IOSUD –„DUNĂREA DE JOS" UNIVERSITY OF GALAȚI

Doctoral School of Biomedical Sciences

PHD THESIS

Abstract

EMERGENCY MANAGEMENT OF POLYTRAUMA IN CHILDREN AND YOUNG ADULTS

PhD Student,

Mihaela IONAȘCU (ANGHELE)

Scientific Advisor,

PROF. UNIV. DR. Aurel NECHITA

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CONTENTS

ABBREVIATIONS

AAST = American Association for the Surgery of Trauma

AIS = Abbreviated Injury Scale

APACHE = Acute Physiology and Chronic Health Evaluation

ATLS = Advanced Trauma Life Support

AV = Ventricular Rate

B = Breathing

C = Circulation

CPU = Emergency Room

CT = Computed Tomography

D = Disability

DGU = German Trauma Society

E = Exposure

EKG = Electrocardiogram

EMTRAS = Emergency Trauma Score

ESTES = European Society for Trauma and Emergency Surgery

FR = Respiratory Rate

GAP = GCS, Age, Arterial Pressure Score

GCS = Glasgow Coma Scale

HIV = Human Immunodeficiency Virus

HRQOL = Health-Related Quality of Life Contribution

IOT = Orotracheal Intubation

ISS = Injury Severity Score

MGAP = Mechanism of Injury, GCS, Age, Arterial Pressure Score

MTC = Major Trauma Center

OMF = Oro-maxillofacial

OMS = World Health Organization

ORL = Otolaryngology

OTA = Orthopaedic Trauma Association

PedsQL 4.0 = Pediatric Quality of Life Inventory

PTT = Partial Thromboplastin Time

QWM = Well-Being Quality Scale

RCP = Cardiopulmonary Resuscitation

REMS = Rapid Emergency Medicine Score

RMN = Magnetic Resonance Imaging (MRI)

RTS = Revised Trauma Score

SAJ = County Ambulance System

SIDA = Acquired Immunodeficiency Syndrome (AIDS)

SMURD = Mobile Emergency Service for Resuscitation and Extrication

SpO2 = Oxygen Saturation

SPSS = Statistical Package for the Social Sciences

SPSSv24 = SPSS version 24

TA = Arterial Pressure

TAD = Diastolic Arterial Pressure

TAS = Systolic Arterial Pressure

TCC = Cranio-Cerebral Trauma

TCF = Cranio-Facial Trauma

TS = Trauma Score

UE = European Union

UK = United Kingdom

UPU = Emergency Room Unit

INTRODUCTION

Polytrauma represents a complex situation involving the presence of two or more severe injuries in a patient, severe enough to be life-threatening or to require complex and coordinated medical care [1]. Following this definition, it is observed that patients with multiple traumas have a higher mortality rate than the combined mortality rate of individual injuries [2]. Additionally, the treatment of multiple traumas requires considerable resources due to the frequent use of resuscitation procedures and long-term stays in intensive care units. Due to the mortality rate and costs, polytrauma represents a major health issue, particularly in younger age groups [3].

Due to the severity of the injuries and the systemic effects induced, trauma is the leading cause of mortality and disability worldwide, with over 5 million deaths per year resulting from incidents such as falls, drownings, burns, vehicle collisions, landslides, and explosions. Polytrauma patients contribute the most to this statistic, representing 65% to 72% of cases [4]. In Europe, polytrauma is the sixth leading cause of death in the general population and the leading cause of death and disability among individuals under 35 years old [5]. According to EUROSTAT, 153,500 people died in accidents in the European Union in 2020, representing approximately 3.0% of total deaths (data includes traffic, work-related accidents, or violent acts). In Romania, the figures show 6,725 deaths, representing 2.3% of total deaths [6]. In terms of the affected age groups, in 2020, accidents accounted for 33.7% of the death rate among individuals aged 15 to 19 and between one quarter and one third of deaths among individuals aged 20-24 and 25-29 years old [6].

The incidence of polytrauma varies globally, partly due to objective reasons related to its frequency, but also due to the way data is classified in national statistics using international classification codes, sometimes based on limited or inconsistent descriptions of injury severity [7].

The Abbreviated Injury Scale (AIS) and the Injury Severity Score (ISS) are among the most commonly used evaluation systems in emergency medicine for classifying and quantifying injury severity. Often used together, these systems are complementary and can provide a comprehensive assessment of the traumatized patient [7]. Differences in the description of injury incidence can arise based on these two systems, leading to varying statistics in different parts of the world [8]. Thus, the development of a new evidence-based definition of polytrauma, focusing on multiple factors that determine mortality rates, was a natural evolution [7].

A severe injury is defined as an ISS >15, and internationally, it is conventionally accepted that mortality prevalence exceeds 20% when the ISS threshold is greater than or equal to 16 [3,9]. Polytraumatized patients represent a challenge, and optimizing treatment methods and properly managing these cases are essential [10]. The introduction of trauma registries and trauma centers

has led to improvements in patient care, significantly reducing mortality rates, often around 10-13% [9].

The etiology of polytrauma can be diverse, usually resulting from incidents involving significant force or impact. Injuries often result from energy transfer, most commonly kinetic, but in specific cases such as explosions or fires, thermal or chemical energy causes the injuries. Both the nature and severity of the injuries depend on the type and magnitude of the impact energy and the vulnerability of the host [5].

In patients with severe multiple traumas, pre-hospital care is crucial for reducing the incidence of early complications, as well as those that may develop later, such as tissue hypoxia, ischemic injuries, reperfusion injuries, and multiple organ failure [11]. A distinctive characteristic of the pathophysiology of polytrauma is the imbalance between oxygen supply and the body's oxygen needs, caused by various factors such as hypoxia, anemia, or reduced cardiac output as a result of shock. In some patients, an increased oxygen demand may be observed, induced by pain, anxiety, panic, or agitation [11].

In polytraumatized patients, shock is most often caused by hypovolemia resulting from massive hemorrhage and tissue injuries present in the body, termed traumatic and hypovolemic shock [11]. Additionally, shock following trauma may result from injuries to the central nervous system, known as neurogenic shock, or may result from obstructions in the circulatory system, such as tension pneumothorax or cardiac tamponade [12]. The complex situations represented by traumatic shock require rapid and coordinated interventions to stabilize the patient and prevent complications, including hemorrhage control, restoration of fluid and electrolyte balance through the administration of crystalloid and colloid solutions, treatment of coagulopathy, metabolic acidosis, and hypothermia, and cardiovascular support through pharmacological agents (e.g., vasopressors, catecholamines) [12]. Each patient has specific needs, and the treatment plan must be adjusted based on the patient's response to initial interventions.

In cases where hemorrhages cannot be controlled in the pre-hospital setting, such as in thoracic injuries, penetrating abdominal injuries, or traumatic amputations of the lower limbs, moderate blood volume support and slightly reduced arterial pressure are recommended, followed by immediate transport of the patient to a hospital. In contrast, when the patient presents with severe cranial trauma, it is crucial to avoid hypotension [13].

As mentioned above, the type, location, and severity of injuries, the systemic response, and the functional impact on organs are essential elements in the integrated and rapid approach to managing the polytraumatized patient. Considering the importance and relevance of the subject, this thesis aims to identify the factors influencing the injury patterns of polytrauma, contributing to

the improvement of the approach strategy for such incidents. To this end, the objectives of the thesis are:

- Defining a profile of pediatric patient cases based on the variables monitored (average age, paraclinical characteristics, imaging assessments, analysis results, presentation mode);
- Highlighting the clinical particularities based on the trauma mechanism and associated complications;
- Analyzing trauma prognostic factors;
- Analyzing the role of air ambulance teams in trauma management;
- Evaluating the need for psychological and psychiatric assistance for polytraumatized patients;
- Evaluating the effectiveness of current trauma protocols and management applied in hospitals in Galați, with suggestions for improvement.

Additionally, the study of specialized literature and the comparative description of therapeutic trauma management protocols for children at the Emergency Unit of the "Sfântul Apostol Andrei" Emergency Clinical Hospital in Galați, as well as at the Emergency Reception Unit of the "Sfântul Ioan" Children's Emergency Clinical Hospital in Galați, can highlight ways to optimize trauma management.

The thesis is structured into two main parts comprising eight chapters as follows: **Part I** – The current state of knowledge and research in the field consists of two chapters and presents current data on the epidemiology, risk factors, and impact of trauma, as well as data on trauma pathophysiology, mechanisms of occurrence, complications, and management. A special chapter is dedicated to the particularities of pediatric polytrauma, highlighting anatomical characteristics and specific management elements.

Part II of the thesis represents the personal contributions and consists of six chapters describing five retrospective cohort studies. The first study is based on cases encountered between 2015 and 2021 in the two major hospitals in Galați County and analyzes, in Chapters 3, 4, and 5, various clinical and trauma management aspects to identify both demographic and clinical factors influencing treatment outcomes, as well as predictors of complications. Chapter 4 evaluates how imaging examination and laboratory test results influenced therapeutic decisions or had predictive value for patient evolution. Chapter 5 examines particularities related to trauma management in children and young adults, highlighting the need for multidisciplinary interventions in developing effective strategies to prevent complications.

Chapter 6 evaluates, through two retrospective cohort studies, the intervention times in pre-hospital settings for air rescue operations and systematically assesses the maneuvers used to

stabilize and diagnose polytraumatized patients. The chapter also includes a case report as an example.

Given that the psychological component of polytrauma is often neglected, Chapter 7 aims to identify the level of emotional distress in patients who have suffered polytrauma and presents the results of two studies conducted using questionnaires to calculate an overall distress score.

The final chapter (Chapter 8) highlights new trends from trauma centers or emergency departments in developed countries and compares the trauma protocol applied in hospitals in Romania (as exemplified by emergency hospitals in Galați County) to propose new strategies that could be useful in improving trauma management, reducing mortality, and morbidity in this specific and complex pathology.

The final conclusions summarize the most important results in light of the proposed objective.

The results of the studies included in this thesis could be used to develop an improved therapeutic strategy for polytrauma and represent a starting point for further research in various areas of medical practice, such as polytrauma evaluation and diagnosis, intensive care interventions, identifying biochemical markers with predictive roles in patient evolution, and the psychological aspects of polytrauma.

PARTEA II. CONTRIBUȚII PERSONALE

The present thesis aimed to conduct clinical research to highlight the relationship between the decisions made by each member of the care team handling a polytraumatized patient in the Emergency Department (ED) and the risk of complications or death for the patient. The studies presented in this thesis seek to investigate the following:

1. The current data available in the literature regarding the incidence of polytrauma in pediatric patients and young adults;
2. The influence of risk factors or negative prognostic factors in the management, treatment, and evolution of polytraumatized patients in the ED;
3. Management protocols for pediatric patients with polytrauma, aiming to reduce the risk of death;
4. The approach to particular elements and the individual characteristics of pediatric patients and their influence on management decisions;
5. The effectiveness of the rapid transfer of patients by air ambulance;
6. The need for psychiatric/psychological assistance for children and young adults with polytrauma.

Thus, this thesis examines the type of management adopted in study groups consisting of two population groups (defined as the pediatric patient group and the young adult group) from the perspective of a multidisciplinary approach, with the ultimate goal of revealing specific characteristics and their implications on patient outcomes.

The main goal of the research is to identify the management peculiarities of patients admitted to the ED and assess whether these meet the patient's needs in preventing catastrophic complications associated with this type of pathology. This objective is achievable by following secondary objectives, outlined below, which are based on the individual characteristics of the polytraumatized patients evaluated in this cohort:

- Socio-demographic evaluation of the distribution of polytrauma within the studied group, with a special focus on the age and sex of the subjects;
- Identification of the main mechanisms of polytrauma occurrence;
- Identification of the prevalence of polytrauma types;
- Evaluation of vital signs and their relationship with the type of trauma identified;
- Clinical, paraclinical, and therapeutic characterization of the entire studied group;
- Assessment of the risk of polytrauma-associated complications, relative to the Glasgow Coma Scale score;

- Correlations between demographic parameters, trauma mechanisms, complication occurrence, or biochemical parameters to identify patterns and risk factors associated with specific clinical outcomes.

To achieve these objectives, during the doctoral stage, two cohort studies were conducted retrospectively, using information from patient observation charts for those presenting with polytrauma from two major healthcare facilities in Galați County, one of the main counties in southeastern Romania: "Sf. Apostol Andrei" County Emergency Hospital and "Sf. Ioan" Children's Emergency Clinical Hospital. The information obtained from the review of observation charts, consultation registers, and the interpretation of imaging investigations performed on patients was centralized in databases and analyzed based on specific criteria. The data collection period ranged from January 2015 to December 2021.

The thesis also includes two studies on patient transfer by air ambulance, as well as a case report illustrating the applied management.

To evaluate the psychological impact of polytrauma, two studies were conducted using specific questionnaires applied to a cohort of patients selected from "Sf. Apostol Andrei" County Emergency Hospital.

All studies were approved by the Bioethics Committee of the Hospitals.

1. PARTICULARITIES IN THE MANAGEMENT OF POLYTRAUMA IN CHILDREN AND YOUNG ADULTS

1.1 Research General Methodology

The study included in this chapter is a retrospective cohort study, utilizing information from the observation charts of patients who presented with polytrauma and were admitted to the emergency departments of the hospitals mentioned above. The information obtained from reviewing observation charts, consultation registers, and the interpretations of imaging investigations performed on the patients was grouped into centralized databases, then statistically analyzed based on specific criteria aimed at achieving the objectives of the thesis. The data collection period spans from January 2015 to December 2021. The creation of the final summary tables, on which the statistical tests described later were performed, was done in a phased manner.

The first phase involved selecting cases that met the necessary inclusion criteria for the study. Initially, 457 cases were selected. These were subsequently filtered based primarily on the completeness of the information, followed by the exclusion of cases that did not fully meet the inclusion criteria. This resulted in a final total of 352 cases.

No filtering criteria based on sex, age, or place of origin were applied in this doctoral work. The inclusion criteria for this study group were as follows:

- The presence of polytrauma in the diagnosis of patients admitted to the ED;
- Obtaining consent to participate in the study;
- Patients aged 0-35 years;
- Use of imaging investigations in their management;
- Admission date during the study period, specifically between January 2015 and December 2021;
- Documentation of complications associated with polytrauma;
- Patients with complete information.

Patients were excluded based on the following criteria:

- Age over 35 years;
- Refusal to participate in the study or to provide the necessary information;
- Patients declared deceased before reaching the hospital.

Data collection and processing were conducted while respecting patient anonymity. Approval was obtained from the Bioethics Committees of the hospitals for accessing and collecting patients' personal information from the hospital's electronic or paper records (observation sheets, consultation registers), as well as the images obtained from imaging evaluations. Consent was obtained from the legal representatives of the patients (through information collection and completion of the prepared questionnaire), as well as from the management of the healthcare facilities (to obtain permission to access their archives). This study was initiated after obtaining approval from the ethics committees of both healthcare institutions.

The subsequent statistical study approached both descriptive and analytical statistics. Descriptive statistical elements (distribution, central tendency, variability or dispersion, minimum and maximum values, Skewness index, and Kurtosis index) were used to describe, display, and summarize the basic characteristics of the data set, as well as to describe the sample and its measurements. In terms of descriptive statistical elements, graphical representations such as pie charts, bar charts, and scatter plots were used.

To determine the degree of dependence between the variables studied, the Chi-square test was used for non-parametric variables, and Pearson correlations for parametric variables. Additionally, contingency tables were created, in which the relative risk concerning different variables was analyzed, as described in detail in the following chapters.

The One-Way ANOVA test was used to determine whether there is statistical evidence that the population means are significantly different by comparing the means of two or more

independent groups. Statistical analysis of this cohort was performed using SPSS statistical software version 26.

1.2. Rezults

Statistical Analysis of Socio-demographic Distribution

In this study cohort, the average age was 27.27 years (ranging from 1 to 35 years), with a standard deviation of 10.025. The age distribution histogram of the cohort shows a lower prevalence of cases at the extreme ages, confirming the hypothesis that young people aged 15 to 29 are more susceptible to polytrauma due to factors such as risky behavior, high levels of physical activity, and higher rates of participation in certain high-risk behaviors [5,14].

Regarding gender distribution for the 352 subjects included in the study, statistical analysis revealed a prevalence approximately three times higher among men (73.35%) compared to women (36.65%), a finding consistent with similar studies [38, 40].

The cohort's distribution by year of admission shows a higher prevalence of cases in 2019 (26.43%, n=93). For the other studied years, the identified prevalence ranged between 7.95% and 17.05%.

Analysis of Injury Characteristics in Polytraumatized Patients

A. Statistical Analysis of Vital Signs

Polytrauma refers to the presence of multiple injuries resulting from a traumatic event, which can have severe consequences on the patient's vital signs and overall health [15]. Monitoring these vital signs in the context of polytrauma can help identify potential complications or other issues that may require immediate intervention [16]. The vital signs monitored in this study include: blood pressure (systolic/diastolic, Tas/TAd), heart rate (HR), respiratory rate (RR), and Glasgow Coma Scale (GCS).

To evaluate the distribution of the cohort based on vital signs, both analytical and descriptive statistical methods were used, identified through distribution histograms with the presence of a distribution curve (Figures 1-5).

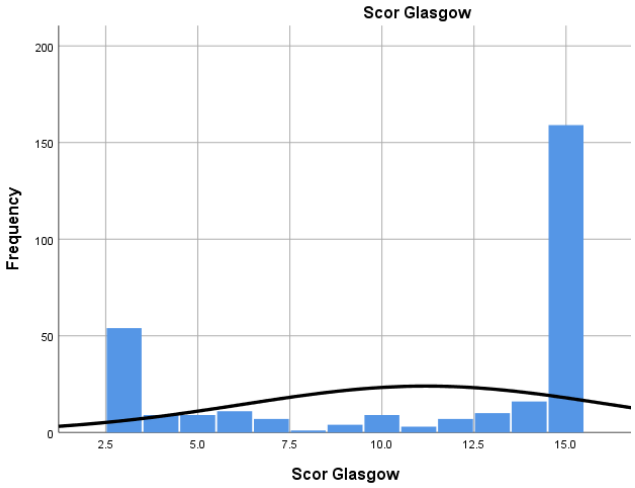


Figure 1. Distribution Histogram of the Cohort Based on GCS

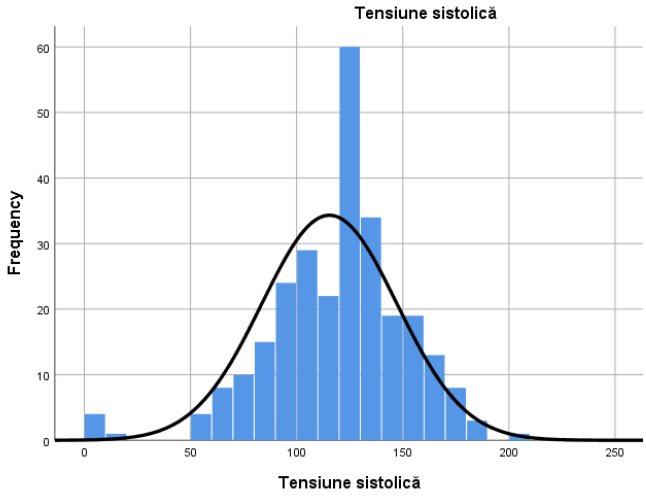


Figure 2. Distribution Histogram of the Cohort Based on systolic blood pressure

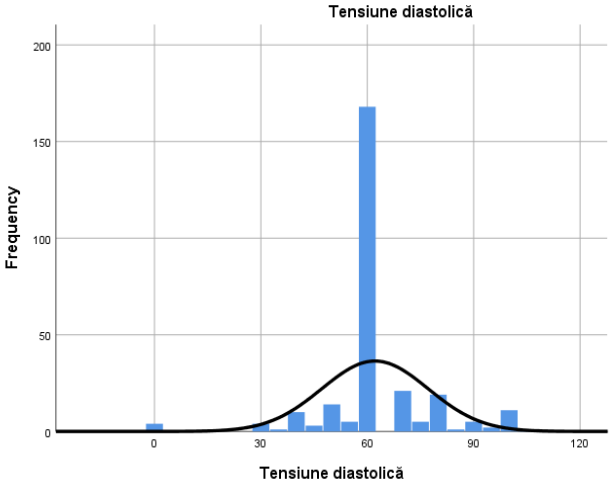


Figure 3. Distribution Histogram of the Cohort Based on diastolic blood pressure

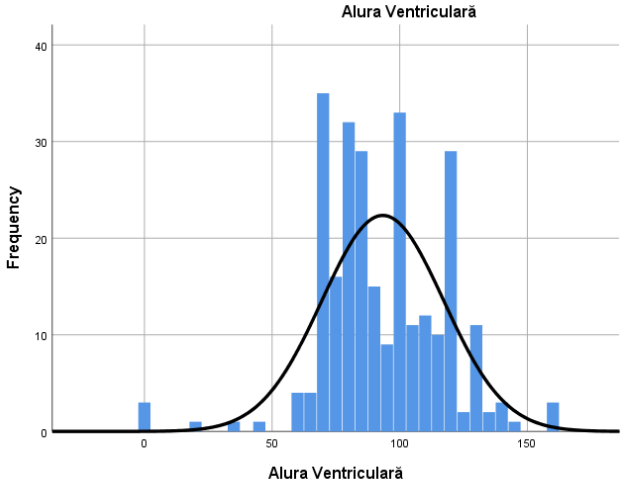


Figure 4. Distribution Histogram of the Cohort Based on pulse

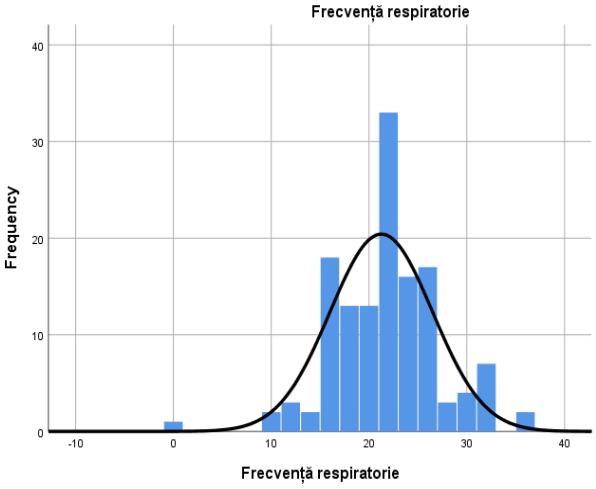


Figure 5. Distribution Histogram of the Cohort Based on respiratory frequency

For the analyzed parameters, a Pearson correlation analysis was performed, and subsequently, the correlation results were examined using the Holm correction to adjust for multiple comparisons based on an alpha value of 0.05. The interpretation of the data indicates that:

- The Glasgow score shows a moderate negative correlation ($r = -0.187$), with statistical significance at $p < 0.05$ ($p = 0.031$), only with heart rate.
- Diastolic blood pressure shows weak positive correlations but with statistical significance with systolic blood pressure ($r = 0.847$, $p < 0.01$) and heart rate ($r = 0.163$, $p < 0.05$).
- Systolic blood pressure shows a strong positive correlation with diastolic blood pressure ($r = 0.847$, $p < 0.01$) and significant negative correlations with heart rate ($r = -0.249$, $p < 0.01$) and respiratory rate ($r = -0.561$, $p < 0.01$).
- Heart rate is moderately correlated with systolic blood pressure ($r = -0.249$, $p < 0.01$) and respiratory rate ($r = 0.495$, $p < 0.01$).
- The strongest positive correlations are between diastolic blood pressure and systolic blood pressure ($r = 0.847$).
- Heart rate has a moderate negative correlation with both systolic blood pressure and respiratory rate, suggesting interdependence between these parameters.

B. Prevalence of Injuries Identified in the Study Group

The specific types of traumatic injuries that can occur in polytrauma patients may vary depending on the cause and severity of the trauma, the injury mechanism, the patient's age and overall health, as well as the body's response to injuries.

The prevalence of cranio-cerebral (CCT) or cranio-facial trauma (CFT) in the cohort was 60.22% (n=212). The most frequently recorded cranio-cerebral trauma (CCT) in this study group was severe acute CCT (20.17%, n=71). Different levels of severity of cranio-cerebral trauma were identified within the cohort, associated with the following prevalence (Figure 6):

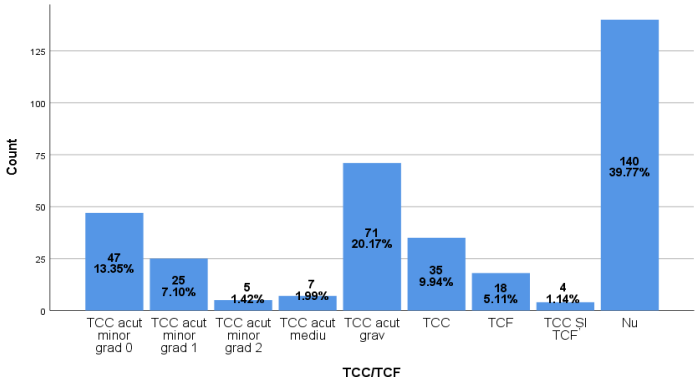


Figure 6. Prevalence of Identified Cranio-cerebral and Cranio-facial Trauma Types in the Study Group

Out of the 352 subjects, 25.00% (n=88) presented with thoraco-abdominal trauma, 7.39% (n=25) had thoracic trauma, and 1.42% (n=5) had spinal cord trauma. Additionally, 2.56% (n=9) had lower limb trauma, while 1.70% (n=6) had upper limb trauma, and 3.69% (n=13) had pelvic trauma. A small percentage, 0.28% (n=1), presented with both pelvic and lower limb trauma.

Spinal traumas were divided according to anatomical segments involved. The highest prevalence was recorded at the cervical spine level (11.08%, n=39). Furthermore, 2.56% (n=9) had lumbar spine trauma, 1.14% (n=4) had thoracic spine trauma, and 0.57% (n=2) had sacroiliac spine trauma. In addition, 0.83% (n=3) presented with complete spinal trauma.

In this subchapter, the prevalence of fractures was evaluated according to the affected anatomical segment. It was observed that most fractures occurred in the upper limbs (9.09%, n=32) and lower limbs (3.98%, n=14), followed by skull fractures (5.97%, n=21), rib fractures (5.68%, n=20), pelvic fractures (2.53%, n=9), vertebral fractures (3.41%, n=12), and clavicle fractures (0.85%, n=3).

C. ***Prevalence of the Mechanism of Polytrauma Identified in the Study Group***

Polytrauma can result from various mechanisms that cause multiple traumatic injuries affecting different parts of the body. In this study, the most frequent mechanism of polytrauma was road traffic accidents. The second most common mechanism identified in this study was polytrauma caused by falls from height (15.50%, n=51). Polytrauma resulting from falls and assaults also represented a significant proportion of the study group (Figure 7).

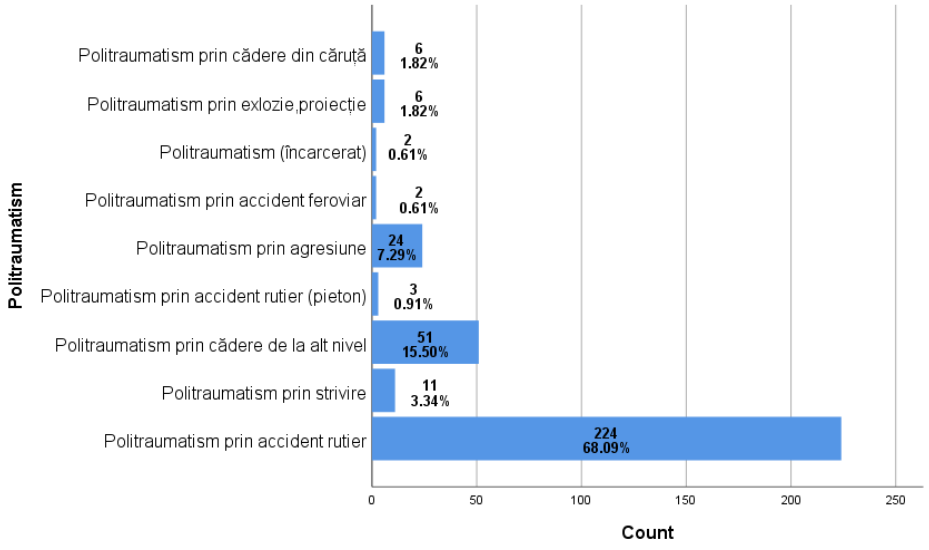


Figure 7. Prevalence of Trauma Mechanisms in Relation to the Study Group

For the statistical analysis of the relationship between the subjects' gender and the type of trauma presented, contingency tables were developed, and chi-square independence tests were applied to determine whether there was a statistically significant dependency between the subjects' gender and the type of trauma sustained. In both men and women, the most common type of cranio-cerebral trauma (CCT) in the cohort was severe CCT (M=50, F=20), followed by acute minor CCT grade 0 (M=31, F=15). It was observed that, among female subjects, only cervical and lumbar spinal traumas were identified, while male subjects presented with sacroiliac, thoracic, and complete spinal traumas.

Chi-square correlation tests did not show significant correlations ($p>0.05$) between the patients' gender and the type of trauma.

D. Analysis of Complications Associated with Polytrauma in the Studied Cohort

Polytrauma can lead to various life-threatening complications if not promptly identified and treated. This subchapter examines the prevalence of post-traumatic complications, categorized by affected anatomical segments, the type of complication, and the consequences associated with them. The most common type of shock identified in the cohort was traumatic shock (3.14%, n=12), followed by hemorrhagic shock (2.56%, n=9). In 0.85% of subjects, both traumatic and hemorrhagic shock were present. A fraction representing 0.57% (n=2) experienced hypovolemic shock, while 0.28% (n=1) had cardiogenic shock.

The study identified a high prevalence of spleen ruptures (3.14%, n=12), while 0.57% (n=2) presented with liver ruptures. Additionally, 0.28% (n=1) of the subjects had both spleen and liver ruptures.There was a low prevalence of hemoperitoneum (3.14%, n=12) and pneumomediastinum (0.57%, n=2), while the prevalence of hemopneumothorax was approximately five times higher, at 2.56% (n=9). On the other hand, pneumothorax had a prevalence approximately three times higher than hemopneumothorax, with 8.52% (n=30) of subjects presenting this complication.

Coma, intubation, mechanical ventilation, and cardiorespiratory arrest are all potential complications that may occur in trauma patients. Out of the 352 subjects, 17 experienced cardiorespiratory arrest (CRA). Of these, 11 patients (3.13%) did not respond to resuscitation efforts, while 1.7% (n=6) were successfully resuscitated. Out of the 352 subjects, 7.39% (n=26) were intubated and mechanically ventilated, while 92.61% (n=326) did not require this procedure. A total of 11.36% (n=40) of subjects experienced coma.

In the study cohort, there was a 6.82% (n=24) prevalence of subarachnoid hemorrhage, and a minor percentage (1.14%, n=4) of subjects had epistaxis. This study also highlighted that subdural hematomas had the highest prevalence (4.84%, n=17), while 1.42% (n=5) were epicranial, 2.28% (n=8) were extradural, and 0.28% (n=1) were paravertebral or intraparenchymal.

Ethanol intoxication can have a significant impact on the management and outcomes of polytrauma patients who have sustained multiple injuries to different parts of the body. In this study, a prevalence of 4.26% (n=15) for ethanol intoxication was identified.

The relationship between the type of trauma and the severity or nature of complications can vary depending on the specific injuries involved. This chapter also evaluated the statistical relationships between polytrauma complications, the mechanism of polytrauma occurrence, and the types of polytrauma identified in the studied cohort.

1.3. Discusions

According to the results obtained from data processing, there is a high incidence of cranio-cerebral or cranio-facial injuries (60.22%), followed by thoraco-abdominal injuries (25%), thoracic injuries (7.4%), and pelvic injuries (3.7%). The most common type of cranio-cerebral trauma in the cohort was severe cranio-cerebral trauma (n = 71 cases, M = 50, F = 21). Limb injuries had a significantly lower prevalence (2.5% for lower limbs and 1.7% for upper limbs), while spinal cord injuries had the lowest incidence (1.4%). Contusions were primarily localized to the abdominal area (82% of cases) and thoraco-abdominal area (10%). In 84 cases, representing 23.8%, polytrauma affected both the thoraco-abdominal area and the head, while in only 16 cases (4.54%), cranial trauma was associated with limb or pelvic trauma, and in 19 cases (5.39%), cranial trauma coincided with spinal trauma.

The data obtained are consistent with recent literature, which also reports a high incidence of cranio-cerebral injuries compared to other types of trauma, noting that cranial trauma is the leading cause of trauma-related mortality [17].

The study presented in this thesis reports a higher incidence of thoraco-abdominal trauma (25%) compared to other studies, with the majority of patients being male (male-to-female ratio of 3.3). None of the male subjects presented with pelvic or lower limb trauma, while no female subjects presented with spinal cord trauma. The Chi-square test results suggested that there is no significant correlation between the gender of the patients and the type of thoraco-abdominal trauma ($p = 0.386$).

Traffic accidents were the primary mechanism of thoraco-abdominal trauma (76%), followed by falls from height (13.5%) and crush injuries (5.4%). Assaults accounted for a relatively small proportion of this type of trauma (2.7%, n = 3). A total of 21.6% of patients with this type of trauma had a GCS score < 8. Associated thoraco-abdominal trauma injuries include internal injuries such as abdominal contusions (93.7%), pneumothorax (5.4%), liver contusions (3.6%), hemothorax (2.7%), and organ ruptures. Chest wall injuries such as rib fractures and pelvic fractures were relatively rare, each accounting for 3.6% of cases. Thoraco-abdominal trauma was often associated

with upper limb fractures (75.6%). Spinal fractures were observed in 2 cases of thoraco-abdominal trauma. The data are consistent with recent literature, which identifies thoraco-abdominal trauma as a life-threatening cause [18-21].

Regarding fractures, the majority were recorded in the upper limbs (9.09%, n = 32) and lower limbs (3.98%, n = 14), followed by skull fractures (5.97%, n = 21), rib fractures (5.68%, n = 20), pelvic fractures (2.53%, n = 9), vertebral fractures (3.41%, n = 12), and clavicle fractures (0.85%, n = 3). Additionally, 2 subjects presented with spinal canal fractures. Multiple fractures were also identified, each representing 0.28% (n = 1), in combinations such as lower limbs and ribs, ribs and clavicle, pelvis and spine, pelvis and skull, skull and ribs. Extremity traumas accounted for 4.2% of total cases, with a higher prevalence in the upper limbs, as also reported by other studies [22].

As for trauma etiology, traffic accidents were the dominant mechanism of injury, accounting for 71.4% of cases, followed by falls from height (15.5%) and assaults (7.3%). Only 3.3% of patients had crush injuries as the cause of trauma, and only 1.8% were caused by explosions.

Since patients with multiple traumas represent a heterogeneous group, the development of complications is difficult to predict. Therefore, this study focused on possible variables and correlations that could influence the evolution of a patient regarding complications. According to recent literature, traumatic injuries that can lead to life-threatening complications include: tension pneumothorax, untreated open pneumothorax, massive hemothorax, cardiac tamponade, hemorrhagic shock, myocardial infarction, sepsis, pulmonary embolism, traumatic shock, organ rupture, acute respiratory distress syndrome (ARDS), acute renal failure, orotracheal intubation, and coma [11,18,23].

This study highlighted the following complications in descending order of prevalence: coma (11.36% of cases in the study cohort), pneumothorax (8.52%), cardiorespiratory arrest (4.8%), hemoperitoneum (3.31%), organ rupture (3.26%, with spleen rupture being the most common at 3.14%), traumatic shock (3.14%), and hemorrhagic shock (3.14%). A total of 7.4% of patients were intubated, 7.12% had hematomas (predominantly subdural, 4.84%), and 6.8% had subarachnoid hemorrhages.

The statistical relationship between polytrauma complications and the types of trauma identified in the study cohort revealed a highly significant dependency between cranio-cerebral or cranio-facial trauma (CCT/TCF) and coma ($p < 0.001$), a significant relationship for orotracheal intubation and mechanical ventilation ($p = 0.005$), and hematomas ($p = 0.03$), with a significance level of $\alpha = 0.05$. A highly significant relationship ($p < 0.001$) was also found between spinal trauma and organ rupture and pneumomediastinum, as well as a significant relationship between spinal trauma and hemopneumothorax ($p = 0.002$). No significant relationships were found in other

situations ($p > 0.05$). Cranial trauma was significantly correlated with orotracheal intubation and mechanical ventilation ($p = 0.005$).

Pneumothorax had a prevalence of 8.5% among the study participants, but statistical analysis did not show significant correlations with the type of trauma ($p > 0.05$).

Compared to reports in the literature, cardiorespiratory arrest had a high prevalence (4.8%, n = 17) in the group of polytrauma patients included in this study. Of these, 11 patients (3.13%) did not respond to resuscitation efforts, while 1.7% (n = 6) were successfully resuscitated. The primary data analysis in this thesis suggests that cardiorespiratory arrest is associated with thoracic or thoraco-abdominal trauma (n = 8), CCT (n = 6), or spinal trauma (n = 4). In most cases, polytrauma involved a combination of the aforementioned injuries (thoracic and cranial trauma, thoraco-abdominal and spinal trauma). In 35.3% of cases, patients had a GCS score < 8.

Organ rupture had a prevalence of 4%, with spleen rupture being the most common (3.14%, n = 12) in this study, while 0.57% (n = 2) had liver ruptures. Statistical analysis showed a significant correlation with spinal trauma ($p < 0.001$).

Although rare in this study, pneumomediastinum and hemopneumothorax were significantly correlated with spinal trauma ($p < 0.001$ for pneumomediastinum and $p = 0.002$ for hemopneumothorax).

Hematomas were relatively rare in the study cohort, with the majority of cases being without hematomas (n = 320). Subdural hematomas had the highest prevalence (4.84%, n = 17), while 1.42% (n = 5) were epicranial, 2.28% (n = 8) were extradural, and 0.28% (n = 1) were paravertebral or intraparenchymal. Subdural hematomas had a prevalence of approximately 5% (n = 17). Their distribution showed significant variation in the data set. In terms of correlation analysis, hematomas were significantly correlated with cranio-cerebral or cranio-facial trauma ($p = 0.03$).

Shock occurrence was also relatively rare in the data set (7.6%), with traumatic shock being the most frequent type (n = 15), followed by hemorrhagic shock (n = 9). A combination of traumatic and hemorrhagic shock was recorded in only 3 cases, while hypovolemic shock was less frequent, with only 2 cases. Cardiogenic shock was reported in one case. Although statistical analysis did not show correlations between the occurrence of shock and the type of trauma, the primary data revealed that both traumatic and hemorrhagic shock occurred in most cases with cranial trauma (n = 15), followed by thoracic, spinal, pelvic, or combined cranial and thoraco-abdominal trauma. In the majority of shock cases, polytrauma resulted from a traffic accident (n = 18). In only six cases was the cause a fall from height. Based on the etiology and hemodynamic characteristics, the literature divides traumatic shock into four subtypes: distributive, hypovolemic, cardiogenic, and obstructive.

Surprisingly, only 4.2% of cases in the study involved ethanol intoxication, defined as a blood alcohol concentration greater than 0.4 g/L. In most cases of ethanol intoxication, it was associated with cranial trauma (67%) or with polytrauma involving cranial and thoraco-abdominal or pelvic injuries. A total of 33.3% of patients with ethanol intoxication had a GCS score < 8 points. These data are confirmed by the literature, which associates alcohol consumption with an increased incidence of cranial trauma. Moreover, the severity of cranio-facial injuries was found to be higher in intoxicated patients [24].

Data analysis shows that polytrauma etiology is primarily represented by traffic accidents, although assaults account for a higher proportion in these cases (33.3%) compared to the overall prevalence of assaults in total trauma cases (6.8%). The mechanism of polytrauma occurrence was significantly correlated with the presence of hematomas ($p = 0.063$) and the incidence of cardiorespiratory arrest ($p = 0.012$). This variable is also related to the presence of hemoperitoneum ($p = 0.003$), hemopneumothorax ($p = 0.097$), pneumothorax ($p = 0.013$), and ethanol intoxication ($p = 0.027$).

The relative risk of polytrauma occurrence, as described above, was assessed by the odds ratio (OR) for different types of polytrauma, categorized simply by their presence or absence, without detailing severity levels.

- OR had a value of 0.745. Additionally, it was observed that among female subjects, the relative risk of coma was 1.246 times higher compared to the opposite gender.
- The initial phase evaluated the estimated risk of cranio-cerebral trauma occurrence. OR had a value of 1.006. The relative risk of CCT was 1.002 times higher among male subjects.
- The estimated risk of cranio-facial trauma occurrence was also evaluated. OR had a value of 2.003. The relative risk of CFT was 1.258 times higher among male subjects.
- OR for lower limb trauma was 1.476. Additionally, the estimated risk of lower and upper limb trauma was 1.121 times higher in male subjects compared to females.
- The estimated risk of pelvic trauma occurrence was also evaluated. OR had a value of 1.102. The relative risk of pelvic trauma was 1.029 times higher among male subjects.
- OR had a value of 0.754. Additionally, it was observed that among female subjects, the relative risk of abdominal trauma was 1.135 times higher compared to the opposite gender.
- Furthermore, females had an estimated 1.104 times higher risk of thoracic trauma compared to males, with OR having a value of 0.874.
- Finally, females were associated with an estimated 1.595 times higher risk of lumbar spinal trauma compared to males. The OR value was 0.549.

2. EVALUATION OF CLINICAL AND PARACLINICAL COMPONENTS USED IN POLYTRAUMA MANAGEMENT

2.1. Motivation and Study Method

Imaging is thus an essential component in reducing mortality among polytraumatized patients, serving as part of proper diagnosis and guiding both emergency and definitive treatment. Additionally, laboratory tests play a crucial role in the management of polytraumatized patients, contributing to treatment monitoring and adjustment. Key tests include arterial blood gas analysis, hemoglobin levels, blood glucose, and lactate levels, as well as monitoring acid-base balance, electrolytes, and coagulation potential, providing information about respiratory function and the degree of hemorrhagic shock. In this chapter, the results obtained from imaging and laboratory tests for the study cohort described in the previous chapter are examined.

The identified imaging methods included computed tomography (CT), radiography, and ultrasound. Regarding laboratory tests, in addition to the complete blood count (CBC), tests used to monitor coagulopathy included prothrombin time (PT), activated partial thromboplastin time (aPTT), international normalized ratio (INR), and fibrinogen levels. Electrolyte imbalances, or dys-electrolytemia, are common in trauma patients and can have a significant impact on clinical outcomes. Thus, in this study, the distribution of the cohort based on blood electrolyte levels and other biochemical and hematological tests was assessed using specific distribution indices found in frequency analysis.

An analysis of variance (ANOVA) was performed to determine whether there were significant differences in leukocyte values depending on the presence of certain types of trauma. The conclusion of the ANOVA tests suggests that among the types of trauma analyzed, only cranio-facial trauma showed significant differences between the evaluated groups. This means that there are important variations in how cranio-facial trauma affects patients in different groups (possibly depending on severity, treatment, or other variables). For other types of trauma, such as cranio-cerebral trauma, abdominal trauma, thoracic trauma, and cervical and thoraco-lumbar spine trauma, no statistically significant differences were identified between the groups. This indicates that in these cases, the traumatic impact is similar across the compared groups, and there are no major variations suggesting significant differences in approach or severity. From a medical perspective, this may mean that interventions or injury severity for most of the analyzed traumas are relatively constant, except for cranio-facial traumas, which may require special attention or a different approach depending on the patient groups.

2.2. Discusions

Imaging and laboratory testing play a crucial role in trauma care [25–28]. Imaging is essential for diagnosing clinically missed injuries to reduce complications and morbidity. Imaging protocols must continuously adapt to the patient's dynamic clinical status. Radiologists need to adopt a patient-centered approach to ensure appropriate early care for these severely injured patients [28]. In this study, radiography, ultrasound, and computed tomography (CT) scans of the thorax, spine, brain, abdomen, and pelvis were highlighted.

For radiographs, a significant number of exams showed no detectable post-traumatic changes (n = 58, representing 41.1% of the total 141 cases in which radiographs were performed). Fractures were the most frequent finding (n = 26, representing 18.4%). Opacities and emphysema were the next most common findings, recorded in 10 and 7 cases, respectively. Rarer findings included mediastinal displacement, pulmonary interstitial thickening, and pneumothorax.

Emphysema, on the other hand, appeared to be the most common finding in thoracic CT scans (n = 78). The variety of findings, such as fractures, pneumothorax, pulmonary contusions, pseudomediastinum, and fibrotic changes, suggests a wide range of pathologies evaluated in thoracic CT scans. Pneumothorax was mentioned in 16 cases, and fractures in 8 cases. In the dataset representing findings from CT scans of the abdomen and pelvis, a wide range of findings were observed, including fractures (n = 7), hematomas (n = 4), splenic changes, hepatomegaly, hemoperitoneum, and fluid accumulations. In the dataset related to CT interpretations of the spine, notable findings included fractures (6 records), fissures, and retrolisthesis, each observed in 3 records.

Intracerebral lesions observed in native CT brain scans included epidural/subdural hematomas and subarachnoid hemorrhage in 9 and 8 cases, respectively, as well as small hemorrhagic contusions in 7 cases. Complex injuries combining multiple types of lesions, such as fractures, hematomas, and hemosinus, were observed in a smaller number of cases (n = 4). Simple fractures and other specific lesions, such as diffuse cerebral edema, punctate hyperdense lesions, and intracerebral hemorrhagic collections, were even rarer, with only 2 cases each. Single occurrences of rare conditions, such as maxillary/sphenoidal hemosinus, paracerebral foreign body, or pneumocephalus, highlight both the diversity of possible injuries in such trauma cases and their rarity. Combined injuries suggest a subgroup of patients with particularly severe trauma, reflecting a multidimensional impact.

For 45 patients, multiple imaging exams were performed, including radiography, CT, and ultrasound. Of these cases, over 50% (n = 25) were victims of traffic accidents, and 15 polytrauma patients had a GCS score <8. A total of 22 cranio-cerebral traumas and 11 cases of cranial and

thoraco-abdominal trauma were diagnosed. For 109 patients, both CT and radiographs were performed, for 45, CT and ultrasound, and for 54, radiographs and ultrasound

The combination of emergency imaging exams is recommended, especially in thoracic and abdominal trauma. While an upright radiograph can rule out air under the diaphragm, suggesting bowel perforation, ultrasound may be a better diagnostic tool than supine radiography for pneumothorax and pulmonary contusions [20]. According to studies, abdominal CT scanning in blunt trauma has a sensitivity of 67% for predicting the need for surgery (with a negative predictive value of 98.7%) [29]. CT scanning is the best choice for solid organ imaging (liver and spleen) and remains the gold standard for evaluating abdominal trauma in hemodynamically stable patients [29,30]. Although ultrasound is not as sensitive for intra-abdominal trauma and does not provide as much anatomical detail to grade injuries, it can effectively visualize peritoneal fluid/blood, which usually originates from solid organ injury [31]. The use of ultrasound to evaluate stable or unstable patients with abdominal trauma has been described by the term "Focused Assessment with Sonography for Trauma" (FAST) [20].

Regarding laboratory tests, initial assessment protocols recommend routine testing to gather sufficient information about the patient's hemodynamic, respiratory, and metabolic stability, including the severity of blood loss. These include hematological tests, arterial blood gases, coagulation tests, and biochemistry specific to renal and liver function [32]. In this study, laboratory tests for trauma patient assessment included complete blood counts, electrolyte and acid-base balance parameters (pH, Na, Cl, K serum levels), liver tests (ALT, AST, bilirubin), kidney tests (urea, creatinine), amylase, and creatine kinase. Statistical analysis (ANOVA, correlation tests) of the collected data did not identify significant correlations between trauma type and the hematological or biochemical parameters analyzed ($p>0.05$). It should be noted that over half of the study subjects did not have available laboratory test results. However, some observations were deduced from raw data.

Regarding the number of leukocytes, of the 147 existing records, 95 (64%) presented values above the maximum reference value of 11,000/mm³ blood. Of these, 21 patients had a GCS score <8. Among those with elevated values, 52 (54%) had suffered a cranio-cerebral trauma, 35 (36.8%) had thoraco-abdominal trauma, and 15 (15.7%) had spinal trauma. In 19 cases, polytrauma involved both the head and thoraco-abdominal areas. For hemoglobin and hematocrit, there are 147 available records (46 female patients, 101 male patients). A total of 18 women and 69 men (59.2% overall) had hemoglobin values below the reference value (12 g/dl for women and 14 g/dl for men). Regarding hematocrit, a larger number of patients (20 women and 73 men, representing 63.2% of the total) had values below the reference threshold (41% for men and 26% for women). Nine patients with low hemoglobin and hematocrit were in a coma.

The platelet count (PT) was below the minimum reference value (150,000/mm³) in 20 cases (13.9%). In 6 of these cases, the GCS score was below 8. In 5 cases, values above 450,000/mm³ were recorded, with the highest value being 1,334,000 in a case of severe polytrauma (CCT and thoraco-abdominal trauma). Regarding lymphocyte count, of the 143 existing records, 25 patients (17.4%) had values below the reference threshold (1,000/µl), of which 4 had a GCS score <8, and 14 had values above 4,800/µl (three patients with GCS<8). While leukocyte count, hemoglobin, and hematocrit were altered in approximately 60% of cases, platelet and lymphocyte count alterations were much rarer (14% and 17.4% of records, respectively).

Although the most frequent cases of out-of-range parameters were in the category of cerebral trauma, given the higher general proportion of this type of trauma, no clear conclusion can be drawn about data correlations (as confirmed by statistical analysis). Although significant differences were found in hematological parameters between patients with single and multiple traumas, no correlations could be established between hematological parameters and complication rates. Routine laboratory evaluations of trauma patients should be conducted as a guide to treatment.

Regarding coagulation parameters, in this study, Quick time, activated partial thromboplastin time (aPTT), fibrinogen, and INR were compared between patient groups. Of the 129 Quick time records, in 85 cases (65.9%), values exceeded the reference value (13s). Of these, 23 patients had a GCS score <8. Once again, cerebral (n=45) and thoraco-abdominal traumas (n=25) generated Quick time values outside the reference range. For aPTT, of the 123 records, only 12 cases (9.7%) had values above the reference level (40s). For INR, of the 128 recorded cases, in 55 cases (42.9%), INR>1.2 (as the maximum reference value). In this category, the majority of patients with GCS<8 were recorded (n=19), and 8 patients were in a coma. A total of 31 of these patients suffered CCT, 17 thoraco-abdominal trauma, and 5 spinal trauma. In 8 cases, patients had polytrauma involving both the thoraco-abdominal and cranial areas. No cases with INR values below 0.8 were recorded. Fibrinogen levels exceeded 400mg/dl in 17 of the 36 records (47.2%), while values below 200mg/dl were found in 7 cases (19.4%). Approximately half of the patients with fibrinogen levels outside the reference range (n=8) had a GCS score <8. Except for aPTT, coagulation parameters were altered in over 42% of polytrauma patients. INR can be correlated with trauma severity (GCS<9).

It was also noted that, although Quick time, aPTT, and INR were prolonged, this did not coincide with a significant reduction in platelet count except in a small number of cases (for INR, of 55 cases with values >1.2, in only 6 did the platelet count drop below 150,000; for Quick time, of 85 cases with values above 13s, only 8 had platelet counts below 150,000/mm³). The incidence of coagulopathy in this study was over 42%, observations comparable to other studies, which also

reported a higher number of coagulopathic patients: approximately 60% in a 2-year study (2012-2014) at a tertiary trauma center [33] or 41.4% in a study conducted at a Level 1 trauma center (2015) [34]. Contrary to other hematological parameters, coagulation parameters are good predictors of morbidity and mortality [33,35].

It is known that trauma patients have the potential to develop electrolyte imbalances. In this study, the available parameters from observation sheets were analyzed: serum Na, serum Cl, and serum K. Of the 107 records containing the result for serum Cl, in 9 cases (8.4%), the parameter value was above the physiological limit (>110 mmol/L), and in one patient, the critical limit of 120 mmol/L was exceeded. Increased serum Cl coincided in 5 of the 9 cases with increased serum creatinine. Additionally, Cl elevation was associated with increased Na values in all 9 cases, while K levels remained normal. Three of the patients had a GCS score <8. Regarding serum Na, the data revealed 111 records, none of which reached the critical threshold of 120 mmol/L. Four values below the physiological minimum (135 mmol/L) and 11 values above the physiological maximum (145 mmol/L) were recorded, representing 13.5% of cases with electrolyte imbalances. For potassium, with the same number of records (n = 111), 24 values (21.6%) were recorded below the physiological limit of 3.5 mmol/L, but in no case did serum K fall below the critical threshold of 2.5 mmol/L. In only two cases did serum K exceed the physiological maximum (5.1 mmol/L), without exceeding the critical value of 6.5 mmol/L.

In this study, the most frequent imbalance was in potassium ions, without being simultaneously associated with Na or Cl imbalances. Furthermore, the prevalence of imbalances among patients did not exceed 25% of cases, varying depending on the parameter analyzed. Other studies show different values, such as 13.7% of trauma patients presenting electrolyte abnormalities [36], 65% of hypokalemia cases in cranial trauma patients, the most frequent imbalance recorded at a tertiary trauma center (Thailand) [37], or 36.5% of hyponatremia and 48% of hypokalemia cases recorded at a tertiary trauma center (China) [38].

Creatinine, urea, aspartate transaminase, alanine transaminase, and amylase were reviewed in all study cases to correlate with trauma severity or complications. Regarding creatinine as a marker of renal function, the collected data showed 140 records, of which 22.1% (n=31, average value 1.46 mg/dl) exceeded the parameter's maximum limits (1.3 mg/dl for men and 1.1 mg/dl for women), but 20.7% (n=29) of cases had values below the minimum limits. Of these patients, 9 had a GCS score <8. In only two cases were the patients in a coma.

For transaminases, the data showed 136 records, of which in 48 cases (35.3%), the measured values exceeded the physiological limits. In 14 of these cases, patients had a GCS score <8, and 5 patients were in a coma. Total bilirubin was elevated in 8% of the 112 records, while direct bilirubin exceeded the maximum limit in 47% of the 98 records.

A biochemical parameter that showed the highest rate of alteration was creatine kinase. Of the 81 available records, in 56 cases representing 69.1%, CK values exceeded the maximum limits (192 U/L for women, n=18, and 306 U/L for men, n=38).

As shown, the prognostic value of biochemical parameters is relatively low, but knowledge and monitoring of these values throughout treatment are necessary. Studies have also shown that transaminase levels were significantly higher in patients with severe rhabdomyolysis, indicating liver damage, and that there is a positive correlation between CK and liver enzymes in trauma, suggesting hepatic involvement in severe rhabdomyolysis [39].

3. STUDY ON THE MULTIDISCIPLINARY APPROACH TO THE PEDIATRIC PATIENT

3.1. Introduction

Due to anatomical and physiological particularities, pediatric traumatology is a complex field with unique characteristics and requirements [40–42]. The larger head-to-body ratio of a young child requires either torso support or an occipital recess to avoid cervical spine flexion in the supine position [43]. When airway assessment considers intubation, the short trachea and relatively vertical right main bronchus must be taken into account [44]. The high surface area-to-body mass ratio must be considered in preventing hypothermia, which, along with acidosis and coagulopathy, forms the lethal triad [45]. Physiologically, children have a high capacity for compensation in the context of blood loss (blood pressure remains normal until more than a quarter of the circulating volume is lost), but decompensation is more abrupt, with tachycardia being a more important sign in pediatric trauma than in adults [41,46]. Moreover, unlike the sequential and delayed onset of multi-organ failure in adult patients, children with trauma experience early multi-organ failure, with simultaneous organ system dysfunction [43].

Prognostic evaluation of pediatric polytrauma patients is more difficult because trauma scores developed for adults are not universally applicable to children [7]. The Pediatric Trauma Score (PTS), dedicated to pediatric patients, includes not only skeletal, skin, and central nervous system injuries but also physiological parameters such as body weight, systolic blood pressure, and airway status. However, the value of PTS as a prognostic factor in pediatric patients has been controversial [47]. The Injury Severity Score (ISS), calculated based on the Abbreviated Injury Scale (AIS), takes into account the three most severely injured body regions [10]. [Butcher NE, 2014].

To better understand the age-related characteristics of polytrauma in children, this chapter presents the results of a retrospective study conducted at "Saint John" Children's Hospital in Galați.

3.2. Study Cohort and Research Method

This study involves a cohort of 80 pediatric patients, aged between 3 and 18 years. Data from the archives of the “Saint John” Children's Hospital in Galați, covering a 7-year period (from 2015 to 2021), were evaluated. Statistical analyses and the results obtained are retrospective in nature.

Inclusion Criteria:

a) The study includes patients aged between 0 and 18 years who present with polytrauma, defined as the presence of two or more severe injuries involving different systems or anatomical regions.

b) Patients must be hospitalized in a facility or unit specializing in pediatric trauma care.

c) Patients must have a confirmed polytrauma diagnosis based on initial evaluations such as primary trauma assessment (ABC), radiological evaluations (e.g., chest X-ray, computed tomography), and/or other relevant clinical assessments.

Exclusion Criteria: refusal of informed consent. Patients or their parents/legal representatives who refuse to provide informed consent for participation in the study will be excluded.

Data Collection: Demographic data were collected about the patients, including age, sex, and relevant medical history, as well as initial patient assessment data, such as injury severity scores and other specific clinical evaluations.

Statistical Analysis: Microsoft Office 2010-EXCEL was used for data recording, and the SPSS program, version 20.0, was used for statistical analysis. Frequency tables were created and graphically represented using bar charts. For descriptive analysis of variables, central tendency indicators were used: mean value and standard deviation for normally distributed variables, and median and mean deviation for abnormally distributed variables. The Chi-square test (Pearson Chi-square) was used for differences between nominal variables, and Fisher's test was applied in cases where a low frequency of specific variables was recorded. The threshold for statistical significance was set at $p<0.05$. The graphs and tables presented in the study were generated using the SPSS editor.

The study was conducted in accordance with ethical principles and with the approval of the institution's ethics committee.

Limitations of the Comparative Research on the Multidisciplinary Approach to the Management of Polytrauma in Pediatric Patients included the following aspects:

- Patient selection: Due to the specific nature of polytrauma and pediatric patients, various factors may influence the inclusion and exclusion of patients in the study, such as the availability of eligible patients, informed consent, and patient compliance with the study.
- Clinical practice variation: Significant variation in clinical practice among different institutions and specialists may influence the results and interpretation of the study. Differences in approaches, treatment protocols, and polytrauma management may affect the comparability of results and the generalizability of the study.
- Outcome measurement: The definition and measurement of clinical and care outcomes may be subjective or vary between different institutions and specialties. Standardized evaluation of outcomes may be difficult and could affect comparability between intervention and control groups.
- Variability in resources and medical teams: The availability and access to resources necessary for a multidisciplinary approach may vary between institutions and regions. The quality and experience of multidisciplinary medical teams may differ, which could influence the results and generalizability of the study.

These limitations highlight the complexity and challenges associated with comparative research on the multidisciplinary approach to managing polytrauma in pediatric patients. However, such research can contribute to improving patient care and outcomes in the future.

3.3. Rezults

As in the previous study, male patients represent a majority of 68.7% (n=55) of the total patients. The age histogram of the patients reveals a normal Gaussian distribution curve, with peak incidences around the ages of 5-7 years, an average of 10.26 years (standard deviation SD of 4.9), and a median of 9 years.

From the descriptive data resulting from the statistical analyses performed on the scalar parameters obtained from the patients in this study cohort, the following conclusions are drawn:

- At the time of admission by the SAJ/SMURD teams, the GLS score was assessed for each patient. It can be observed that the mean value is 11.84 points, ±SD of 4.6 points. The minimum score was 3 points, and the maximum score was 15 points.
- The heart rate (HR) of the subjects varies between 65 – 160 bpm, with an average of 103.77 bpm and an SD of ±21.7 bpm.
- The average respiratory rates are 23.79 breaths per minute, ±SD of 3.5. As in the previous case, the statistical indicators describe a homogeneous distribution, with a minimum of 19 breaths and a maximum of 29.
- The average blood pressure values are around 101.98 mmHg (SD 27.7) for systolic blood pressure (SBP) and 59.39 mmHg (SD 13.27) for diastolic blood pressure (DBP).
- The Glasgow Coma Scale (GCS) score for the patients ranged between 3 and 15, with an average of 11.84 (SD .65).
- The correlation matrix between physiological parameters and GCS shows a significant correlation between GCS and systolic blood pressure (p=0.009) as well as between GCS and heart rate (p=0.001). It is worth noting that complete data for these parameters were available for 48 patients.

Among the trauma complications of the patients included in the study, listed in descending order of incidence, are: contusions (18.75%), coma (10%), orotracheal intubation (10%), pneumothorax (8.75%), hemopneumothorax (6.25%), shock (5%), cardiorespiratory arrest (3.75%), hemoperitoneum (3.75%), epistaxis (2.5%). Alcohol intoxication (>0.4‰) was recorded in two cases (2.5%). Analyzing the data variation by age groups, a different distribution was observed, both in the causes of trauma and in its effects. It can be seen that both traffic accidents and falls from height are major causes of trauma in the 3-6 year age group (Figure 8).

Additionally, for the same age group, there is a higher prevalence and diversity of trauma complications (Figure 9).

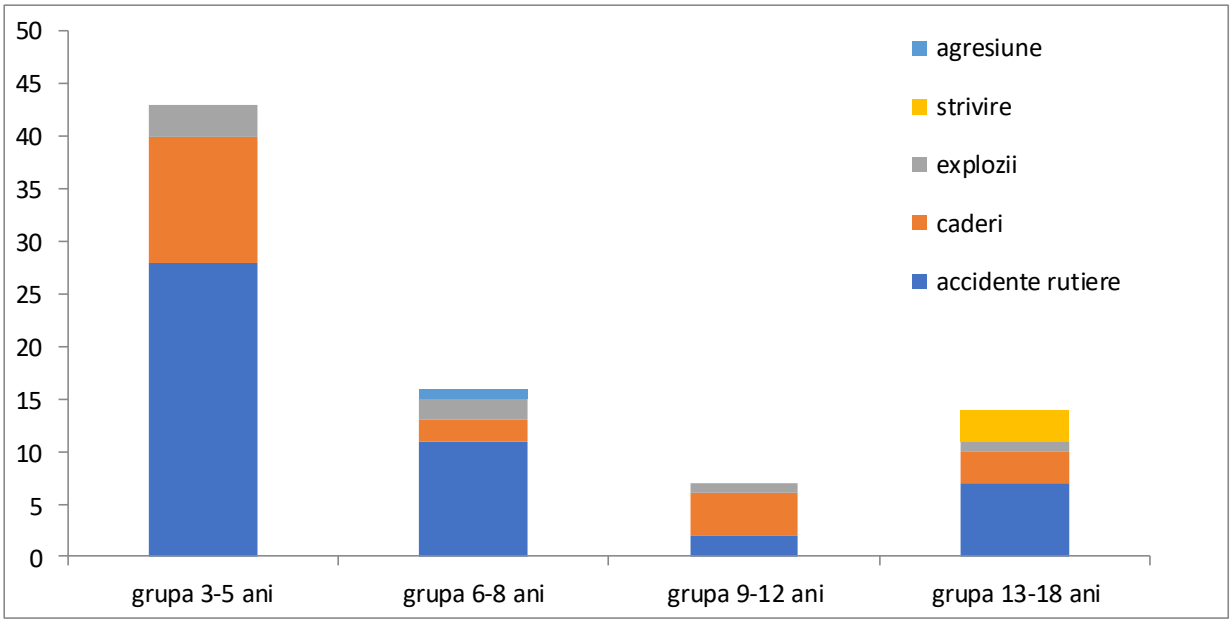


Figure 8. Mechanisms of Trauma by Age Groups

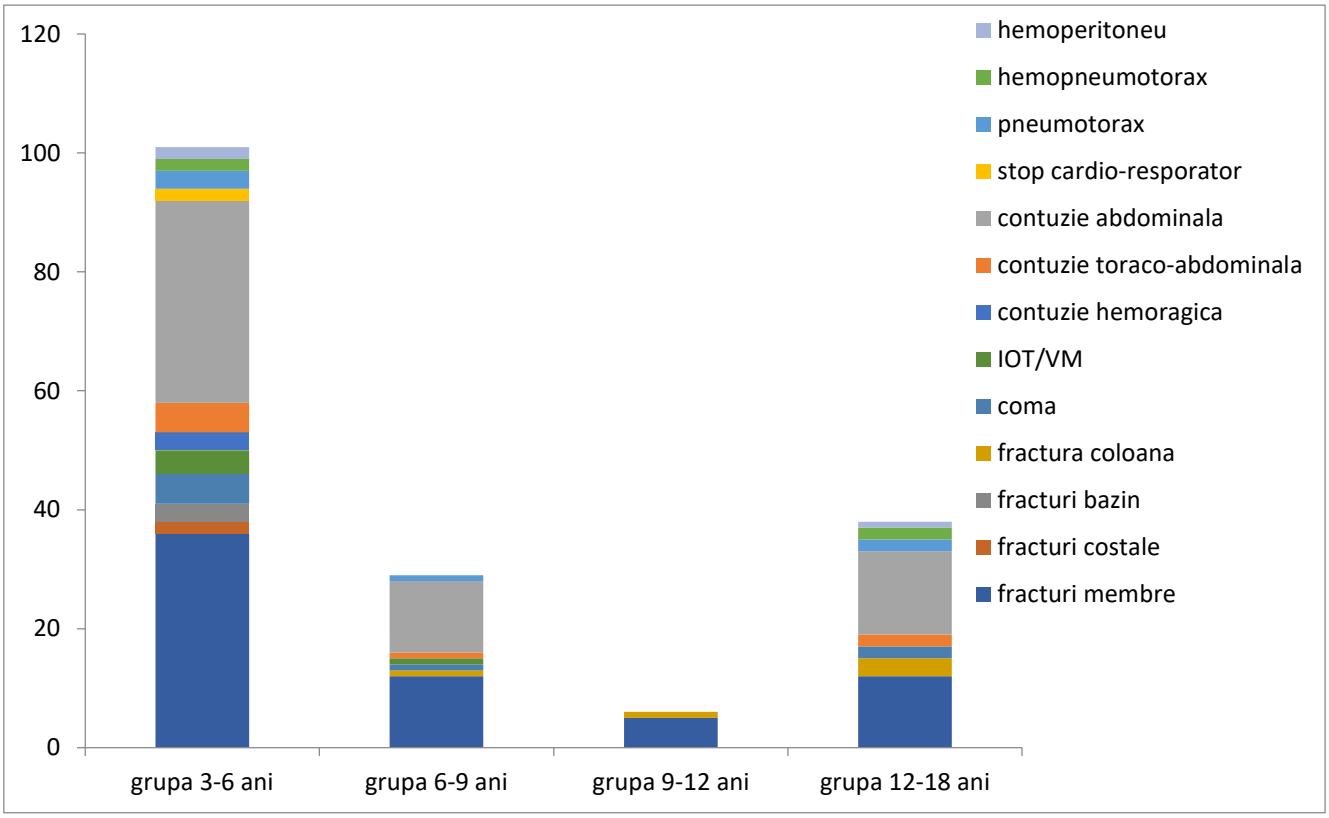


Figure 9. Trauma Complications by Age Groups

Clinical, imaging, and laboratory investigations were used for diagnosing patients. X-rays were used for 20% of the patients, ultrasounds for 11.25%, and CT scans for 18.75%. Complete blood count, coagulation parameters, electrolytes, and biochemical parameters such as

glucose, transaminases, creatine kinase, urea, creatinine, and amylase were analyzed for 21.25% of the patients admitted to the Emergency Department (n=17). The correlation matrix applied to the hematological parameters, coagulation parameters, serum ions, and other biochemical parameters, as well as the GCS score, did not reveal any correlation between these variables.

3.4. Discusions

From the number of records (n=80) collected over a relatively long period (7 years) from the County Emergency Children's Hospital, it can be deduced that a relatively small number of patients are classified as polytraumatized. Males predominated in all age groups, accounting for 68.75% of the patients included in the study. The age distribution of the patients peaked in the 3-5-year age group, while the other 3 age groups covered the 5-18-year range. The case distribution was relatively constant, with a lower frequency in the 10-12-year range. There is significant variation in the mechanism of polytrauma, severity, and pattern of pediatric trauma based on age groups. For example, traumatic brain injury is the most frequent consequence of polytrauma in school-aged children. In older children, the most affected segments are the extremities, chest, and abdomen [48]. In this study, cranial trauma was present in all recorded cases, with a high prevalence of severe acute cranial trauma (25%). The dominant type of injury was blunt force trauma, primarily caused by road accidents (60%) or falls from height (26.25%). There is a trend toward fall-related injuries as age increases. Thus, for road accidents, the average age was 7 years (SD = 4), while for fall-related traumas, the average age was 7.6 years (SD 4.6). Only minor differences were observed in the physiological variables across age groups. This is due to the large number of missing data regarding these variables, as well as the fact that normal ranges for vital parameters vary between age groups, making it more difficult to define substantial differences.

From the analysis of primary data, the 3-5-year age group had the highest number of cases (n=43), representing 53.75% of the total recorded cases. Among these, 65% (n=28) were injured in road accidents, 28% (n=12) were polytraumas resulting from falls from height, and 3 children were injured in explosions. In the 6-9-year age group, a total of 16 cases were recorded (20% of the total), with 68.75% (n=11) due to road accidents, 12.5% (n=2) due to falls from height, and the same proportion resulting from explosions. This age group also recorded one case of trauma due to assault. Only 7 cases, representing 8.75% of the total, were recorded for the 10-12-year age group, with the majority resulting from falls from height (57%). In this age group, road accidents as a mechanism of trauma production were less frequent, and no cases of polytrauma due to assault were recorded. In the 13-18-year age group, the causes of polytrauma

were similar to those in other age groups, with 50% resulting from road accidents, 21% from falls from height, 21% from crush injuries, and 7% from explosions.

The Glasgow Coma Scale (GCS), as an indicator of the severity of patients' conditions, varied by age group, with a higher proportion of cases with GCS <15 as age increased. In the 3-5-year age group, 32.5% of cases had a GCS <15, which increased to 50% in the 6-9-year age group and 71.4% in the 10-12-year age group.

Although the 3-5-year age group had the highest number of patients, the proportion of complications was relatively low: there were only 3 cases of coma (7%), 4 intubated patients (9.3%), and 2 cases (4.6%) each of hemopneumothorax, hemoperitoneum, and cardiorespiratory arrest (one of whom was unresponsive). In the 6-9-year age group, there was one case each of coma (6.5%), intubation/ventilation, and pneumothorax. In the 10-12-year age group, there were no cases of coma, pneumothorax, or other complications, but in patients over 13 years old (n=14), the proportion of complications increased. Specifically, there were 2 cases of coma (14.2%), 3 intubated patients (21.4%), 3 cases of pneumothorax/hemopneumothorax (21.4%), and 1 case of hemoperitoneum.

Hemorrhagic contusion was a relatively rare complication (7% of total patients), seen in patients in the youngest age group (3-5 years). Thoracic contusion was recorded in 10% of the total cases, particularly in the 3-5-year age group (5 out of 8 total cases). On the other hand, abdominal contusion was present in the majority of cases (82.5%) across all age groups.

Fractures were present in all recorded cases, mostly affecting the limbs (81.25% of the total), with fewer involving the spine (6.25%), pelvis (3.75%), ribs (2.5%), or clavicle (1.25%).

The results are consistent with recent literature. Studies show that nearly 63% of pediatric polytrauma cases present one or more fractures [49], with the highest incidence in school-aged children, especially males [46].

Regarding vital parameters, age group analysis reveals that, for the 1-4-year group, respiratory rate, pulse, and systolic blood pressure were within the indicated limits in Table 5.13 for all cases. In the second age group (5-11 years), 2 cases had a heart rate above 140 beats/min, and 4 cases had systolic blood pressure below the minimum range, between 50-80 mmHg. In all cases with altered vital signs in this age group, GCS was <15. In the over-12 age group, respiratory rate and heart rate were within normal limits, but 6 cases had systolic blood pressure below 90mmHg, ranging from 60-89 mmHg. For these cases, GCS was >15, except for one case (GCS 14).

Pediatric polytrauma is often hemodynamically unstable upon presentation [50]. In the presented cases, only 17 out of 80 had available hematological parameters. In 2 cases, hemoglobin and hematocrit were abnormal (8.4 g/dl and 25.4%, respectively, 8.1g/dl and 24.3%).

Both patients had polytrauma with traumatic brain injury (TBI) and thoraco-abdominal trauma caused by road accidents. Coagulation parameters such as platelet count, activated partial thromboplastin time (aPTT), INR, and Quick time were recorded for a limited number of patients in the study cohort. No deviations from normal values were found for INR (2.95) and aPTT (35.57 s) except in one case of severe acute TBI and thoraco-abdominal trauma from a fall from height (14-year-old patient). However, Quick time exceeded the normal range (10-13s) in 8 cases (representing 61.5% of the recorded values). With the exception of the previously mentioned case, where Quick time was 30.6s, this parameter ranged from 11.4 to 15.3 with a mean of 13.2 (SD 1.1).

Imaging techniques are important because clinical examination in children can be unreliable. Injuries often do not manifest on initial clinical examination, and it is often impossible to establish a reliable history when children have head injuries, are intubated, or are preverbal. Additionally, children are often unable to provide a reliable history [46,51]. In this study, 19 X-rays, 18 CT scans, and 12 ultrasounds were performed on the recorded patients. Fractures were the most common findings on X-rays and CT scans, along with pleural effusion, emphysema, pneumothorax, accentuated pulmonary interstitium, and epicranial/subdural hematoma. Ultrasounds generally revealed pleural fluid and hepatic contusions.

A small number of patients were classified as severely injured. Transportation-related trauma was responsible for the majority of patients with major injuries. Given that the study describes a 7-year period, it is noteworthy that the use of emergency procedures (e.g., intubation and chest drainage) was low. Thus, hospital trauma care was characterized by the low use of intensive care and the need for orthopedic and emergency surgical procedures, given the large number of fractures and abdominal/thoraco-abdominal contusions.

This study has several limitations. Being a single-center retrospective study, the epidemiological data are limited to a specific area. Additionally, the total number of patients is not large, and some subgroups are small, making them unsuitable for statistical calculations.

The factors predisposing to pediatric trauma have been rarely investigated, and currently, there are no injury prevention programs for the pediatric population. The high incidence of pediatric trauma in road accidents and falls indicates the need for better supervision during play, the use of special car seats for child transport, and the identification of specific risk factors for these traumas.

4. MEDICAL HELICOPTER INTERVENTIONS AND GROUND MEDICAL TEAMS – THEIR ROLE IN THE MANAGEMENT OF POLYTRAUMA

4.1. Specific Aspects of Trauma Management in Children and Young Adults During Air Transport

Study Group and Research Method

The first study is based on a dataset comprising a total of 77 patients (young adults, children, and adolescents aged 0 to 30 years) with multiple injuries that required air ambulance transport. The study is retrospective, with subject information collected over a period of 5 years, between 2015 and 2019. In the research underlying this study, each of the air transports conducted (n = 77) benefited from a full flight team, consisting of a doctor and a nurse.

The data obtained from reviewing the patients' observation sheets were entered into statistical analysis software (IBM Statistics V. 24 * SPSS) and Excel 2019, then filtered and sorted based on various criteria. Raw descriptive statistical parameters were calculated for all variables for which this calculation approach was considered relevant: mean, standard deviation (SD), minimum and maximum values for continuous numerical variables, frequency for categorical variables, median and mode, skewness, and kurtosis indices. Descriptive graphs were represented using the corresponding charts, utilizing software dedicated to these programs.

Categorical values were entered into contingency tables, and the non-parametric Chi-square test ($\chi 2$) was applied. Descriptive statistics, using a 95% confidence interval (CI 95%), standard error of the mean, minimum, and maximum values, were used to calculate central tendency and data dispersion. For each of the existing statistical tests, a significance level of 0.05 was employed, and the p-value was calculated as two-tailed. To highlight statistically significant differences between the groups or subgroups generated within the study cohort, the Student's t-test was used.

Rezults

In terms of the socio-demographic characteristics of the patients, a predominance of male subjects (n = 51, 66.2%) was noted compared to female subjects, with an odds ratio of 2:1. The nature of the SMURD crew's missions was as follows: 59.7% of the missions had a primary nature, followed by secondary missions (n = 29, 37.7%). The smallest proportion (2.6%) consisted of special/rescue missions. Regarding the scalar variable defined by the ages of the patients included

in this study, descriptive statistical analysis revealed a mean age (MA) of 17.3 years, associated with a standard deviation (SD) of 8.52 years. The corresponding histogram for this variable describes a normal Gaussian curve, slightly skewed to the left. Incidental peaks were observed around the ages of 25 and 10, with minimal incidence among patients under 2 years of age and those aged 11.

In the group, only one patient with multiple trauma due to a traffic accident evolved toward fatality.

From the descriptive statistical analysis of the values of the main vital parameters, the following results were obtained:

- The GCS scores ranged widely, from 3 to 15 points, with a mean of 10.82 points and a standard deviation of 5.25 points.
- The average respiratory rate was 9.91 breaths/min, with a standard deviation of 7.499 breaths/min. Regarding ventricular rate, the maximum recorded value was 161 bpm, with a mean of 95.60 bpm (SD 35.09 bpm). In both cases, the statistical indices describe a homogeneous distribution.
- Only 3 subjects exhibited cardiac arrhythmias, such as tachycardia (n = 2, 2.6%) or asystole (1.3%). In terms of respiratory distress, only one patient exhibited severe mixed dyspnea (1.3%). A series of maneuvers necessary for the stabilization of patients were monitored within the group.

In the study group, several patients experienced sudden desaturation, including cardiac arrest, as follows:

- A total of 53 patients required oxygen for stabilization. Of these, 27 received supplemental oxygen via mask (35.1% of the total group), 19.5% required artificial ventilation, and 6.5% of the total group (n = 5) were intubated during air transfer.
- Intubation was performed on 20 patients, with 16 requiring rapid intubation through induction (20.8% of the total).
- 2.6% of the subjects required external cardiac massage, while 7.8% of the patients required extraction during the rescue.

An important aspect to consider when analyzing the evolution of patients with polytrauma is the trauma mechanism and its severity (number and type of affected regions). From this perspective, it is notable that the majority of polytrauma cases (74%) were due to traffic accidents, while the remaining 26% were represented by polytrauma resulting from falls (13%) or other mechanisms (11.7%), such as crush injuries, drowning, or physical assault.

In terms of the localization of polytrauma, the majority of patients (51.9%) presented with minor tri-regional injuries, predominantly affecting the thorax, limbs, and spine.

Specific tests applied to identify statistically significant correlations or causal relationships between individual variables revealed no statistically significant correlation between age and the mechanism of polytrauma production, according to the ANOVA test (Mr. Levene = 0.410, Mr. ANOVA = 0.452). The same outcome was observed regarding the interaction between this scalar variable and the number of affected regions, with no statistically significant correlation demonstrated (Levene = 0.986, sig. ANOVA = 0.679). For continuous variables, bivariate correlations using Pearson's index were employed. No statistically significant correlations were detected, except for the relationship between the mechanism of polytrauma production and the need for orotracheal intubation (sig = 0.038).

Two groups of patients were formed based on the mechanism of trauma production: those who were victims of traffic accidents (n = 57 - subgroup A) and those with polytrauma from other causes (n = 20 - subgroup B). The following statistically significant differences were analyzed in relation to these two subgroups:

- GCS score (mean for polytrauma due to traffic accidents was 10.39 points, compared to 12.05 points for the other subgroup). Although the sig value according to the t-test of mean equivalence is 0.225, it can be concluded that lower GCS scores are observed in subgroup A polytrauma cases.
- There were no statistically significant differences between the two subgroups regarding oxygen requirements (sig = 0.832) or the performance of cardiac massage for patient stabilization during transfer (sig = 0.403).
- For intubations performed during transfer, significant differences were observed between the two subgroups (Levene’s test sig < 0.01, and the t-test sig for mean equivalence of 0.01). Therefore, we reject the null hypothesis and accept that, in the analyzed group, there are differences between subgroups A and B regarding IoT and MV.

From the statistical analysis of the various variables examined in this research, based on the trauma production mechanisms, the only variables with significant differences (sig = 0.000) were trauma mechanisms and injury localization. It was observed that in traffic accidents, multi-region involvement was common, while head injuries predominated in falls, and thoracic injuries were more frequent in polytrauma from other mechanisms.

The above study reveals several conclusions:

- The flights for air transport of the 77 patients included in the study benefited from a full flight team consisting of a doctor and a nurse.
- The patients had GCS scores ranging from 3 to 15, with a mean of 10.8 (SD 5.2), and lower scores were recorded in cases of polytrauma resulting from traffic accidents.
- Traffic accidents were responsible for the majority of assisted victims (74%).

- A significant proportion (68.8%) of patients required oxygen for stabilization during air transfer. Oxygen was administered either via mask, artificial ventilation, or through intubation. Sixteen patients (20.8%) underwent rapid intubation by induction.
- Three patients exhibited cardiac arrhythmias in the form of tachycardia, asystole, or mixed dyspnea, while two patients in cardiac arrest underwent external cardiac massage during transport. One fatality was recorded.
- The average age of the patients in the study was 17.3 years (SD 8.52). Incidental peaks were observed around the ages of 25 and 10, with minimal incidence among patients under 2 years old and those aged 11.
- No statistical correlations were identified between the study variables, except for the correlation between the trauma mechanism, injury localization, and the need for orotracheal intubation.

4.2. Current Approaches to Aeromedical Transport in Polytrauma Management

Study Sample and Methodology

This chapter of the thesis includes a recent study conducted at the "Sf. Ap. Andrei" Emergency County Hospital in Galați between January 2020 and October 2021, involving a cohort of 89 patients. The study encompassed not only children and adolescents but also young adults up to 45 years of age. The inclusion of this study aims to identify potential differences between the two age categories: children and young adults in the first study, and children and young adults in the second study. Like the first, this study is also a cohort-based, retrospective investigation. The final database was built using data collected from the observation sheets of patients who suffered polytrauma and were transported via the SMURD Galați air unit to the nearest medical facility for further investigations and specialized treatment.

Inclusion Criteria:

The inclusion criteria for this study were:

- Presence of polytrauma.
- Transport to a medical facility by either ground ambulance or SMURD air services.
- Documentation of the type of intervention.

Considering the objectives of this study, exclusion criteria were defined as the absence of pre-hospital interventions by ground medical service teams. Following the application of these criteria, 13 cases were excluded from the final database.

The statistical evaluation was performed using SPSS v26 software and Microsoft Excel version 2019, with statistical significance considered at a level of $P < 0.05$ and a 95% confidence interval.

The retrospective design allows for a comparative analysis of patient outcomes based on age categories and the type of trauma, while also considering the specifics of aeromedical interventions.

Rezults

In the frequency analyses conducted on the study variables, a higher prevalence was observed among males (80.3%, n=61), while females accounted for only 19.7% (n=15). Regarding the participants' background, there was a nearly symmetrical distribution between rural and urban areas, with a slight predominance from rural areas (57.9%, n=44) compared to urban settings (42.1%, n=32). The average age in the sample was 21.6 years, with a standard deviation of 22.089 years. The youngest participant was an infant (age 0), while the oldest was 45 years old.

From the analysis of the mechanisms of polytrauma in the study group, it was found that the most frequent causes were traffic accidents (34.83%, n=31) and falls (33.7%, n=30).

A descriptive statistical analysis was also performed on the vital parameters and other measured variables such as: Glasgow Coma Scale (GCS), blood pressure values, oxygen saturation, pulse, respiratory rate, blood glucose levels, and body temperature. Twenty-five patients, representing 28.1%, had a GCS score of 8 or lower.

Regarding patient diagnoses, with a few exceptions (2 cases of hanging, psychomotor agitation due to alcohol intoxication, and 2 cases of drowning), the patients in this study presented polytrauma involving combinations of cranial and craniofacial injuries, thoraco-abdominal and pelvic injuries, spinal injuries, and limb injuries.

From the data analysis, it is evident that most patients suffered from various degrees of cranial injuries, often associated with thoraco-abdominal or limb injuries. Ethanol intoxication was identified in 12 cases (13.4%). Among the most common complications of polytrauma in the study group were: coma (GCS<8), cardiopulmonary arrest, hypovolemic and hemorrhagic shock, hematoma, hemopneumothorax, traumatic shock, burns, splenectomy, and acute respiratory distress syndrome.

A total of 7 patients (7.8%) died during the intervention. The most frequent type of intervention was primary care, representing 89.5% (n=68) of the cases. Additionally, one search and rescue mission was identified. Furthermore, only three missions (3.9%) involved extrication procedures. The types of missions and specific maneuvers for stabilizing polytrauma patients during these missions are summarized in Table 1.

Cervical immobilization was required in cases of cranio-cerebral trauma to preserve the integrity of the spinal cord. Cervical collars were used in the majority of cases (65.8%, n=50), while 26 patients (34.2%) did not require cervical immobilization.

In this study group, 51.3% (n=39) of the patients did not require complete immobilization. Splints, primarily used in complex limb trauma, were applied in 10.5% (n=8) of the cases. Scoop stretchers were employed in 36.8% (n=28) of the cases, while vacuum splints were used in only one case (1.3%).

Table 1. Types of Missions and Specific Management and Stabilization Maneuvers for Polytrauma Patients

Intervention	Frequency (n)	Percent	Oxygen Therapy	Frequency (n)	Percent
Primary	68	89.5%	Mask	48	3.2%
Secondary	5	6.6%	Ventilator	5	0.6%
Cross-border	2	2.6%	Balloon	8	0.5%
Rescue Search	1	1.3%	Intubated transfer	2	0.6%
None	13	7.1%			
Extrication			Guedel Airway		
No	73	96.1%	Yes	55	2.4%
Yes	3	3.9%	No	21	7.6%
Cervical Collar			IOT+VM		
No	26	34.2%	No	65	5.5%
Yes	50	65.8%	Without induction	6	0.5%
Immobilization			IV Line		
No	39	51.3%	No	13	7.1%
Splints	8	10.5%	Peripheral x2	20	3.2%
Scoop Stretcher	9	11.8%	Peripheral central	1	0.3%
Stretcher	19	25.0%	Central	1	0.3%
Vacuum	1	1.3%	Peripheral	41	3.9%
Bandage			Aspiration		
No	50	65.8%	No	71	3.4%
Yes	26	34.2%	Asp IOT	8	0.6%
Foil			Oral cavity	1	0.3%
No	67	88.2%			
Yes	9	11.8%			
Hemostasis					
No	67	88.2%			
Yes	9	11.8%			

Bandages were used in 34.5% (n=26) of the cases in the group due to the presence of hemorrhagic wounds related to trauma. Complex hemostasis was only necessary in 11.8% (n=9) of the cases.

Oxygen therapy was used as the first line of treatment in cases of hypoxia symptoms in most cases, either through non-invasive methods (mask or Ambu bag) or invasive methods (endotracheal intubation, mechanical ventilation). Oxygen therapy via a face mask was employed in

most of the subjects included in the study group (63.2%, n=48); eight (10.5%) of the subjects were ventilated using the Ambu bag, while 6.6% (n=5) required mechanical ventilation (VM). Two subjects were already intubated (2.6%) upon arrival. Subsequently, 14.5% (n=11) of the subjects underwent endotracheal intubation and mechanical ventilation, of which 5 (6.6%) did not require induction, while 6 (7.9%) required pharmacological induction. Additionally, 5.3% (n=4) required aspiration through the intubation tube.

To administer the necessary medication for patient stabilization, venous access is imperative. In this study group, intravenous lines were inserted in 13 subjects (17.1%). Most subjects had a peripheral line inserted (53.9%, n=41), while 26.3% (n=20) had two peripheral lines inserted. One patient received a central line (1.3%), and another subject had both a central and peripheral intravenous line inserted.

Intervention times in polytrauma cases were also evaluated in this study group. A total of 4 different time phases were identified, each representing a necessary step of the intervention, defined as follows: T1 – time elapsed from the emergency call to patient pick-up; T2 – transport time until patient handover to the ground team; T3 – time from patient handover to refueling (this step is optional depending on the distances covered); T4 – time needed to return to the Galați Aeromedical Operating Point.

The average T1 intervention time was 24.30 minutes, with a standard deviation of 11.66, a minimum value of 6 minutes, and a maximum of 70 minutes. The average T2 intervention time was 23.09 minutes, with a standard deviation of 9.8, a minimum recorded time of 5 minutes, and a maximum of 58 minutes.

4.3. Discusios

In both studies presented, primary interventions were the most frequent, occurring as the first response following events that caused polytrauma. The average response time was approximately 24 minutes until the patient was picked up, and an approximately equal average time for transport and handover of the patient to the ground emergency team. Thus, it is evident that helicopters provide a faster response compared to ground ambulances over medium to long distances, in situations where rapid transport is essential. Studies show that the total response time for emergency medical services using helicopters, from receiving the call to hospital arrival, can vary from 20 to 30 minutes for distances up to 80 km. For longer distances, the response time extends to 30 to 60 minutes [52].

In the studies presented in this chapter, the air ambulance provided assistance to a large number of critically injured polytrauma patients (average GCS of 11, with a minimum of 3 and a maximum of 15, GCS <8 in 46 cases in total), who presented multiple traumas to the head, chest,

limbs, spine, abdomen, or pelvis. Among the complications of polytrauma in these patients were recorded: hemorrhagic shock, hypovolemic shock, pneumothorax, open fractures, traumatic amputations, respiratory distress, cardiac arrest, or coma—complications that posed a life-threatening risk for these patients.

Prompt, efficient intervention and collaboration with ground emergency teams led to life-saving outcomes in most of the assisted cases. Thus, from the total number of patients combined from the two studies (n=166), only 7 deaths were recorded (4.2%). During the interventions, the air ambulance crew assisted patients with primary assessments and provided oxygen therapy (68.8% of cases in the first study, 89.5% in the second), hemostasis, fracture immobilization, cardiac massage (12 cases of cardiac arrest), thermal protection, and insertion of central or peripheral venous lines.

There is a notable good collaboration between the SMURD Galați air ambulance unit and the Mobile Intensive Care Unit of the Galați Emergency Hospital, as well as hospitals in Iași, Bucharest, Constanța, and with SAJ Brăila and the Tulea Ambulance Service.

4.4. Case report

To illustrate such a mission of the air ambulance, the case of a 44-year-old man who survived a railway accident is presented, due to the prompt intervention of the medical team of the air rescue helicopter serving the Galați Aeromedical Operating Point, Romania, as well as the multidisciplinary management provided by the doctors who admitted this patient to the Intensive Care Unit - neurosurgery department.

The patient was involved in a road accident as the driver of a car hit by a train, near a village, 85 km from the nearest multidisciplinary hospital. The helicopter was alerted, took off, and reached the scene in 17 minutes. A ground paramedic team also arrived at the accident scene (Figure 14)..

Figure 14. Images at the accident scene showing how the accident occurred and the patient's transfer by the air ambulance crew

The paramedics identified a male victim of the road-railway accident. The patient was conscious, agitated, and confused, with a GCS score of 12 points, normal and bilaterally reactive pupils, right periorbital hematoma, bilateral anterior epistaxis; open and clear airways, normal breathing, respiratory rate of 16 breaths/minute; present and rhythmic peripheral pulse; sinus rhythm, narrow QRS complex, ventricular rate = 125/min, rhythmic heart sounds, blood pressure = 120/70 mmHg; no focal neurological changes; bilateral vesicular breath sounds present but diminished in the right lung area, oxygen saturation = 75%, warm, dry, cyanotic skin, normal abdomen; Revised Trauma Score = 11.

After the primary evaluation, advanced airway management was decided, including orotracheal intubation with pharmacological induction (atropine, midazolam, etomidate, fentanyl, suxamethonium, rocuronium), controlled mechanical ventilation, cervical spine immobilization with a cervical collar, full spinal immobilization on a rigid spine stretcher with lateral head stabilizers, head and chin restraint, peripheral venous access (two 14G lines), anti-inflammatory corticosteroids (methylprednisolone sodium succinate), and maintenance of anesthesia (etomidate, midazolam, rocuronium).

The patient arrived at the hospital, where a multidisciplinary team was waiting, approximately 90 minutes after the accident. Upon admission to the Emergency Department, the patient had a GCS score of 3 (pharmacologically induced coma), was mechanically ventilated, and was hemodynamically stable.

Imaging investigations were decided, which revealed the following:

1. CT scan of the cervical spine: C2 fracture of the right transverse processes involving the entire transverse plane. The posterior alignment of the vertebral bodies was preserved; later cervical subcutaneous emphysema; a small air inclusion in the medullary canal.
2. CT scan of the brain (Figure 15) revealed: a right frontal-parietal epidural hematoma of 11 mm thickness; bilateral diffuse hemispheric subarachnoid hemorrhage and tentorial hemorrhage; multiple bilateral intracranial air inclusions, supra- and infratentorial; a right frontal-parietal fracture, a fracture of the anterior and posterior wall of the right frontal sinus with blood in the sinus; a lateral and medial fracture of the right orbital wall; bilateral maxillary and sphenoid sinus fractures with bilateral blood in the sinuses; a right temporal fracture and zygomatic fracture; left mastoid fracture with partially dense material – mastoid fracture under observation.

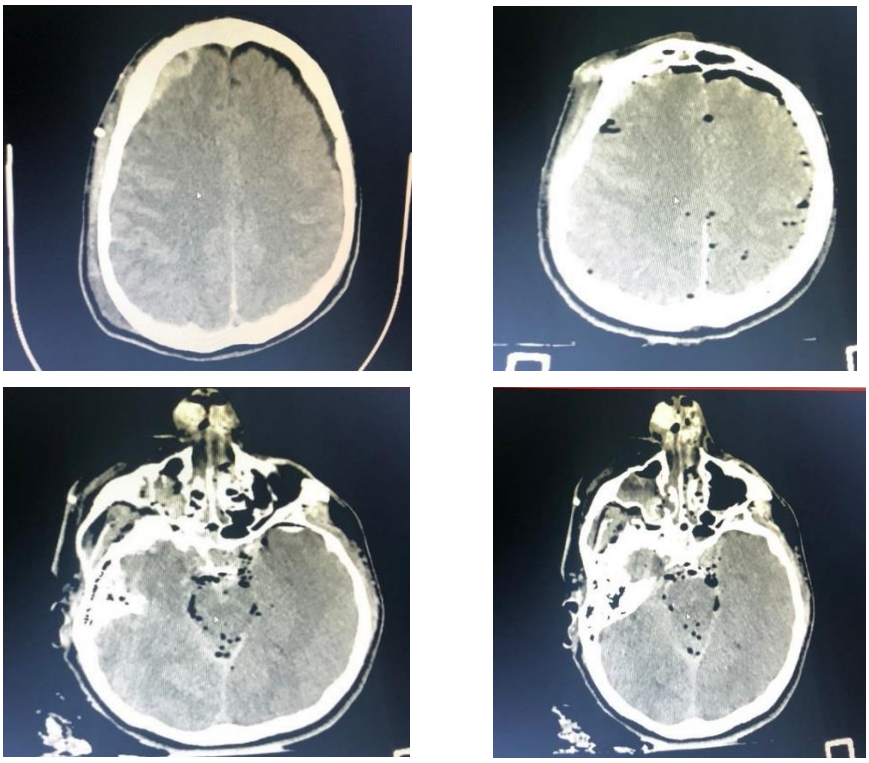
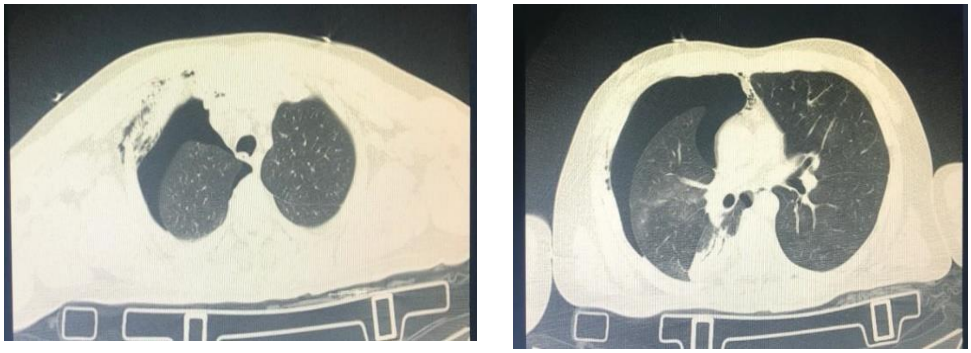


Figure 15. Native brain CT scan

A. Chest CT scan: significant right pneumothorax; minimal right pleural effusion of 15 mm thickness; partially collapsed right lung to the hilum; lower right atelectasis; small glassy foci in the right upper and left lower lobes; spontaneous hyperdensity with localized air inclusion in the anterosuperior mediastinum – hematoma; deep lateral thoracic subcutaneous emphysema; fracture of the manubrium sterni; fractures of the lateral III, IV, V ribs on the right arc.

B. Pelvic-abdominal CT scan (Figure 16): liver, spleen, pancreas, kidneys without post-traumatic injury; no free intraperitoneal fluid; no post-traumatic bone injuries.



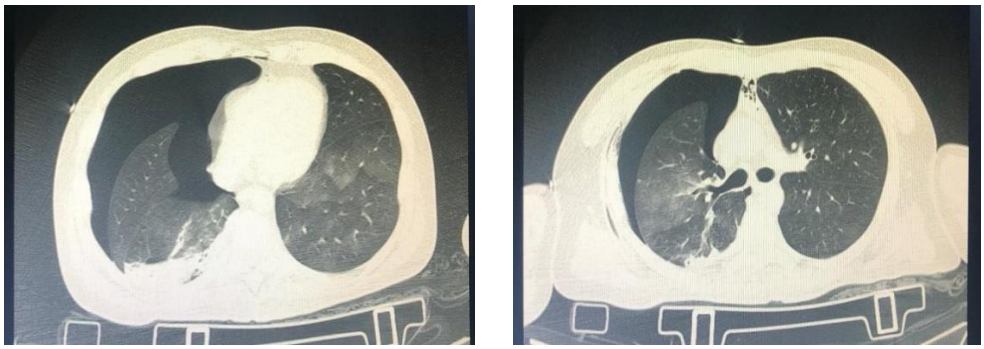


Figure 16. Contrast-enhanced CT scan of the chest, abdomen, and pelvis

In the Emergency Department, a right pneumothorax was surgically drained, confirmed by radiology with re-expansion of the right lung, after which the patient was admitted to the Neurosurgery Intensive Care Unit.

A brain CT scan performed 24 hours post-injury showed: right frontal epidural hematoma of 10 mm thickness and right anterior temporal hematoma of 8 mm thickness; thin bilateral posterior parietal subdural hematomas of 4 mm thickness; spontaneous hyperdensity in the brain and at the tentorium level; minimal bilateral temporal-parietal subarachnoid hemorrhage; thin cortical relief; midline shift to the left by 4 mm; bilateral frontal encephalitis; sphenoid, maxillary, and frontal sinuses bilaterally filled. A control brain and chest CT scan with intravenous contrast performed 48 hours post-injury showed good progression: A. Cranial CT compared to the initial moment: absence of bilateral pneumocephalus, no deviation of the midline structures, otherwise relatively stationary appearance, cervical spine without post-traumatic bone injuries. B. Soft tissue neck CT with intravenous contrast: no changes in the soft tissues of the neck were visualized. An intubation tube is patent. C. Chest CT with intravenous contrast: moderate basal pneumomediastinum, mild right and left upper lung contusion, mild bilateral hemothorax, mild right cervical-lateral subcutaneous emphysema, sternal fracture, rib fractures. Non-conservative treatment (20 days) showed progressive favorable evolution, with recovery of consciousness and lung functions within physiological limits.

The neurological examination showed no abnormalities. A psychiatric evaluation revealed no cognitive disorders, and the patient was discharged.

5. STUDY ON EMOTIONAL DISTRESS IN POLYTRAUMA PATIENTS

5.1. Introduction

Polytrauma often results from high-impact accidents, falls, or violent incidents. These catastrophic events can have profound physical and psychological consequences, including PTSD (post-traumatic stress disorder), depression, anxiety, leaving individuals with complex medical conditions and long-term emotional suffering [53,54].

This chapter aims to explore various dimensions of emotional distress experienced by patients after polytrauma. The purpose of the research is to identify the level of emotional distress in patients who have suffered polytrauma, evaluating their responses through the WBSI questionnaire (White Bear Suppression Inventory) and the PDA scale (Pathological Demand Avoidance). The total distress score was obtained by summing all the negative items found in the PDA questionnaire.

5.2. **Materials and Methods**

For the PDA scale, data for this study were collected through a questionnaire consisting of 43 items, including 39 specific questions related to emotional distress and sociodemographic data. The questionnaire was administered to patients who suffered polytrauma and were hospitalized at the Emergency Hospital of Galați between January 2018 and December 2021. The questionnaire was distributed to all eligible patients who experienced polytrauma during this period, with no exclusion criteria applied. The final dataset included information from 145 patients, aged between 14 and 34 years.

The White Bear Suppression Inventory (WBSI) questionnaire included 15 items and was administered to patients who suffered polytrauma and were hospitalized at the County Emergency Hospital “St. Andrew” in Galați during the same period (January 2019 - December 2021). The final summary tables included characteristics of 152 patients, aged between 19 and 33 years. It is worth noting that not all patients agreed to answer both questionnaires, and not all hospitalized patients wished to participate in any questionnaire.

The questionnaires used are included in Appendix 1 (PDA) and Appendix 2 (WBSI) of this doctoral thesis. The collected data were statistically evaluated using SPSS v26 software and Microsoft Excel 2019. To assess emotional distress, the Affective Distress Profile scale was used. The PDA scale consisted of 39 items designed to identify and measure both functional and dysfunctional negative emotions, as well as positive emotions. Scores were assigned to each item based on a rating scale ranging from 1 to 5, with specific values assigned for direct and reverse assessments. The overall distress score was calculated by summing the values obtained

from the negative items. Separate scores were also calculated for functional negative emotions, dysfunctional negative emotions, worry, anxiety, sadness, and depression.

5.3. Results

Study Using the WBSI Questionnaire

The majority of subjects in the sample were male (72.4%). The average age recorded in this study group was 21.2, with a standard deviation of 10.848; the minimum age recorded was 19, while the maximum was 33. It was observed that the most frequent mechanisms of multiple trauma among the study participants were: road accidents (69.1%), accidental falls from another level (14.5%), and assaults (4.6%).

The distribution of the sample based on the WBSI score was evaluated using frequency elements from statistical tests. The average WBSI score was 45.64, with a standard deviation of 6.884; the minimum score recorded was 19, and the maximum was 69. The Chi-square independence test did not reveal a statistically significant relationship between the WBSI score and the mechanism of polytrauma ($\chi2=146.509$, C.I.=95%, p=.883), the age of the subjects ($\chi2=1026.102$, C.I.=95%, p=.182), or the gender of the subjects ($\chi2=31.508$, C.I.=95%, p=.342). Thus, it can be concluded that the WBSI score was not influenced by these variables, and its values showed specific variations at the individual level.

Study Using the PDA Scale

From the distribution of the research group based on the gender of the subjects, a quasi-symmetric distribution between the two genders was observed (M=75, 51.72%; F=70, 48.28%) (Figure 6.1). From a socio-demographic perspective, this study group predominantly included subjects from urban areas (n=110, 75.85%), while only 24.14% (n=35) came from rural areas (Figure 7.1). This difference could be due to higher accessibility to medical services for patients in urban areas. The average age recorded in this study group was 24.17, with a standard deviation of 9.541; the minimum age was 14, and the maximum was 34.

The total distress score was calculated by summing all the negative items found in the PDA questionnaire. It was observed that most subjects showed a high level of distress (n=108, 74.48%). A moderate level of distress was identified in 16.55% (n=24) of subjects, while 4.14% (n=5) of subjects exhibited a very high level of distress. Only 4.83% (n=7) showed a low level of distress.

The prevalence of functional negative emotions showed a quasi-symmetry between a high level (46.90%, n=68) and a moderate level (42.76%, n=62) of negative emotions. Only 0.69% (n=1) of subjects exhibited a very high level, while 6.21% (n=9) had a low level, and 3.45% (n=5) had a very low level of functional negative emotions.

The evaluation of dysfunctional negative emotions revealed a very high prevalence of a high level of dysfunctional negative emotions (76.55%, n=111). Additionally, there was a symmetrical distribution between a moderate level (10.34%, n=15) and a very high level (10.34%, n=15), while only 2.76% (n=4) exhibited a low level of dysfunctional negative emotions.

When evaluating the interaction between the scores presented above and the subjects' gender to see if a certain level of stress was more frequently associated with either gender, it was found that men had a higher prevalence of a high level of distress (n=59, 40.7%) compared to women (n=49, 33.8%). Moreover, men had the highest level of functional negative emotions (n=50, 27.6%), while in women, this level was 29.3% (n=28). The most frequent moderate level of negative emotions was recorded in women (n=33, 22.8%).

Additionally, the high level of dysfunctional negative emotions was more frequent among men (n=62, 42.8%), while it was lower among women (n=49, 33.8%).

5.4. Discussion

The aim of these studies was to identify the psychological aspects of major physical trauma and detect the risk factors associated with psychological distress. Both studies described in this chapter show a high level of distress among polytrauma patients (PDA study: n=108, 74.48%; WBSI study: mean score 45.6, significantly higher than the minimum of 15 points, suggesting an increased prevalence of thought suppression). A breakdown of the results based on functional and dysfunctional negative emotions in the PDA test demonstrated that most subjects exhibited a high degree of negative emotions, as follows: a high level (46.90%, n=68) and a moderate level (42.76%, n=62) of functional negative emotions, and a high level of dysfunctional negative emotions (76.55%, n=111). Moreover, no subject in this study group exhibited a very low level of dysfunctional negative emotions, while only 0.69% (n=1) had a very low level of functional negative emotions.

After statistical analysis, neither study identified a statistically significant relationship between the subjects' gender and the results obtained from the questionnaires. However, in the PDA test, an observation of the primary data revealed that men recorded the highest values for a high level of dysfunctional negative emotions and a high level of distress, while women recorded a higher level than men in terms of functional negative emotions, moderate levels of dysfunctional negative emotions, and a lower level of distress. These results differ from those found in the literature, which not only identifies emotional distress as predominantly occurring in women but also highlights significantly poorer recovery from major trauma in women compared to men, regardless of the severity and mechanism of injury [55].

No significant correlations were found between the level of distress and the type or mechanism of trauma (p=0.883), with data suggesting that the response to trauma is highly individualized, as also shown in the literature [54,55].

In the current investigation, gender was not found to be a strong predictor of emotional distress in those who suffered polytrauma. However, while women tended to have significantly higher levels of functional negative emotions, men generally exhibited higher levels of dysfunctional negative emotions and distress.

Overall, these findings highlight the need for more clinical and academic studies to address the emotional and mental health needs of polytrauma patients. Long-term mental health issues can be avoided, and quality of life can be improved through early intervention and ongoing support.

GENERAL CONCLUSIONS

The studies presented in this thesis explored various aspects of polytrauma in both children and young adults through a retrospective methodology, based on clinical data regarding the therapeutic management of polytrauma in children treated in the Emergency Clinical Hospital "Sfântul Apostol Andrei", Galați, as well as in the Emergency Department of the Clinical Emergency Hospital for Children "Sfântul Ioan", Galați. The thesis comprises three retrospective cohort studies (including a total of 518 patients), which highlighted the demographic characteristics of the patients, the clinical, paraclinical, and therapeutic characterization of the studied groups, as well as the evaluation of the risk of complications. A series of variables were statistically processed, including demographic indicators, vital parameters, diagnosis, results of paraclinical investigations, types of complications, trauma mechanism, and therapeutic management. Using SPSS Statistics (IBM, version 26), statistical methods aimed to identify correlations between the relevant variables.

A case report presented in Chapter 6 exemplifies the management of polytrauma and the therapeutic approach during an air ambulance intervention. Chapter 7 includes two studies based on interviews that assess the psychological impact of polytrauma. All studies received approval from the Bioethics Committee of the hospitals involved.

The main conclusions of the studies described in the thesis include:

- The collected demographic data outline the profile of the polytrauma patient as a young male (average age 27 years), with a high likelihood that the polytrauma resulted from a traffic accident or a fall.

- The annual prevalence of polytrauma during the analyzed period (7 years, 2015-2021) tends to decrease, especially among male subjects, while females presented a relatively constant number of cases.
- The most common types of traumatic injuries observed in polytrauma patients in the analyzed cohorts, in order of prevalence, include: traumatic brain injuries, chest injuries, abdominal and pelvic injuries, extremity injuries, and spinal injuries.
- The most frequent mechanism of polytrauma was traffic accidents (68.9%), followed by falls from a height (15.50%), assaults (7.29%), crushing injuries (3.34%), and explosions/projectiles (1.82%). Traffic accidents were the primary mechanism for both head injuries (76.8%) and thoraco-abdominal injuries (76%).
- A GCS score of <8 was recorded in 27.19% of patients with thoraco-abdominal trauma, 26.8% of patients with head trauma, 20% of those with spinal trauma, and 18.7% of patients with extremity trauma.
- The following complications of polytrauma were identified in descending order of prevalence: coma (11.36%), pneumothorax (8.52%), cardiorespiratory arrest (4.8%), hemoperitoneum (3.31%), organ rupture (3.26%, predominantly splenic rupture, at 3.14%), traumatic shock (3.14%) or hemorrhagic shock (3.14%). A total of 7.4% of patients were intubated, 7.12% presented hematomas (mostly subdural, 4.84%), and 6.8% had subarachnoid hemorrhages.
- The correlation study between polytrauma complications and the types of trauma identified in the study cohort revealed a highly significant correlation ($\alpha=0.05$) between craniofacial trauma and coma ($p<0.001$), significant for orotracheal intubation and mechanical ventilation ($p=0.005$), and for hematomas ($p=0.03$). A highly significant relationship ($p<0.001$) was also found between spinal trauma and organ rupture and pneumomediastinum, as well as a significant relationship between spinal trauma and hemopneumothorax ($p=0.002$). No significant relationships were identified for the other situations studied ($p>0.05$).
- Alcohol intoxication (blood alcohol levels >0.4 g/L) was recorded in 4.2% of the cases in the study, most commonly associated with head trauma (67%) or polytrauma involving head and thoraco-abdominal or pelvic trauma. 33.3% of alcohol-intoxicated patients had a GCS score of <8 points. Assaults were more common in these cases (33.3%).
- The mechanism of polytrauma correlated significantly with the presence of hematomas ($p=0.063$), cardiorespiratory arrest ($p=0.012$), hemoperitoneum ($p=0.003$), hemopneumothorax ($p=0.097$), pneumothorax ($p=0.013$), and alcohol intoxication ($p=0.027$).
- Head trauma had the potential to cause coma (80% of comatose patients had suffered head trauma); gender-related coma analysis indicated that females had a relative risk of coma 1.246 times higher than males.

- Imaging and laboratory testing play a key role in treating trauma, reducing complications and morbidity. The methods identified in the studies included CT scans (37% of patients), X-rays (40%), and ultrasound (16.5%); generally, multiple imaging exams were performed.
- The importance of laboratory tests in the evaluation of polytrauma patients was also highlighted. No significant correlations were found between the type of trauma and the hematological or biochemical parameters analyzed ($p>0.05$). Cases with abnormal biochemical and hematological parameters were most frequent in the category of brain injuries. The incidence of coagulopathy in this study was over 42%.
- The most common imbalance was in potassium ions, without simultaneous disturbances in sodium or chloride levels. The prevalence of imbalances among patients did not exceed 25%, depending on the analyzed parameter.
- Creatine kinase recorded the highest rate of values exceeding the upper limits (69.1% of cases).

To highlight the differences in pediatric trauma compared to young adults, data from the Children's Emergency Hospital were processed separately, with several conclusions:

- In the 3-5-year age group, although larger in number, 32.5% of cases had GCS <15, increasing to 50% in the 6-9-year age group and 71.4% in the 10-12-year age group.
- The proportion of complications was relatively low: only 3 cases of coma (7%), 4 patients were intubated (9.3%), 2 cases each of hemopneumothorax and hemoperitoneum (4.6%), and 2 cases of cardiorespiratory arrest (4.6%), with one non-responsive case in the 3-5-year age group. In the 6-9-year age group, there was one case each of coma (6.5%), IOT/VM, and pneumothorax. In the 10-12-year age group, there were no complications, but in patients over 13 years, the proportion of complications increased: 14.2% coma, 21.4% intubated patients, and 21.4% cases of pneumothorax/hemopneumothorax. It can be concluded that the severity of polytrauma increases with age in children aged 0-18 years.
- A small number of patients were classified as severely injured, with fractures being the most common finding. Transport-related trauma accounted for the majority of severely injured patients.
- Given the long duration of the study, the use of emergency procedures (e.g., intubation and chest drainage) was low. The use of intensive care was low, but there was a high need for orthopedic and surgical emergency procedures, given the large number of fractures and abdominal/thoraco-abdominal contusions.

Chapter 6 of the thesis analyzes prehospital trauma management during air rescue missions conducted by the SMURD Galați air unit, through two cohort studies: the first covering

seven years with a population aged 0-30 years, and the second covering a shorter period (two years) but including young adults (up to 45 years). The conclusions include:

- Air transport missions benefited from a complete flight team consisting of a doctor and a nurse.
- In both studies, patients had an average GCS score of approximately 11, with lower scores recorded in cases of polytrauma from traffic accidents, responsible for the majority of assisted victims (74%). 28.1% of patients had a GCS score of 8 or below.
- The most common complications in polytrauma patients included coma (GCS <8), cardiorespiratory arrest, hypovolemic and hemorrhagic shock, hematomas, hemopneumothorax, traumatic shock, burns, splenectomy, and respiratory distress syndrome.
- Cervical immobilization using a cervical collar was used for the majority of patients (65.8%); splints were used in 10.5% of cases, and scoop stretchers in 36.8%. Bandages were applied in 34.5% of cases, while complex hemostasis was only required in 11.8% of cases.
- Oxygen therapy via mask was used for the majority of subjects (63.2%); 17.1% of patients required orotracheal intubation, of which 7.9% required pharmacological induction.
- For 17.1% of patients, peripheral or central intravenous lines were inserted.
- The average response time was approximately 24 minutes to patient pick-up, with a similar average transport and handover time to the ground emergency team.

It can be concluded that the intervention protocols applied and the collaboration with ground emergency teams saved the lives of most assisted cases (95.8%). During the interventions, the air ambulance crew assisted patients through primary assessment, oxygen therapy, hemostasis, fracture immobilization, cardiac massage (12 cases of cardiac arrest, of which 6 were unresponsive), thermal protection, and insertion of central or peripheral venous lines.

Since less emphasis is placed on psychological evaluation and support for patients who have suffered polytrauma, Chapter 7 aimed to identify the psychological aspects of major physical trauma and the associated risk factors, using the White Bear Suppression Inventory and the Pathological Demand Avoidance (PDA) questionnaire. Both studies showed a high level of distress in polytrauma patients (74.48%, PDA study). No significant correlations were found between the level of distress and the type or mechanism of trauma, suggesting that the response to trauma is highly individualized.

In conclusion, the results of this doctoral thesis contribute to a better understanding of risk factors and patterns in the management of polytrauma, offering a solid basis for developing effective treatment strategies that could improve clinical outcomes and reduce the mortality and morbidity associated with polytrauma.

ORIGINAL CONTRIBUTIONS AND FUTURE PERSPECTIVES

Trauma remains a major cause of death among children and young adults, including in our country. By its nature, polytrauma involves a heterogeneous population as a study group. However, identifying common patterns drives progress and improvement in current trauma practices and guidelines. This thesis aimed to identify the factors that influence the injury patterns in polytrauma, thus contributing to the enhancement of strategies for managing such incidents. The main goal of the research was to determine the pattern of polytrauma and the management particularities of patients admitted to the Emergency Department (UPU) to assess whether current practices meet the patient's needs, prevent complications associated with this pathology, and avoid unfavorable outcomes.

In general, based on the results presented in this doctoral thesis, it can be deduced that the management of polytrauma and the protocols applied in emergency hospitals in Galați show significant potential in saving lives and are aligned with international standards for the care of trauma patients. However, it is necessary to adjust these practices according to the latest medical research, and establishing a local trauma registry would be extremely beneficial. Subtle improvements made by trauma centers or emergency departments in each hospital can have a further positive impact on patient care.

This thesis proposes a flowchart that integrates the most recent recommendations for polytrauma management.

Flowchart for polytrauma management

Prehospital – Primary Evaluation	**Resuscitation in the Emergency Department**
├── **Scene and safety assessment** ├── **Primary evaluation: ABCDE** │ ├── Airway assessment and securing a clear airway (endotracheal intubation if necessary) │ ├── Assessment of breathing and adequate ventilation – Respiratory support │ ├── Circulation assessment with hemorrhage control. Administering intravenous fluids to maintain blood pressure. │ ├── **Disability** – Neurological status assessment. Evaluate consciousness using the Glasgow Coma Scale. Assess pupils for size, symmetry, and reactivity. Evaluate limb movement and sensation. │ └── Exposure assessment with hypothermia	├── **Primary Survey and Resuscitation (ATLS)** │ ├── Reevaluation of ABCDE │ ├── Advanced airway management: endotracheal intubation; rapid sequence intubation; supraglottic airway devices; cricothyrotomy; video laryngoscopy; fiberoptic intubation │ ├── Oxygen administration and ventilation │ ├── Massive transfusion protocol │ ├── FAST │ └── Maintaining normal body temperature └── **Imaging and Diagnosis** ├── Whole-body CT scan

prevention ├── **Interventions** │ ├── Hemorrhage control │ ├── Administration of tranexamic acid │ └── Intravenous fluid (IV) management – maintaining or restoring blood volume and electrolyte balance └──**Transport** └── Continuous reevaluation	└── Additional imaging as needed
Definitive Treatment ├── **Surgical and Interventional Procedures** │ ├── Life-saving surgical interventions │ ├── Hemostatic procedures │ └── Early spine decompression/stabilization └── **Critical Care Management** ├── Hemodynamic stability (mean arterial pressure > 85 mmHg): fluid resuscitation; pharmacological approach with vasopressors and inotropes; hemodynamic support devices; administration of antibiotics, steroids, or anticoagulants as needed; continuous monitoring ├── Hemoglobin and oxygenation management: mechanical ventilation ├── Blood product administration ├── Laboratory tests: monitoring lactate levels, arterial blood gases, and other biomarkers to assess tissue perfusion and metabolic status └── Coagulation management (laboratory tests) └── Continuous clinical assessment of organ perfusion indicators, such as urine output, mental status, and skin perfusion	**Ongoing Care and Rehabilitation** ├── **Post-acute care** │ ├── Monitoring in ICU │ ├── Coordinated and comprehensive care involving a multidisciplinary team │ └── Early physical therapy └── **Long-term Rehabilitation** ├── Comprehensive rehabilitation program └── Regular follow-ups and reevaluations └── Psychological/psychiatric therapy to prevent post-traumatic syndrome

Recent approaches in trauma management have significantly improved the capacity to effectively manage pediatric trauma, reducing complications and increasing the chances of full recovery. These approaches include:

- Point-of-care ultrasound (POCUS) – enabling rapid evaluation while reducing the need for CT scans and minimizing radiation exposure.

- Damage Control Resuscitation (DCR) – emphasizing early use of blood products, minimizing crystalloids, and permissive hypotension. This approach has demonstrated improved outcomes in cases of severe hemorrhagic shock.
- Implementation of massive transfusion protocols.
- Advanced airway management techniques, such as videolaryngoscopy and rapid sequence intubation, which improve success rates in pediatric intubation.
- Controlled hypothermia and hypertonic saline perfusion, initiated within 24 hours and maintained up to 48 hours, which reduces intracranial pressure (ICP), increases cerebral blood flow, and offers neuroprotection (not yet widely accepted as a standard of care).
- Continuous monitoring for hemodynamic instability in children who respond to early resuscitation is recommended.
- Recent guidelines suggest a conservative initial approach for all patients with renal trauma, using ultrasound to assess injury progression, with immediate surgery reserved for those with hemodynamic instability.
- Due to the different pathophysiology of trauma-induced coagulopathy in children, an INR of 1.2 or higher at presentation is an independent predictor of mortality, particularly in those with brain injuries.
- The use of telemedicine for remote consultation and guidance during trauma resuscitation by pediatric trauma specialists.

The trauma protocol at a county hospital such as the “Sfântul Ioan” Children's Hospital or the “Sfântul Apostol Andrei” Emergency County Hospital in Galați involves standardized procedures aimed at efficiently managing patients with severe trauma. The main stages of this protocol include:

1. Patient Triage:
   - The patient is received by the Emergency Department (ED) staff, where a rapid assessment of the patient's condition is performed (ABCDE - Airways, Breathing, Circulation, Disability, Exposure). Based on this, patients are evaluated and classified according to the severity of their injuries to prioritize care.
2. Primary Survey:
   - Ensure the airway is clear and stable.
   - Stabilize the cervical spine.
   - Assess and ensure adequate breathing; administer supplemental oxygen if needed.
   - Control major external hemorrhages and manage hypovolemic shock.
   - Assess neurological status using the Glasgow Coma Scale (GCS).
   - Fully expose the patient to assess all injuries and protect against hypothermia.

3. Secondary Survey:
   - A detailed history (symptoms, allergies, medications, medical history, last meal, events leading to injury) is taken.
   - Perform a thorough physical examination to identify all injuries and hidden trauma.
   - Perform imaging investigations (X-rays, CT scans) as needed.
4. Stabilization and Initial Treatment:
   - Administer intravenous fluids and blood products if necessary.
   - Provide specific treatment for injuries (fractures, internal organ injuries, etc.), pain management, and appropriate medication administration.
5. Decision for Transfer or Admission:
   - Patients requiring specialized care are transferred to trauma centers.
   - Patients who can be treated at the county hospital are admitted to the appropriate departments (surgery, orthopedics, intensive care).

These protocols are constantly adapted based on the latest medical guidelines and practices, ensuring optimal and up-to-date care for patients with severe trauma.

The information above highlights the need to improve trauma management in the emergency hospitals of Galați by establishing a local trauma registry to better understand trauma patterns and outcomes. This could lead to the improvement of trauma practices and guidelines. Additionally, there is a need for enhanced pediatric trauma systems, including a specialized pediatric trauma center and integrated care networks.

LIST OF PUBLICATIONS RESULTING FROM DOCTORAL RESEARCH

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1. **Anghele M.**, Marina V, Anghele A-D, Moscu C-A, Dragomir L. Negative Factors Influencing Multiple-Trauma Patients. *Clinics and Practice*. 2024; 14(4):1562-1570. IF (2024) 1.7; Q2; https://doi.org/10.3390/clinpract14040126.

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