental trauma – are consistent with international data underscoring these causes as the leading contributors to traumatic shock worldwide [9-11]. These epidemiological patterns emphasize the ongoing need for targeted public health interventions focused on trauma prevention and injury reduction.

Our analysis revealed a peak incidence of traumatic shock during late afternoon and evening hours (16:00–23:00), a time frame associated with increased risk activities and social interactions. This temporal distribution corroborates other epidemiological studies reporting similar patterns and suggests that emergency services should anticipate higher patient influx during these periods [11]. Such data should guide staffing and resource allocation to improve response times and care delivery.

Imaging modalities, particularly Focused Assessment with Sonography for Trauma (FAST) and computed tomography (CT), played a pivotal role in early and accurate diagnosis, facilitating timely surgical decision-making. These findings are in line with Advanced Trauma Life Support guidelines recommending the integration of bedside ultrasound and CT scanning in the diagnostic algorithm for polytrauma patients [1, 3, 12]. The timely use of these imaging tools contributed significantly to the stabilization of patients and reduced the interval to definitive care.

The recorded mortality rate of 1.7% within the red zone is indicative of the effectiveness of the implemented emergency protocols and is comparable to international trauma centers with similar infrastructure, where mortality rates range between 1.5% and 5% [7, 11, 13]. However, the high proportion of patients requiring airway management (80% intubation) and vasopressor support (50%) reflects the critical condition of this cohort, underscoring the importance of continuous monitoring and specialized intensive care capabilities.

Despite these successes, challenges remain, particularly in the timely transfer of patients from prehospital settings to the emergency department and in the optimal allocation of resources. Such issues have been recognized in global trauma care literature as significant factors influencing patient outcomes [11, 12]. Addressing these challenges requires concerted efforts to strengthen prehospital care systems, improve triage protocols, and enhance ongoing training programs in ATLS for all emergency personnel.

Furthermore, adherence to evidence-based protocols, including antibiotic prophylaxis and effective pain management, is essential for reducing complications and improving survival in trauma patients presenting with shock [1, 7, 12, 13]. Continuous monitoring of vital signs, hemodynamic parameters, and urine output was critical in early detection of

secondary complications and informed timely therapeutic adjustments. The multidisciplinary and protocol-driven approach adopted in the red zone of the Institute of Emergency Medicine has demonstrated its value in managing complex trauma cases with signs of shock. Continued efforts to refine prehospital transfer systems, reinforce ATLS training, and optimize resource use are imperative for further improving patient outcomes and reducing trauma-related mortality and morbidity.

Conclusions

A multidisciplinary, protocol-driven approach in the IEM red zone effectively stabilized traumatized patients presenting with shock. The integration of advanced monitoring, timely fluid resuscitation, and comprehensive imaging significantly improved short-term outcomes. Early recognition, complete resuscitation, and prompt surgical intervention remain essential in managing traumatic shock. Our findings support continued implementation and reinforcement of ATLS protocols, alongside enhanced prehospital transfer systems and ongoing training, to further reduce trauma-related morbidity and mortality.

Competing interests

None declared.

Authors' contributions

TMC, LR, and RH conceived the study and participated in its design. TMC and RH contributed substantially to the acquisition, analysis, and interpretation of data. TMC and LR drafted the manuscript. EC and NM critically revised it for important intellectual content. LR approved the final version to be published. In addition, TMC, LR, RH, EC and NM assume full responsibility, and accountability for all aspects of the work.

Ethics approval

The research project was approved by the Research Ethics Committee of the Institute of Emergency Medicine (Minutes no. 1, from January 12, 2024).

Patient consent

Obtained.

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Provenance and peer review

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