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# Analysis of mortality between 2019-2020 at the Neuroorthopedic and Traumatic Orthopedic Departments

PAWEŁ BARANOWSKI<sup>1,2,A,B,C,D,E,F</sup>, TADEUSZ PŁUSA<sup>1,2,A,B,C,D,E,F</sup>, ALICJA BARANOWSKA<sup>1,2,B,C,D,E,F</sup>,  
WOJCIECH MIKUŁA<sup>3,B,E,F</sup>, PRZEMYSŁAW MATUSZEWSKI<sup>3,B,E,F</sup>, TOMASZ WYDRA<sup>3,C,E,F</sup>, JAN DUDEK<sup>1,C,E,F</sup>,  
ZBIGNIEW SZYMCZAK<sup>1,2,B,C,E</sup>, MICHAŁ BURCZY<sup>1,B,C,E</sup>, JOANNA BARANOWSKA<sup>1,B,C,E</sup>

<sup>1</sup>Department of Neuroorthopedics, Mazovian Rehabilitation Centre STOCER, Konstancin-Jeziorna, Poland; <sup>2</sup>Faculty of Medicine of Łazarski University in Warsaw, Poland; <sup>3</sup>Department of Traumatic and Orthopedic Surgery, Mazovian Rehabilitation Centre STOCER, Konstancin-Jeziorna, Poland

A – research concept and design, B – data collection, C – data analysis and interpretation, D – article writing, E – critical review of the article, F – final approval of the article

## Analysis of mortality between 2019-2020 at the Neuroorthopedic and Traumatic Orthopedic Departments

Baranowski P<sup>1,2</sup>, Płusa T<sup>1,2</sup>, Baranowska A<sup>1,2</sup>, Mikuła W<sup>3</sup>, Matuszewski P<sup>3</sup>, Wydra T<sup>3</sup>, Dudek J<sup>1</sup>, Szymczak Z<sup>1,2</sup>, Burczy M<sup>1</sup>, Baranowska J<sup>1</sup>.

<sup>1</sup>Department of Neuroorthopedics, Mazovian Rehabilitation Centre STOCER, Konstancin-Jeziorna, Poland; <sup>2</sup>Faculty of Medicine of Łazarski University in Warsaw, Poland; <sup>3</sup>Department of Traumatic and Orthopedic Surgery, Mazovian Rehabilitation Centre STOCER, Konstancin-Jeziorna, Poland

The number of deaths from skeletal injuries is still significant, but is declining with advances in emergency medicine. The adopted principles of emergency procedures and the availability of specialist centres enable the treatment to be effective.

**The aim** of the study was to analyse the deaths of patients with spine and limb injuries who required surgery.

**Material and methods.** The analysis covered 22 deaths in the years 2019-2020. The assessment took into account: the cause of admission, the condition of the patient and comorbidities, the medical scales which were used to assess the possible risk of complications, the diagnostic correctness and qualification for surgical treatment, the waiting time for surgery and the cause of death and prior course of action.

**Results.** It can be stated that in 2019, the mortality rate was 0.21 (10 deaths out of 4658 hospitalized), in 2020, the mortality rate was 0.31 (12 deaths out of 3852 hospitalized). The mortality rate in the Department of Traumatic Orthopedics was: 0.30 in 2019 (8 deaths out of 2625 hospitalized) and 0.39 in 2020 (8 deaths in 2020 hospitalized). 10 patients with hip fractures (trochanteric and femoral neck) underwent surgery within 2.7 days (from 1 to 4 days). The causes of death within 1-9 days (average 4.86 days) from admission in this group were complex, and associated with the presence of chronic diseases, including: circulatory failure (9), septic shock (1), heart rhythm disturbances (7), renal failure (6), pulmonary congestion (4), hyperkalemia (1), coagulation disorders (1). In patients after spinal injury with quadriplegia, decompression (1), stabilization (1) and disc removal (1) were performed on the day of admission to the hospital. The patients were hospitalized in the ICU, and deaths occurred on days 9, 15 and 187 from admission due to respiratory and circulatory failure and sudden cardiac arrest. Patients after arthroplasty of the knee (1) and hip (2) were operated on day 2 from admission, and deaths occurred on day 4, 22 and 53 due to: sepsis (1), pulmonary embolism (1), respiratory failure in the course of pneumonia (1).

**Conclusions.** The deceased were admitted in a serious general condition, burdened with numerous concomitant chronic diseases and their age ranged from 66 to 97 years. The surgical treatment was undertaken for life saving reasons but 5 of the deceased did not undergo surgery due to the extreme general condition leading to respiratory and circulatory failure.

**Key words:** deaths, hip fractures, spinal injury, arthroplasty

## Analiza umieralności w latach 2019-2020 w Oddziałach Neuroortopedii i Ortopedii Urazowej

Baranowski P<sup>1,2</sup>, Płusa T<sup>1,2</sup>, Baranowska A<sup>1,2</sup>, Mikuła W<sup>3</sup>, Matuszewski P<sup>3</sup>, Wydra T<sup>3</sup>, Dudek J<sup>1</sup>, Szymczak Z<sup>1,2</sup>, Burczy M<sup>1</sup>, Baranowska J<sup>1</sup>.

<sup>1</sup>Oddział Neuroortopedii, Mazowieckie Centrum Rehabilitacji STOCER, Konstancin-Jeziorna; <sup>2</sup>Wydział Lekarski Uczelni Łazarskiego w Warszawie; <sup>3</sup>Oddział Ortopedii Urazowej Mazowieckiego Centrum Rehabilitacji STOCER, Konstancin-Jeziorna

Liczba zgonów z powodu urazów narządu ruchu jest nadal znaczna, ale ulega zmniejszeniu wraz z postępem w zakresie medycyny ratunkowej. Przyjęte zasady postępowania w nagłych wypadkach oraz dostępność specjalistycznych ośrodków umożliwiają skuteczne leczenie.

**Celem** pracy była analiza zgonów chorych po urazach kręgosłupa i kończyn, którzy wymagali leczenia operacyjnego.

**Materiał i metody.** Analiza objęła 22 zgony w latach 2019-2020. W ocenie uwzględniono: przyczynę przyjęcia, stan chorego i choroby współistniejące, stosowane skale medyczne, którymi posłużono się do oceny możliwego ryzyka powikłań, a także poprawność diagnostyczną i kwalifikację do leczenia operacyjnego, czas oczekiwania na operację oraz przyczynę śmierci i wcześniejszego sposobu działania.

**Wyniki.** Można stwierdzić, że w 2019 r. umieralność wyniosła 0,21 (10 zgonów z 4658 hospitalizowanych), a w 2020 r. umieralność była 0,31 (12 zgonów z 3852 hospitalizowanych). Umieralność w Klinice Ortopedii Urazowej wyniosła: 0,30 w 2019 r. (8 zgonów z 2625 hospitalizowanych) i 0,39 w 2020 r. (8 zgonów w 2020 r. hospitalizowanych). 10 chorych ze złamaniami szyjki kości udowej (krętarza i szyjki kości udowej) operowano w ciągu 2,7 dnia (1-4 dni). Przyczyny zgonu w ciągu 1-9 dni (średnio 4,86 dnia) od przyjęcia w tej grupie były złożone i związane z występowaniem chorób przewlekłych, w tym: niewydolności krążenia (9), wstrząsu septycznego (1), zaburzeń rytmu serca (7), niewydolności nerek (6), zastoju w krążeniu płucnym (4), hiperkaliemii (1), zaburzeń krzepnięcia (1). U chorych po urazie kręgosłupa z tetraplegią w dniu przyjęcia do szpitala wykonano dekompresję (1), stabilizację (1) i usunięcie krążka międzykręgowego (1). Chorzy byli hospitalizowani w OIT, a zgony nastąpiły w 9., 15. i 187. dobie od przyjęcia z powodu niewydolności oddechowej i krążeniowej oraz nagłego zatrzymania krążenia. Chorzy po endoprotezoplastyce stawu kolanowego (1) i biodrowego (2) byli operowani w 2. dobie od przyjęcia, a zgony nastąpiły w 4., 22. i 53. dobie z powodu: posocznicy (1), zatorowości płucnej (1), niewydolności oddechowej w przebiegu zapalenia płuc (1).

**Wnioski.** Zmarli przyjmowani byli w ciężkim stanie ogólnym, obciążeni licznymi współistniejącymi chorobami przewlekłymi, a ich wiek wahał się od 66 do 97 lat. Leczenie operacyjne podjęto w celu ratowania życia, ale 5 zmarłych nie poddano operacji z powodu skrajnego stanu ogólnego prowadzącego do niewydolności oddechowej i krążeniowej.

**Słowa kluczowe:** zgony, złamania biodra, uraz kręgosłupa, endoprotezoplastyka

The mortality rate from limb and spine injuries has decreased over the years due to advances in emergency medicine. Nevertheless, those injuries are still life threatening, especially in the elderly population and those suffering from numerous comorbidities. The geriatric population ( $\geq 65$  years old) represents the fastest growing demographic in the world. The aging of the general population corresponds to increased occurrence of injuries due to age-related decline in musculoskeletal function, neurological function, and bone robustness. [5,11].

Hip fractures occur in around 1.5 million people per year worldwide, the highest rates are found in Scandinavia, whereas the lowest rates are in Africa [7]. Hip fractures are a heterogeneous group with two main types of fractures: the intracapsular (femoral neck) and the extracapsular (trochanteric and subtrochanteric) fractures. The absolute majority of them occur in patients with a tendency to falling, who are also at an increased risk of morbidity and mortality [14,19].

The incidence of spinal cord injury (SCI) is also connected with the aging population and progress of civilization [6,11]. Road traffic accidents are the most frequent cause of spinal fractures all over the world [7,12].

The aim of the analysis was to conduct a critical assessment of the correctness of the procedures, and to identify possible shortcomings in the process of treating post-traumatic patients, as well as to indicate the direction of changes in order to improve care for seriously ill patients.

## MATERIAL AND METHODS

The medical histories of the deceased at the STOCER Rehabilitation Centre in the years 2019-2020 were analysed retrospectively.

The assessment took into account:

- the cause of admission,
- the condition of the patient and comorbidities,
- the medical scales which were used to assess the possible risk of complications,
- the diagnostic correctness and qualification for surgical treatment,
- the waiting time for surgery,
- the cause of death and prior course of action.

All patients on admission to the hospital were assessed according to the adopted scales in order to reduce the occurrence of possible complications. For this purpose, questionnaires were used, including: assessment of the risk of thromboembolic changes according to the *Caprini* score [13],

assessment of the risk of infections, assessment of the risk of complications before surgery, and assessment of nutritional status. Moreover, the ASA (American Society of Anesthesiologists) Physical Status Classification System has been used to assess a patient's pre-anesthesia medical comorbidities. These steps were helpful in predicting perioperative risks.

All data was analysed statistically.

## RESULTS

In the period 2019-2020:

- 10 patients died at the STOCER Rehabilitation Centre (RC) in 2019 and 12 in 2020, including 12 women and 10 men aged 66 to 99 years. Converted into the number of hospitalized in the analysed years, it can be stated that
- in 2019, the mortality rate was 0.21 (10 deaths out of 4658 hospitalized);
- in 2020, the mortality rate was 0.31 (12 deaths out of 3852 hospitalized).

The mortality rate in the Department of Traumatic Orthopedics was:

- 0.30 in 2019 (8 deaths out of 2625 hospitalized);
- 0.39 in 2020 (8 deaths in 2020 hospitalized).

19 patients were admitted urgently, and they were qualified for surgical treatment necessary in order to preserve life. 2 patients were admitted for knee and hip arthroplasty, and 1 patient was admitted to the Rehabilitation Department after left hip arthroplasty performed in another hospital. The reasons for admission to RC STOCER are listed in tab. 1.

Hip fractures are a heterogeneous group with two main types of fractures: the intracapsular (femoral neck) and the extracapsular (trochanteric and subtrochanteric) fractures [15]. It should be emphasized that the deceased analysed in the study were at the advanced age of 70 to 97 years. The general condition of 15 patients admitted for a trochanteric and subtrochanteric or a femoral neck fractures was severe. 5 patients with signs of circulatory failure, 6 patients with congestion in the pulmonary circulation, 10 patients with cardiac arrhythmias, and 9 patients with signs of renal failure. In addition, the findings of gastrointestinal bleeding and symptoms of pneumothorax or pleural fluid required life-saving procedures. Moreover, the patients were diagnosed with comorbidities, mainly including hypertension and cardiac arrhythmias (atrial fibrillation), which led to cardiopulmonary destabilization during the injury. In order to objectify the observed symptoms and to assess the size of the risk taken, scales were used to approxi-

**Table 1.** Reasons for admitting the analysed deceased at the STOCER Rehabilitation Centre  
**Tabela 1.** Przyczyny przyjęcia analizowanych zmarłych w Centrum Rehabilitacji STOCER

Reasons for admitting	No	Age	Sex	Condition at the time of admission (n)	Comorbidities (n)	Rates
Hip fractures	15	82-97 (95,99) 70-91 (84,4)	10 Female 5 Male	Circulatory failure (5) Pulmonary edema (6) Pleuro- and pneumothorax (3) After heart infarct (5) Arrhythmia (10) Renal failure (9) Bleeding form gastrointestinal tract (1)	Dementia (6) Hypertension (8) Renal failure (3) Atrial fibrillation (7) Diabetes (3) Heart failure (3) Esophagus cancer (1) Hypothyreosis (3)	Risk of infection – 2-17 Risk of complications – 2-7 Risk of thrombosi – 6-10 ASA – III-IV
Spinal injury (accidents)	3	66-82 (73,0)	3 Male	Quadriplegia (3) Fracture of cervical spine with spinal injury (3)	Hypertension (2) Ankylosing spondylitis (1) Diabetes (1) Withdrawal symptoms (1)	Very severe (intensive care dept.) (2) Sudden cardiac arrest (1)
Arthroplasty of hip and knee	3	72-87 (78,0)	2 Female 1 Male	Purulent fistula (1) Planned operation (1) Rehabilitation (1)	Diabetes (1) Anemia (1) Hypertension (2) Asthma (1) Heat failure (1)	Infection of <i>Staph. aureus</i>
Fracture of the left humerus	1	74	Female	Circulatory failure Diabetes Pleurothorax	Heart failure	Risk of infection – 20 Pleural drainage

mate the incidence of infection and thromboembolic changes. In this group, they indicated the highest risk of possible complications. Despite these risks admitted patients were operated in order to preserve life.

3 patients with spinal injury with quadriplegia were in a very serious condition and required care in the ICU. The diagnosed diabetes and ankylosing spondylitis worsened the prognosis. Three patients admitted for arthroplasty, including 2 for elective surgery, showed a significant burden of comorbidities, including respiratory failure in the course of pneumonia, and the presence of a purulent fistula in poorly controlled diabetes. One patient did not pose an increased risk (sudden death during upright standing). A fracture of the left humerus after the injury was found in a 74-year-old patient with severe symptoms of circulatory failure, with fluid in the right pleural and abdominal cavities, with cirrhosis of the liver and advanced COPD, which significantly worsened the prognosis after surgery performed for life saving reasons (intramedullary nail). The causes of death of hospitalized patients are presented in tab. 2.

**10 patients with hip fractures (trochanteric and femoral neck) underwent surgery** within 2.7 days (from 1 to 4 days, depending upon the patient's condition). Surgical treatment was discontinued in 5 patients because of the following: pneumothorax and pleural fluid, kidney failure, gastrointestinal bleeding, heart failure (bradycardia), heart failure and pulmonary edema.

The causes of death within 1-9 days (average 4.86 days) from admission in the group of patients with hip fractures were complex, and associated with the presence of chronic diseases, including: circulatory failure (9), septic shock (1), heart rhythm disturbances (7), renal failure (6), pulmonary congestion (4), hyperkalemia (1), coagulation disorders (1).

**In patients after spinal injury** with quadriplegia, decompression (1), stabilization (1) and disc removal (1) were performed on the day of admission to the hospital. The patients were hospitalized in the ICU, and deaths occurred on days 9, 15 and 187 from admission due to respiratory and circulatory failure and sudden cardiac arrest.

**Table 2.** Time of death is numerous from the date of surgery and cause of death  
**Tabela 2.** Czas zgonu liczony od daty zabiegu i przyczyna zgonu

Rescue operation	Operation time since admission	Cause of death	Death (days since admission)	Applied therapy	Reasons for withdrawal from surgery (5 patients)
<b>Reposition and surgical fixation of hip fractures</b>	2,7 days (1-4 days)	Circulatory failure (9) Septic shock (1) Heart arrhythmia (7) Renal insufficiency (6) Pulmonary edema (4) Hyperkalemia (1) Coagulation disorder (1)	1-9 (4,86 days)	Dopamine Furosemide Atropine Antibiotics Pleural cavity drainage	Pneumo- and pneumothorax Renal insufficiency Gastrointestinal bleeding Bradycardia Heart failure Pulmonary edema
<b>Decompression (1) Stabilization (1) Disc removal (1)</b>	Day of admission	Circulatory and respiratory insufficiency (2) Sudden death on rehabilitation (1)	9 15 187	Intensive therapy in intensive care unit	Operated for vital reasons on the day of admission
<b>After alloplasty</b>	2 days	Sepsis (1) Pulmonary embolism (1) Respiratory insufficiency (pneumonia) (1)	22 4 53	Intensive care unit Sudden death Intensive care unit	Operated for vital reasons on the day of admission
<b>Reposition and fixation of humerus fractures</b>	4 days	Pulmonary edema Pleurothorax	4	Symptomatic therapy	Operated for vital reasons on the day of admission

Numbers of admitted traumatic patients according to ICD in the analysed time periods are presented in table 3. The marked low number of deaths in relation to individual types of fractures indicates the effectiveness of the treatment procedures. The main causes of deaths were comorbidities, closely correlating with the age of the treated patients and the extent of past injuries.

**Patients after arthroplasty** of the knee (1) and hip (2) were operated on day 2 from admission, and deaths occurred on day 22, 4 and 53 due to: sepsis (1), pulmonary embolism (1), respiratory failure in the course of pneumonia (1).

**Patient with a surgical reposition and fixation of the left humerus fracture** required drainage of the pleural cavity

**Table 3.** Numbers of admitted traumatic patients according to ICD and numbers of deaths in the analysed time periods  
**Tabela 3.** Liczby przyjętych chorych pourazowych wg ICD i liczba zgonów w analizowanych okresach czasu

Injury	ICD	2019		2020	
		n	%	n	%
<b>Trochanteric fracture</b>	S 72.1	209	13,51%	208	15,36%
	Deaths	6	2,87%	5	2,40%
<b>Femoral neck fracture</b>	S 72.0	96	6,20%	112	8,27%
	deaths	2	2,08%	2	1,78%
<b>Spinal injury</b>	S 12 S 22 S 32	234	15,13%	178	13,15%
	deaths	2	0,85%	1	0,56%
<b>Knee arthroplasty</b>	M 17	414	26,76%	335	24,74%
	deaths	1	0,24%	-	-
<b>Hip arthroplasty</b>	M 16	476	30,77%	425	31,39%
	deaths	1	0,21%	1	0,23%
<b>Fracture of the left humerus</b>	S 42	118	7,63%	96	7,09%
	deaths	1 (0,84%)	-	-	-
<b>Total</b>		1547	100%	1354	100%

due to exudative pleurisy and pneumothorax, which, despite treatment, resulted in death on day 4 from admission, following surgery performed for life preservation.

The list of analysed cases includes the deceased, aged 87, who stayed at the Rehabilitation Department after left hip arthroplasty performed at another orthopedics department in Warsaw. Due to worsening circulatory failure, he was transferred to the Intensive Care Unit after 8 days, where he died 38 days later due to respiratory and circulatory failure.

## DISCUSSION

The analysis of deaths in our trauma and orthopedic, and neuro-orthopedic departments indicates that the main factor responsible for their occurrence was the serious condition of the patients and numerous comorbidities. Moreover, in the most analysed cases the fatal injuries were caused by road accidents or falls. The most common consequences of musculoskeletal injuries are intracranial trauma, femur, tibia or fibula fractures with internal disturbances leading to serious complications and death [22,25].

### Hip fractures

The incidence of hip fractures has increased rapidly in recent decades in close connection with the aging of the world population. According to performed statistic analyses hip fractures are affecting around 1.5 million people per year worldwide, with the highest rates documented in Scandinavia and the lowest in Africa [4,20]. With the aging of the world's population, hip fractures are expected to reach 6.3 million by the year 2050 [1,29]. The mortality rate after sustaining a hip fracture is up to 10% at 30 days, and 35% at one year after the fracture [2,5]. It was documented that almost half of the survivors are unable to reach their previous functional levels, partly related to the surgical treatment and fixation failure [3]. The majority of the trochanteric and subtrochanteric hip fractures are observed in patients with a tendency to fall (low impact fractures) and an increased number of comorbidities, which increases the risk of mortality [9].

The surgical options for transtrochanteric and subtrochanteric hip fractures commonly include plating with sliding hip screw or intramedullary nailing, with nailing today being the predominant procedure in many parts of the world [18]. The analysis of our material showed that the number of deaths within 2 years in patients following trochanteric or femoral neck fracture was very low – 2.87% in 2019 and 2.40% in 2020, although all subjects were very advanced in age and suffered from multiple comorbidities. It was documented that 27.6%-40.5% of men and 15.8%-23.3% of women die within the first year after a hip fracture, and nearly 40% of patients may lose their mobility and need long-term care [21].

There are several publications recommending that hip fracture patients should be operated without delay to decrease mortality and morbidity [6,28]. Our hip fracture patients were treated within 1-4 days (average 2.7 days). The immediate cause of death was connected with the symptoms of circulatory failure, combined with arrhythmias and renal failure. In 5 patients with hip fracture the surgical treatment was discontinued because of diagnosed pneumothorax, heart and kidney failures. The percentage of deaths after the trochanteric fracture was higher than after the femoral neck fracture, which may be due to the different blood circulation in the site of injury. In addition trochanteric fractures generally occur in older member of the population [16]. Performed analysis over 320,000 hip fractures occurred in North America each year showed that a mortality rate was ranging from 14% to 36% within 1 year of surgery. A comparison of these mortality rates based on 70 trials published between 1981 and 2012 documented similar mortality. However, 1-year mean mortality rates for intertrochanteric fractures diminished from 34% to 23% in studies published before 2000 and after 1999 [23].

### Spinal cord injury

Causes of death in spinal cord injury (SCI) have changed in recent years. The frequency of spinal fractures in road traffic accident victims is growing, and is more predominant in the

cervical region [1]. The largest increase in incidence of SCI was observed in older patients, which was associated with an increase in numbers of falls [15]. The important risk indicators for death in this group of patients include the neurological level of injury [10,12,26], completeness of the SCI [8] and older age at injury [24]. Cervical spine injuries account for the majority of the spinal injuries followed by thoracolumbar fractures and almost half of the spinal injuries result in neurological deficits. Survival is inversely related to the patient's age, and neurologic level of injury. Mortality rate of spinal cord injury during the initial hospitalization is reported to be almost 10% [30].

In our material the patients with SCI demonstrated quadriplegia, they underwent decompression, stabilization and disc removal, on the day of admission in order to preserve life. They were hospitalized in the ICU, and deaths occurred due to respiratory and circulatory failure and sudden cardiac arrest.

It is well known that persons with SCI are particularly exposed to potential risk factors associated with cardiovascular diseases [2] and deaths are frequent in this group [26]. In the analysis of the cause of death and risk indicators for death in Norwegian patients with SCI it was demonstrated that risk indicators for death were: higher age at injury, tetraplegia, functionally complete spinal cord injury, pre-injury cardiovascular disease, alcohol or substance abuse and psychiatric diagnosis [17]. Deaths in our patients after SCI were also directly related to heart failure and thrombotic complications.

### Arthroplasty of the knee and hip

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are well controlled procedures of orthopaedic surgery. In our THA patients the mortality rate was 0.21% and in TKA patients it was 0.24%. The causes of death were sepsis, pulmonary embolism and respiratory failure in the course of pneumonia. All patients who died after hip or knee replacement surgery suffered from metabolic disorders such as diabetes, hypertension, and asthma that led to circulatory failure. The analysis of the 30-day mortality rates after THA and TKA, according to data from the Australian Orthopaedic Association National Joint Replacement Registry, were in 2003, 0.23% and 0.17% respectively, and reduced to 0.06 and 0.08% in 2017 after improvements in intra-operative and post-operative patient management [14].

The presented analysis of deaths indicates many factors responsible for them. On the one hand, the unmodified factor was the general condition of patients on admission to the hospital, and on the other hand, the procedure applied at particular stages of specialist treatment. In our opinion, the procedures were fully justified and carried out correctly. The introduced new methods of objectifying the degree of risk to the life of a patient with trauma may be helpful in obtaining the best possible clinical results, an example of which may be the Japanese damage control orthopaedics, which made it possible to decrease in-hospital mortality [31]. The factors that predict morbidity and mortality in older patients were evaluated using the Injury Severity Score (ISS), Revised Trauma Score, Glasgow Coma Scale (GCS) [27] and in the United States the Spinal Cord Injury Model Systems [15] which showed a good clinical application. The scales we used were aimed at reducing the occurrence of possible complications. The legitimacy of such a procedure was confirmed by the presented analysis, as the discussed causes of deaths resulted from the severe general condition of the patients.

## CONCLUSIONS

Based upon the analysis of the medical history of people who died at the Neuroorthopedic Department and Trauma and Orthopedics Department of the STOCER Rehabilitation Center, it can be concluded that:

- the deceased were admitted in a serious general condition, burdened with numerous concomitant chronic diseases;
- the age of the deceased ranged from 66 to 97 years;

- surgical treatment was undertaken for life saving reasons;
- 5 of the deceased did not undergo surgery due to the extreme general condition leading to respiratory and circulatory failure.

The above analysis shows that postoperative patients with symptoms of respiratory and circulatory failure should be treated in an intensive care unit. It is necessary to scrupulously assess the risk of potential complications while admitting patients and to control

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Address for correspondence:

Paweł Baranowski

Department of Neuroorthopedics, Mazovian Rehabilitation Center STOCER

05-510 Konstancin-Jeziorna, Wierzejewskiego 12 str.

Phone: 22 711 90 00

e-mail: sekretariat@stocer.pl