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ORIGINAL ARTICLE

Incidence and etiology of mortality in polytrauma patients: an analysis of material from Multitrauma Centre of the University Teaching Hospital no 1 in Szczecin, over a period of 3 years (2017–2019)

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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ABSTRACT:

Introduction: The pattern of traumatic death is a subject of great interest in the worldwide literature. Most studies have aimed to improve trauma care and raise awareness of avoidable fatal complications.

Aim: The objective of the present study was an epidemiological and clinical analysis of causes of traumatic death of patients treated at the Multitrauma Centre of the University Teaching Hospital No 1 in Szczecin, over a period of 3 years (2017–2019).

Material and methods: The study material comprised medical data of 32 patients with a mean age of 63 years, who died due to polytrauma injury. The time of death form admission to the Multitrauma Centre, primary cause of death, spectrum and sites of injuries, as well as method of treatment (operative or conservative) were variables considered in the analysis.

Results: The predominant mechanisms of injury were traffic accidents – 22 cases (69%) followed by falls from a height 8 (25%) and other mechanism – 2 cases (6%). The most common primary cause of death was brain injury – 17 patients (53%) followed by pelvic or spinal fractures – 5 (16%). The predominant constituents of polytrauma were bony injuries (pelvis, spine and limbs) – 28 cases (87%), followed by head injuries – 25 (78%), chest – 24 (75%) and abdominal injuries – 17 (53%). Eighteen patients (56%) required operative treatment; craniotomy for brain injuries was the most commonly performed – in 11 patients, followed by laparotomy – in 5. Five other patients underwent an endovascular procedure – pelvic artery embolization. Twelve patients (38%) died in the first two days from admission to the trauma center, 5 (16%) in the first week and 15 over one week form admission.

Conclusions: Head injuries, pelvic fractures with associated retroperitoneal bleeding and severe injuries affecting several body parts were identified as the most dangerous for the survival of polytrauma patients. A trend to decrease mortality due to hemorrhagic shock was observed, but it remains unchanged for central nervous system injuries.

KEYWORDS: brain injury, haemorrhagic shock, mortality, polytrauma injury

ABBREVIATIONS

ATLS – The Advanced Trauma Life Support
CLUW – Polytrauma Center
CNS – central nervous system
CT – computed tomography
ISS – Injury Severity Score
SPSK – Independent Public Hospital
TAE – transcatheter arterial embolization

INTRODUCTION

Polytrauma injury involves injury to two or more areas of the body, whereby at least one of them is potentially life-threatening. Polytrauma injuries are severe; most require treatment at the intensive care unit, and often times surgical intervention; they are burdened with high mortality reaching even 20% [1, 2]. Causes of death are the concern of scientific research whose fundamental objective is to strive to increase the survival rate and decrease the frequency of potentially avoidable complications which lead to the death of patients. Literature data indicate that the most frequent reason of early (up to 24 hours) death in polytrauma injury still remains central nervous system (CNS) injury, followed by blood loss due to internal injury. The most frequent causes of late deaths are complications of CNS injuries, infections, and multiple organ failure [1–4]. The SPSK 1 Multiorgan Injury Treatment Center in Szczecin is a reference center for the West Pomeranian province whose population is estimated at approx. 2 million. It accepts patients immediately after injuries (the vast majority), as well as those previously hospitalized (usually briefly) in local branches.

The purpose of the paper was to conduct an epidemiological and clinical analysis of the frequency and causes of death in patients treated at the CLUW SPSK 1 in Szczecin over a period of 3 years (2017–2019).

MATERIAL AND METHODOLOGY

The material consisted of medical records of 32 patients: 19 men (59%) and 13 women (41%), aged 63 years (range 24–84) who suffered polytrauma injury and died during hospitalization at CLUW SPSK 1 in Szczecin in 2017–2019. All patients underwent a full-body CT scan in polytrauma injury mode. Two patients underwent a CT

Tab. I. Causes of injuries in the examined group of 32 patients.

CAUSE	TRAFFIC ACCIDENT N = 22 (69%)
Struck pedestrian/cyclist	13
Driver/passenger of car	7
Motorcyclist	2
CAUSE	**FALL FROM HEIGHT N = 8 (25%)**
From stairs	5
From a substantial height	2
Fall at home	1
Suicide attempt	[1]
CAUSE	**OTHER N = 2 (6%)**
Tractor crush	1
Violence (assault and battery)	1

Tab. II. Parts of the body whose injuries constituted the main cause of death.

BODY PART	N	%
Head	17	53%
Bones (pelvis and spine)	5	16%
More than two body parts	5	16%
Chest and pelvis	3	9%
Chest	2	6%

scan after urgent surgery and achieving hemodynamic stability. The mechanism of injury, time of death from admission to CLUW, the main cause of death, spectrum of injuries, area of the body and treatment (conservative or surgical) were analyzed. Due to the small sample size, no statistical calculations were performed.

RESULTS

During the analyzed period, there were 205 trauma patients treated at the Multisystem Trauma Treatment Center SPSK 1 in Szczecin, of which 32 died (16%). Analyzing individual years, in 2017 there were 12 deaths per 76 treated patients (16%), in 2018 – 9/65 (14%) and in 2019 11/64 (17%). The most common cause of death was traffic trauma – 22 cases (69%), fall from a height – 8 (25%) and another mechanism – 2 (6%) (Tab. I.).

a. Structure of injury resulting in deaths:

- The head (encephalon) was a part of the body whose injury was the most prevalent direct cause of death in 17 patients (53%). The next direct cause of death were bony (pelvic or spinal) injuries – in 5 patients (16%), followed by chest and pelvic injuries – 3 (9%) and injury of the chest alone in 2 cases (6%). In the remaining 5 (16%), more than 2 body injuries could be considered as the direct cause of death (Tab. II.). The most common cause of death in pelvic injury was hemorrhagic shock due to retroperitoneal bleeding;
- The most frequent constituent of polytrauma injury were bony injuries (spinal, pelvic, limb) – 28 cases (87%), head injuries – 25 (78%) and chest injuries – 24 (75%). Abdominal injuries were a component of polytrauma injury in 17 cases (53%) (Tab. III.). It should be stressed that abdominal injuries include retroperitoneal hematomas, which were found in a total of 14 patients. The source of these hematomas were pelvic fractures in 13 and ruptured kidneys in 2 (1 patient suffered injuries to both organs);
- combinations of injuries in individual areas of the body that constituted the main cause of death were head, chest, bony and abdominal injuries – 11 cases (34%), followed by head, chest and bony injuries – 8 cases (25%) (Tab. IV.);

b. Surgical treatment (Tab. V.):

- Most patients – 13 required neurosurgical treatment in the form of craniotomy. In 9 cases subdural hematoma evacuation was necessary, and in 3 individuals surgical decompression was performed due to increasing cerebral edema. In 1 patient, there was a need to disimpact the skull bone penetrating to the brain. All decompressive craniotomies were performed over both brain hemispheres; bilateral cerebral hematoma was evacuated in 1 patient;
- Five patients underwent laparotomy; 3 due to the presence of blood in the peritoneal cavity on CT scan or extensive retroperitoneal hematoma, and 2 immediately after transfer to the ICU because of symptoms of severe hemorrhagic shock. The principle of "damage control surgery" was applied in most patients. Two patients underwent removal of a ruptured spleen, 1 underwent suturing of torn mesentery of the small intestine, while another was subject to suturing of a damaged bladder. Abdominal packing was conducted on 3 patients, including 2 cases due to extensive retroperitoneal hematoma from a fractured pelvis;
- Five patients underwent pelvic embolization due to increasing retroperitoneal hematoma caused by comminuted pelvic fracture, which caused hemodynamic instability and anemization. In 4 people, embolization concerned the branch of the internal iliac artery, and in 1, a branch of the common iliac artery;
- Three patients underwent orthopedic treatment: stabilization of transcranial femoral fracture, external pelvic fixation and stabilization of cervical spine fracture;
- Suction drainage of the pleural cavity (or both pleural cavities) was applied in 15 patients due to pneumothorax;
- Four patients had more than one surgery (Tab. V.);

c. Time of death of patients in the analyzed group:

- Twelve patients (38%) died within the first 2 days of admission to CLUW, 5 (16%) between days 2 and 7, and 15 within one week of admission. Fig. 1. illustrates the number of deaths in the days following the injury;

d. Time from injury to death and age of deceased individuals depending on the immediate cause of death:

- The fastest death occurred as a result of bleeding and a sum of severe injuries – after an average of less than two days from the injury, and at the latest following post-traumatic complications (Tab. VI.);
- Brain trauma was the cause of death in younger patients (avg. 50 years), while the remaining causes affected older people (average 74 years);

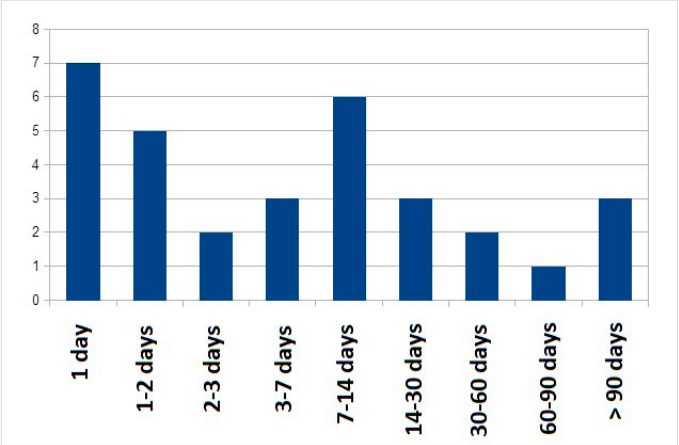

Fig. 1. Graph illustrating the number of patients who died on consecutive days of treatment of injuries.

e. Number of deaths at the SPSK 1 Hospital Emergency Department in Szczecin:

- To obtain a more complete epidemiological picture, we also acquired data on the number of deaths at the Hospital Emergency Department when patients did not have enough time to report to the CLUW. In the analyzed period of 3 years, 37 cases were reported.

DISCUSSION

The paper presents the results of an analysis of mortality at the CLUW SPSK 1 in Szczecin in 2017–2019. The mortality rate of post-traumatic patients in the analyzed period was 16%, which is a relatively good result compared to 18–23% reported in the literature [2]. It should be noted, however, that the presented analysis only concerns patients who were admitted to the CLUW alive, while most studies also include those who died at Hospital Emergency Departments. The mortality rate in the analyzed period, including post-traumatic patients who died at the ICU, is 28% (69 deaths among 242 patients).

The presented analysis shows that the most common mechanism of injury leading to death was traffic accident – in 69% of cases, with the majority of victims (13/22) being pedestrians struck by a vehicle. This is very unfavorable occurrence, typical for developing countries with poor road infrastructure and low traffic culture. For comparison, in Western Europe the percentage of struck pedestrians in the total number of serious traffic injuries does not exceed 10%. On the other hand, severe injuries as a result of cyclist accidents are relatively frequent in that area, but this is due to the high popularity of single-track vehicles in these countries [1]. It should be underlined that in our country, the number of traffic fatalities decreases systematically: in 2007 there were about 5,200; in 2015 – 3,600; and in 2018 and 2019 less than 3,000. This tendency is the result of improved infrastructure (motorways, expressways), driving culture, greater effectiveness of police checks and media campaigns.

The second mechanism of injury leading to death was fall from a height, with the majority of cases in the discussed material being stairway falls, and only 2 falls from substantial heights. This proportion is typical for a population of older patients: in the analyzed material, the average age of people who died as a result of a stairway fall or a fall at home was 77 years (range 63–87). In 2 cases of falls from the 2nd and 4th floors, patients were 29 and 69 years old, respectively. Stairway falls in older people are a relatively prevalent cause of severe injuries; they are caused by imbalances, unsteady gait due to general weakness and disorders of the lower limbs. The way in which seniors fall also promotes widespread injuries: while young people and particularly children fall "like cats", the elderly fall "like logs", without cushioning and protecting their heads from hitting hard ground.

Head injuries (CNS) were the most common direct cause of death in just over half of the cases. This proportion is consistent with data from the literature: in most publications, CNS injuries were the direct cause of death in 22–71% of cases [1, 2, 3]. The seriousness of brain injuries that resulted in death varied: from critical injuries

Tab. III. Specificity of injuries included in polytrauma in the analyzed group.

NUMBER OF PATIENTS	N = 32	
Age	avg. 63 years (range 21–87)	
Gender	M = 19 (59%)	F = 13 (41%)
BONY INJURIES	**N = 28**	**87%**
Spine	19	68%
Pelvis	15	54%
Thigh	5	18%
Shank	4	14%
Arm	3	11%
Other	3	11%
HEAD INJURIES	**N = 25**	**78%**
Skull fracture	16	64%
Cerebral hematoma	14	56%
Brain contusion	14	56%
Subarachnoid hemorrhage	14	56%
Craniofacial fracture	11	44%
Brain edema	16	64%
Spinal cord injury	3	12%
CHEST INJURIES	**N = 24**	**75%**
Rib fracture	18	75%
Pneumothorax	15	63%
Lung contusion	14	58%
Pleural hematoma	3	12%
Sternum fracture	3	12%
Damage to the thoracic aorta	3	12%
Slender chest	1	4%
ABDOMINAL INJURIES	**N = 17**	**53%**
Retroperitoneal hematoma	15	88%
Intraperitoneal bleeding	12	70%
liver injury	7	
splenic injury	5	
mesenteric injury	2	
Kidney injury	10	59%
Small intestine rupture	2	12%

* The number of constituent injuries in individual parts of the body is greater than their total number given in the heading of the table, as one patient usually suffered damage to more than one anatomical structure in a given area of the body (e.g. in the head, skull fracture, cerebral hematoma and brain edema).

Tab. IV. The most common injuries of individual body parts that constituted the main cause of death.

	NUMBER OF PATIENTS	%
Head, chest, bones, abdomen	11	34%
Head, chest, bones	8	25%
Head, bones, abdomen	3	9%
Bones and abdomen	2	6%
Head and chest	2	6%
Head and abdomen	1	3%
Only bones	1	3%
Only abdomen	1	3%
Only head	1	3%

Tab. V. Surgical treatment of n = 18 patients from the analyzed group.

	NUMBER OF PATIENTS = 18	%
Neurosurgical	13/18	72%
Craniotomy (hematoma evacuation)	9	
Decompressive craniotomy	3	
Disimpaction of bone	1	
Surgical (laparotomy)	5/18	28%
Including "packing"	3	
Including "explorative laparotomy"	1	
Orthopedic	3/18	17%
Endovascular (arterial embolization)	5/18	28%
Suction drainage of pneumothorax	15/18	83%
Two surgeries in one patient	Number of patients = 4	%
Laparotomy + orthopedic + endovascular	1	
Laparotomy + craniotomy	2	
Laparotomy + orthopedic	1	

Tab. VI. Time from injury to death and age of the deceased depending on the direct cause of death.

DIRECT CAUSE OF DEATH	NUMBER OF PATIENTS	TIME FROM INJURY TO DEATH (IN DAYS)		AGE OF PATIENTS (IN YEARS)	
		AVERAGE	RANGE	AVERAGE	RANGE
Brain injury	15	6	1–18	50	21–87
Hemorrhagic shock	7	1,7	1–3	74	55–87
Sum of trauma	4	1,7	1–3	68	61–75
Complications	7	44	33–91	80	72–86

that caused death in 1–2 days (4 cases), to less extensive: subdural hematomas and bruises, which led to death over a long period of time following neurological complications, mainly brain edema (Tab. VI.).

The second, but much rarer, direct cause of death in patients was a substantial loss of blood volume, found in 7 people (22%). It is of interest that in 5 out of 7 cases, hemorrhagic shock was caused by bleeding into the retroperitoneal space from communitive fracture of the pelvis, and in the second by the sum of multiple injuries and bleeding from various structures. No patient had primary peritoneal bleeding following peritoneal rupture. Compared to the previous analysis conducted at the authors' center which involved data from 2015, the number of deaths caused by hemorrhagic shock in the presented paper was lower (22% vs 33%) [5]. This tendency is consistent with the literature data and may be due to advances in resuscitation of patients in hemorrhagic shock, using the ATLS (The Advanced Trauma Life Support) procedures [6, 7, 8]. Current guidelines recommend early replenishment of blood deficiencies with red cell concentrate transfusions and simultaneous prevention of consumption coagulopathy with the administration of fresh frozen plasma. Lesser importance is attached to massive transfusion with crystalloid fluids [9]. In 2 papers, the authors emphasize the major role of early intervention in cases of communitive fracture of the pelvis: laparotomy with packing, endovascular surgery and external stabilization. Thanks to the implementation of such a protocol, they were able to significantly reduce mortality in polytrauma injury accompanied by unstable, extensive pelvic fractures [10, 11]. The speed of transporting the patient with internal bleeding to the trauma center is also of a relatively higher significance [1–4].

Eighteen patients (56%) from the analyzed group were treated surgically. The most common reason for intervention was CNS injury. Twelve patients underwent craniotomies, and 1 was subject to disimpaction of the skull bone penetrating to the brain (Tab. V.). The reason for craniotomy was most often subdural hematoma, and less often the need to decompress the brain due to massive edema. Neurosurgical operations were performed during the first 5 days of injury. Five patients underwent laparotomy, most of them due to increasing retroperitoneal hematoma. Only in 2 cases the reason for surgery was intraperitoneal bleeding. Although the presence of blood in the peritoneal cavity was found in polytrauma CT in 12 patients (ruptured liver in 7 and ruptured spleen in 5), there was only one case of massive bleeding, requiring immediate surgery. Compared to the 2015 analysis, there were fewer cases of intraperitoneal bleeding and laparotomies in the presented paper.

Five patients had transcatheter arterial embolization (TAE) to control retroperitoneal bleeding from a fractured pelvis. Their number was the same as that of performed laparotomies. In 3 cases, endovascular intervention was effective and bleeding was controlled, and patients died from other causes. Laparotomy and packing were performed in 2 other patients after TAE. This technique for treating internal bleeding is very recent, but is enjoying increasing popularity, also in gastrointestinal bleeding. Endovascular procedures have become an alternative to surgical treatment due to a lower mortality. The authors of one study concluded that TAE is as effective as surgical treatment in stopping bleeding secondary to peptic ulcers in cases of relapses after endoscopic treatment, with significantly lower mortality [12].

LITERATURE REVIEW

El Mestoui et al. presented the results of an analysis of the causes and incidence of death due to polytrauma injury at the reference center in Amsterdam over a 6-year period (2004–2010). A total of 1,073 patients were treated in the analyzed period, of which 205 died (19%). The average age of the deceased was 59 years and most (61%) were male. The average value of the severity of injury (Injury Severity Score, ISS) was 30. The most common cause of injury that resulted in death was fall from height in 55 cases (27%) followed by bicycle accident in 33 cases (16%). Falls from bodily height, struck pedestrians, car and motorcycle accidents – each of those reasons accounted for 11–12% of the total. In 97 individuals (47%), urgent surgery, most often neurosurgical, was performed

within the first day after admission. The immediate cause of death in 188 patients (91%) was the primary severity of injury, with 45 of those people (24%) dying at the hospital emergency department before admission to the ICU. The most common cause of early deaths was CNS injury – 130 (63%), followed by hemorrhagic shock – 35 (17%). Late deaths were the result of complications: respiratory failure, polytrauma injury and sepsis. The authors stress that a significant percentage of early deaths (91%), which were unavoidable due to the primary severity of injuries, and a very low percentage (8%) of late deaths, as a consequence of complications, indicate a high effectiveness of treatment at this center. This stems from the significant progress in emergency medical services (quick delivery of the trauma patient to the hospital) and the effectiveness of intensive therapy [1].

Pfeifer et al. conducted a meta-analysis of literature from 1980–2008 regarding deaths following polytrauma injury. Data were collected from a total of 22 articles that met the inclusion criteria for analysis. The results of the study indicate that the causes and mechanism of death (pattern of trauma deaths) have not changed significantly over 30 years: traffic accidents are the predominant cause of fatal injuries, with most deaths due to CNS injuries. Within 30 years, there has been no progress in the treatment of head injuries that would result in a reduction in mortality. In the first decade of the 21st century, there was a significant (by 15–25%) reduction in mortality from bleeding secondary to polytrauma injury. The authors believe that this was the result of a substantial improvement in the infrastructure and organization of salvage services, which meant that patients after accidents reached hospitals much faster. This improvement was also a result of the introduction of modern resuscitation procedures, like the aforementioned ATLS, and the spread of multi–detector row computed tomography, which allowed for early and accurate diagnosis of internal injuries. The causes of late deaths remained unchanged over 30 years: most often they were sepsis and polytrauma [2].

Lansink et al. compared the results of polytrauma treatment at the reference center in Utrecht (Netherlands) in 2003–2006 and 2007–2010. The number of patients treated during those periods was 2,400 and 2,900, respectively. The mortality rate was similar, 8.5% and 8.2%, respectively, but after adjusting the results depending on the severity of injury expressed by the ISS rate and the age of patients, a statistically significant improvement was observed later (a relative reduction in mortality in groups with the same parameters). The average likelihood of survival after injuries of similar severity also improved. The most frequent cause of death was CNS (of the encephalon and spinal cord) injuries and they were prevalent in the second analyzed period. The rate of morbidity from hemorrhagic shock was similar in both intervals. The authors stress that the establishment of reference centers for the treatment of polytrauma in the Netherlands has contributed to a substantial improvement in treatment results, which could be observed in the analyzed periods [4].

CONCLUSIONS

The results of the analysis presented in the paper indicate that head injuries, pelvic fractures with retroperitoneal bleeding and severe injuries to several areas of the body pose the most significant risk to life in polytrauma patients. There is a clear tendency to a reduction of mortality due to hemorrhagic shock, while it remains unchanged due to CNS injuries.

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Competing interests: The authors declare that they have no competing interests.

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