

Multi-trauma care in the Intensive Care Unit and the role of the nurse: A literature review

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Abstract

Introduction: Multiple traumas occupy a significant part of the staff in the Intensive Care Unit (ICU), as multi-injured patients almost always require intensive care. These patients are distinguished, depending on the cause and type of injuries, in specific categories such as injuries, bleeding etc. During their stay in the ICU they may experience complications that need immediate treatment. The role of the nurse is mainly focused on the constant vigilance and the correct hierarchy of interventions.

Aim: The purpose of this literature review is to investigate the care of the multi-injured in ICU and the role of the nurse on it.

Method: A bibliographic review was performed on the sites 'PubMed', 'google scholar', 'Scopus' and 'open-archives', with the keywords: 'multi-injured', 'multi-injured in ICU', 'multi-injured care in ICU', "the role of the nurse in ICU" and "patient with trauma in ICU", for the years 2007-21. A total of 28 articles were used, in English and Greek language.

Results: An observational study in Greece (2011) showed that the most common cause of admission to ICUs was road accidents, while a study in China (2014-15) showed that acute intracerebral hemorrhage and brain injury were the most common causes of death. A study in South Korea (2010-15) found that the most common complication in multiple injuries in ICU was respiratory-related pneumonia (VAP), while in another study in the Netherlands (2013-18) 24.6% developed delirium/confusion within the ICU. Meta-analyses in China (2018) and Australia (2016) and a literature review in Canada (2016) showed that early enteral nutrition reduces complications, mortality, and length of stay in the ICU. According to a cohort study in USA (2012), early mobilization of the multi-injured also contributes to the reduction of complications. An observational study in England (2012-15) showed that surgery reduces mortality, while in a prospective study in Brazil (2010-11) the workload of nurses in ICUs with multiple injuries was high and correlated with various factors. Finally, in a contemporary study in Greece (2019) it was observed that 80% of patients in the ICU had experienced positive experiences from the nursing staff.

Conclusions: In recent years, studies have been conducted internationally on the prevention, treatment and care of multiple injuries in ICUs. It is proposed to further strengthen the role of nurses, mainly through the institutionalization of protocols and training programs, to improve patient prognosis and reduce health costs in hospitals.

Keywords: Multi-injured; Multi-injured in ICU; Multi-injured care in ICU; The role of the nurse in ICU; Patient with trauma in ICU

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1 Introduction

'Trauma', according to the World Health Organization, is defined as "any violent destruction of tissues, internal or external, regardless of the cause that caused it" [1]. Multiple traumas refer to serious injuries from a fall, attack or crash. Injuries can cause severe bleeding or large bone fractures. They can also cause damage to the brain or vital organs (eg. lung, spleen, liver) [2]. A multi-trauma patient is defined as a patient who has received multiple injuries. The injuries should include those present to more than one area of the body, or present in one body area but at the same time coexist with injuries to small bones or fractures such as the pelvis [3].

Multiple trauma patients are categorized according to the injuries they have suffered. The first category concerns injuries, which are divided into mechanical, physical and chemical. Another category concerns bleeding, which is divided into arterial, venous and capillary. Other categories are burns, which are divided into first, second and third degree and brain injuries, most of which are due to traffic accidents. This is followed by falls from a height, which are more common in elderly patients. Both the prevention and treatment of intracranial hypertension in these patients lead to a better neurological outcome but also to a lower rate of disability [4]. Finally, there are chest, abdominal, and pelvic injuries. Multi-injured people can also be divided according to the types of injuries they have received. The species are divided into external and internal [3]. Internal, while not usually obvious, are life-threatening (eg. skull, thorax, peritoneal cavity). The external ones are divided into open (abrasions, lacerating wounds, cutting wounds, tearing or extensor wounds, amputations, etc.) and closed (ecchymosis, hematomas) [1].

The largest percentage of multiple injuries is due to traffic accidents and mainly to two-wheelers. Other causes are occupational accidents in mainly manual tasks, such as falls from a height, but also accidents from sports activities. Also, a significant part comes from intense natural disasters, such as fires, earthquakes, etc. Finally, it is worth mentioning that a significant percentage of multiple injuries concern victims of criminal and terrorist acts, depending on the region/country and the corresponding increase in crime [3,5]. In a retrospective cohort study conducted in Shenyang, Northern China, the most common causes of critical illness in the Intensive Care Unit (ICU) were found to be acute intracerebral hemorrhage (26%) and brain injury (16.8%), while most frequent causes of death respectively with 42.2% the first and 36.6% the second, during the first 7 days of hospitalization in the ICU [6].

People with injuries are usually taken to the ICU because they can have brain damage, breathing problems, organ failure, blood loss, infections, or even permanent disability or loss of limbs. They may also have bruising and swelling or even impaired thinking and speech [2]. The multiple trauma patient in the ICU, whose injury may be either blunt or penetrating, may present complications such as reduced functionality, hypovolemia, hypothermia, metabolic acidosis, tissue and organ inflammation, acute respiratory failure and damage to multiple tissues and systems. Both types can be treated with angioplasty/surgical techniques, while only the blunt ones can be treated conservatively, mainly by patching, and thus its care in the ICU is also applied without surgery [7]. The most important complications are respiratory failure, sepsis and organ failure syndrome in various systems. They are divided into direct and indirect. Direct complications include coagulation disorders, acidosis, hypothermia, limb-abdominal compartment syndrome, worsening cerebral edema, and crush syndrome, while indirect complications include mainly ARDS, multiple organ failure, and sepsis [3].

Trauma in developed countries is the leading cause of death in ages 1-45 years and the third leading cause of death for all ages. 50% of these deaths involve young people aged 15–44. The economic cost of traffic accidents alone in the European Union each year is estimated at 70 billion euros. Every day, nearly 16,000 people die from trauma of various causes worldwide, accounting for more than five million deaths each year worldwide. In Greece, approximately 24,000 accidents occur annually (traffic, work, accidental, as well as acts of violence) which lead to an average of 2,500 deaths and 32,000 injuries, of which 4,500 are in a critical condition. The economic cost of these accidents in the country every year is estimated at 338 million euros. 20% of deaths occur during the hospitalization of the wounded and are mainly due to sepsis (78%) and multiple organ failure. 30% occur a few hours after the injury. The remaining 50% occur in the initial minutes at the place where the accident happened. Studies suggest that 1 in 4 deaths that occur within the first two hours of injury could be prevented if treated immediately [1].

1.1 Role of the nurse

The nurse in the ICU must be constantly alert for the prioritization of the patient's needs and the planning of the interventions. In principle, vital signs are monitored hourly, through the monitors. The nurse must also check the central nervous system (with the Glasgow scale), the digestive system (tolerance of enteral feeding, bowel movements etc.) and use other scales and protocols. Indicatively, the trauma score (TS) and the revised trauma score (RTS) are mentioned, where the first is based on both the Glasgow scale and the state of the respiratory and cardiovascular system, and the

second mainly on the Glasgow scale. The nurse may also use the Injury Severity Score, which numerically captures the extent of multiple injuries in different areas of the body [8]. He also places, cares for, and monitors endovascular catheters, urinary and digestive system catheters, and endotracheal tubes, while also handling drains and stoma and treating wounds using bandages and other patches. The administration of drugs is also very important, where the most basic way of administration is through an intravenous infusion pump, in order to ensure accuracy in the dose and the download time. Sedatives and muscle relaxants, anti-inflammatories, antiepileptics, antihypertensives, positive inotropics and vasoconstrictors, diuretics, electrolytes, analgesics, antipyretics, gastroprotectors, antibiotics and other drugs are indicated depending on the needs of the patient [9,10].

The nurse also takes care of the hygiene and cleanliness of the body. Personal hygiene includes cleaning the body, limbs, hair, face, eyes, ears, mouth and mucous membranes, as well as changing clothing. He also takes care of problems of immobility/dyskinesia and the creation of body pressure ulcers. Pressure ulcers/bedsores are a serious complication of ICU patients, requiring high hospital costs as material requirements and hospital days increase. Most commonly they are due to pressure, friction, shear forces or a combination of the above. Common sites of pressure ulcers in ICU patients are coccyx, back, buttocks, heels, and especially in intubated patients at the corners of the mouth due to the pressure exerted by the endotracheal tube and its stabilization system. Thus, the nurse undertakes preventive measures, such as frequent change of position, use of an alternating pressure mattress, clean clothing and bedding without creases, good cleaning of the skin, adequate fluid administration to the patient and maintenance of a good level of nutrition. Furthermore, in case of pre-existing bed rest he takes care of cleaning the points and the using appropriate plasters [9,11]. Finally, the nurse also takes care of the psychological support, especially when the patient shows emotional effects due to the injury and shows changes in his personality and behavior [1,9].

Regarding feeding, the ICU patient needs careful regulation of protein and calories intake. According to the guidelines, enteral feeding must be started early enough during the patient's stay in the ICU, mainly to avoid infections. Caloric energy targets must be achieved within 3 days, otherwise parenteral feeding is selected between days 3 and 7 of the ICU stay. In addition, optimal feeding requires a balanced administration of macronutrients, including lipids along with carbohydrates. Regarding electrolytes, any deficiency of potassium, phosphorus or magnesium can become dangerous for the patient and must be corrected immediately. Protein intake is recommended at 1.3g/kg of patient body weight per day, and in combination with exercise if possible. Dysphagia may occur after weaning from mechanical ventilation, as well as increased rates of pneumonia, ICU readmission, and even mortality. In this case, according to the guidelines of the European Society for Clinical Nutrition and Metabolism (ESPEN), the nutritional needs are replenished with enteral (usually through a nasogastric tube) or parenteral feeding [12].

1.2 Usefulness

It is proven that the admission of thousands of patients to ICUs daily is due to injuries of various causes, and the most frequent cause of admission per year concerns traffic accidents [13]. This is due initially to the high rates of traffic accidents, worldwide, as well as the fact that traffic accidents usually cause multiple and severe injuries to the patient [5,14]. In any case, multi-injury cases cover a large number of beds in ICUs and involve the majority of people up to 45 years of age, i.e. young people in fully productive age, thus causing social and indirect financial costs, as well as direct financial costs for hospitalization in ICUs since many laboratory and imaging tests and use of expensive drugs and materials are required, while at the same time their care and treatment requires the contribution of various health professionals of different specialties [1]. However, their timely discharge from the ICU could reduce the cost but also the length of stay. This could also be achieved by strengthening the knowledge of health professionals and especially nurses, regarding the care of multiple trauma patients in ICUs, as they also play the most important role in their care [5,10].

Aim

During the initial search it was found that most of the literature refers to the initial approach to the multiple trauma patient and his management in the emergency department. However, the purpose of this bibliographic review is to investigate the care of the multi-trauma patient in the Intensive Care Unit and the role of the nurse on it. The goal is to strengthen the literature and raise awareness about the specific topic as it will improve the knowledge of nurses about the treatment and rehabilitation of these patients in the ICU.

2 Material and methods

The following research question arose: “what is the nurse’s role in the care of the multi-trauma patient in the Intensive Care and what that care means?”. For the writing of the specific scientific paper, a bibliographic review was carried out on the websites: 'PubMed', 'google scholar', 'Scopus', 'open-archives', with the key words/phrases in Greek and English:

"multi-injured", "multi-injured in ICU", "multi-injured care in ICU", "role of nurse in ICU" and "patient with trauma patient in ICU". The selection criteria of the articles were the publication year (2007-2020), the age of the injured (adults only) and the language (English and Greek only). There was no restriction on the type of literature, as books, research articles, literature reviews, clinical studies, theses and scientific journals were used. However, sources concerning the initial approach and treatment of the multi-traumatized patient in the ER (Emergencies Room) were excluded, in order to focus on care in the ICU. PRISMA flow chart is illustrated as follows:

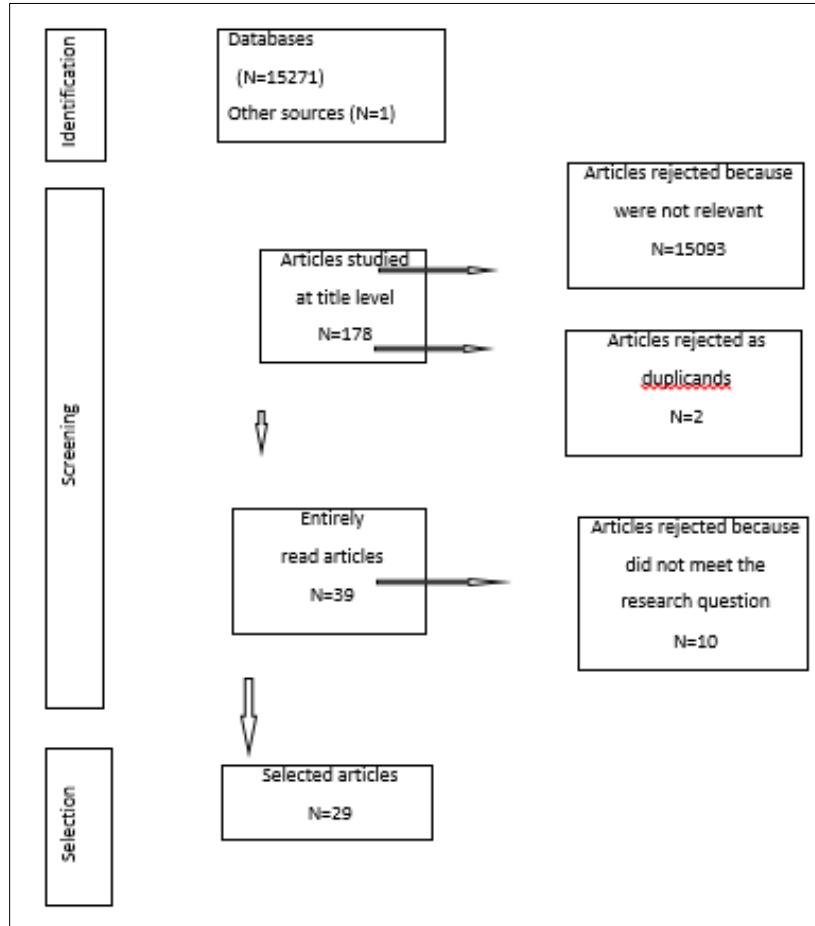


Figure 1 Flow chart according to the method-proposal PRISMA

3 Results

3.1 Epidemiological data

An observational study carried out in six ICUs of public hospitals in Attica, Greece in April 2011, with a population of 555 patients aged 18-40, showed the following results: 24.7% of accidents had upper extremity fractures, 26.4% lower extremity fractures/limbs, 30.2% had more than 3 fractures, 6.9% more than 5 fractures and 75.7% had brain injury. Patients who came to the ICU from a surgery (36.2%) were statistically significantly more likely to live than those who came from another ICU (17.8%), another clinic (12.5%), another hospital (14.3%), or a hospital in another city (16.7%). Traffic accidents were identified as the most important cause of admission of young people to ICUs. The majority of these people were multi-injured [14].

An observational cross-sectional study whose data were obtained from the Trauma Registry of the American College of Surgeons (TRACS) was conducted over three years, from July 1, 2013 to June 30, 2016. This cohort study included 10,684 adult trauma patients presented to the ED. The results showed that more cases of trauma occurred on weekend days and the highest arrival during the change of shift in the evening (6-7pm). The period in which the highest incidence of trauma occurred was from April to the end of October. Motorcycle crashes (MCC) were more common during the Summer, falls slightly more common in Spring, and motor vehicle crashes (MVC) more common in Autumn [15].

In Spain, from 2000 to 2010, the annual increase in trauma hospitalization rates among older adults was 1.1% for male and 0.9% for female patients. In the United States, trauma hospitalizations accounted for 4.4% of all hospitalizations from 2000 to 2011, declining gradually for children and youth and holding steady for the elderly. Also, in the US in 2013, 33.8% of trauma patients entered the ICU, with a higher incidence among people aged 80 years and older (7.8 per 1,000 population). In 2015 trauma accounted for 10.1% of global hospitalizations. In 2017, the Global Burden of Disease (GBD) international program study estimated that non-fatal injuries from falls and traffic accidents disabled 226.2 million people worldwide. Fatal injuries accounted for 8% of the world's overall mortality, affecting 4.48 million people. There was an increase of 2.3% compared to 10 years ago (in 2007) and deaths averaged 57.9 for every 100,000 inhabitants. In 2007 also, trauma accounted for 11.9% of the 1.65 billion potential years of life lost (PYLL). In Canada, from 2002 to 2009, the increase of the hospitalization rate due to major trauma was 22% for people aged 65 years and >10% in younger people. In Brazil, data from the Hospital Information System of the Brazilian Unified Health System were fully analyzed. This analysis showed that hospitalization due to external causes increased by 37.3% between 2002 and 2011, and that the most common causes were falls (41%) and traffic accidents (15%). In Switzerland a study of ICU hospitalizations between 2008 and 2012 found that trauma accounted for 44.3% of all ICU hospitalizations. The most common injuries were brain injury (64.4%) and chest trauma (59.8%), and the main causes were traffic accidents (40.4%) and falls (34.4%).

An ecological retrospective study in Brazil analyzed data from the Hospital Information System from January 1998 to December 2015. Results showed that length of stay rates decreased by 28.5%, while ICU admissions increased by 21.4%. Hospitalization due to trauma increased mainly in the northern (296.9%) and northeastern (167.1%) regions. Mortality fell overall by 25.1%. The most common causes of trauma were falls (4.5%) and complications during hospitalization (5.4%). Overall trauma ICU hospitalization rates were twice as high in men, but the increase was higher among female patients (average 5.4% per year) than male patients (3.8% per year). The hospitalization rates of bicyclists (4.3%) and pedestrians (4%) showed the greatest increase. The annual ICU trauma mortality rate was approximately 1.7% lower [16].

Another retrospective study performed in Switzerland, included 646 adult patients (210 women and 436 men) classified as multiple trauma and treated at a Level I Trauma Center between 2000-2017. The results showed that the most common cause of injury for women was as pedestrians or from suicidal falls, while men were more likely to be injured as bicyclists. After treatment in the ICU, female patients stayed on average significantly longer in the clinic than men, namely 27.1 days versus 20.4 days. The severity of injuries and the difference in mortality between men and women was not statistically significant [17].

A retrospective cohort study conducted in Shenyang, North China from January 2014 to December 2015 found that acute intracerebral hemorrhage and brain injury were the most common causes of critical illness in the ICU with 26% and 16.8% respectively, and the most frequent causes of death with 42.2% the first and 36.6% the second during the first 7 days in the ICU. The incidence of acute intracerebral hemorrhage increased between the ages of 55 and 64 years and the incidence of brain injury respectively between the ages of 65 and 74 years. Older age was also found to be a significant risk factor for death for most critical ICU hospitalizations [6].

Another retrospective study was conducted by the German Trauma Society from 2015 to 2017 and included data from hospitals in Germany, Austria, Belgium, China, Finland, Luxembourg, Slovenia, Switzerland, Netherlands and the United Arab Emirates. In total, 83,313 cases of trauma patients were included. The results showed that the surviving patients had a mean age of 50.3 years, the mean length of stay in the ICU was 6.3 days and length of stay in the hospital in general was 16.9 days. A total of 6,576 patients (8%) died during their hospital stay. 5,481 of these were admitted to the ICU alive and died in the ICU, while 972 patients (17.7%) were discharged from the ICU and died later. Patients who died before leaving the ICU tended to be younger, more severely injured, and had a shorter ICU stay. Of the non-surviving patients discharged from the ICU, 31.5% were treated for less than 3 days and 70.9% for less than 8 days (outside the ICU) [18].

3.2 Common complications

A retrospective study conducted at Gyeongsang National University Hospital in South Korea between January 2010 and December 2015, included 101 patients, with mean age of 66 years, with multiple rib fractures who required mechanical ventilation in the ICU. Of the 101 patients in the study, 46 (45.5%) of them developed pneumonia (ventilator-associated - 'VAP') while the remaining 55 (54.5%) did not. Regarding the types of traumas, it emerged that fractures in the sternum area were observed in 18 patients (17.8%), on the chest in 75 patients (74.3%), while all 101 patients (100%) suffered a pulmonary contusion. Traumatic diaphragmatic injury was observed in 5 patients (5%), traumatic cardiac injuries in 3 patients (3%), pneumothorax in 80 patients (79.2%), and hemothorax in 94 patients (93.1%). Patients in

the VAP group had a longer hospital stay than those in the control group. Additionally, ICU length of stay and duration of mechanical ventilation were significantly longer in the VAP group than in the control group. Furthermore, complications such as acute respiratory distress syndrome (ARDS), acute renal failure, gastrointestinal bleeding, atrial fibrillation (AF) and disseminated intravascular coagulation were investigated and it was found that the rate of these complications was significantly higher in the VAP group. Finally, VAP morbidity was significantly associated with severe pulmonary contusion and was 2.4 times higher in patients with severe pulmonary contusion than in those without [19].

Another retrospective cohort study of 191 patients aged ≥ 65 years with one or more rib fractures after blunt trauma at a tertiary teaching hospital in Breda, Netherlands, and a level II trauma center, between July 2013 and June 2018, showed that 47 (24.6%) patients developed delirium/confusion. More complications were also observed in patients with delirium. The median ICU length of stay and hospital length of stay were 4 and 7 days respectively, of which the latter was significantly longer for delirious patients ($p < 0.001$). Furthermore, patients with delirium had twice the mortality rate compared to non-delirious patients [20].

3.3 Treatment/Nutrition

A retrospective comparative observational study was conducted at a Northwest England Major Trauma Center between August 2012 and March 2015 involving 83 patients who were divided into two groups, those to undergo surgery (47 people) and those who would undergo conservative, non-surgical rehabilitation (36 people). The results showed that the average length of stay in the hospital for patients in the first category was 14.53 days, while in the second category was 30.41 days, and the difference was statistically significant ($p < 0.01$). 23 patients (48.9%) in the operative group were admitted to the ICU compared with 28 patients (77.7%) in the nonoperative group ($p < 0.01$). The incidence of respiratory complications was lower in the first category group, but this difference was not statistically significant. The mortality rate was 2.1% for the surgically treated group compared with 13.9% for the non-operatively treated group ($p < 0.05$) [21].

A meta-analysis which was conducted in China and ended May 1, 2018, aimed to identify evidence to determine whether early enteral nutrition affects the outcome of patients after severe burn injury. Early enteral feeding was shown to significantly reduce mortality, gastrointestinal bleeding, sepsis, pneumonia, renal failure, and length of hospital stay [22].

A meta-analysis by Doig et al performed in 2016 in Australia included 3 randomized controlled trials in 126 patients and demonstrated that provision of early enteral nutrition was associated with a significant reduction in mortality (OR=0.20, 95% confidence interval 0.04-0.91, I²=0) while other analyses confirmed the reduction in mortality [23].

A literature review conducted in Canada in 2016 and including studies published from 1980 to January 2016 compared the two types of nutrition (enteral and parenteral) 5 days after ICU admission. The conclusions were that there was no difference in overall mortality between patients receiving enteral nutrition compared to those receiving parenteral nutrition. But there was a statistically significant difference in the reduction of infectious complications, with enteral feeding significantly superior compared to parenteral feeding. Furthermore, enteral nutrition was associated with a reduction in ICU length of stay, but not with overall hospital length of stay [24].

Another retrospective cohort study was conducted at UAB University Hospital in Birmingham, Alabama, USA in 2012. The purpose of this study was to assess how early mobilization affects complication rates, ventilation days, and ICU days for patients who were admitted to a trauma and burn intensive care unit (TBICU). It involved 2,176 patients, from whom data were collected from May 2008 to April 2010. Results of the study showed that early mobilization of seriously ill patients with injuries and burns is ultimately safe and feasible and results in reduced rates of pneumonia and deep vein thrombosis (DVT), as well as reduced occurrence of airway, lung, and vascular complications [25].

A retrospective study conducted in the USA between January 1, 2015 and December 31, 2016 included trauma patients admitted to the R Adams Cowley Shock Trauma Center at the University of Maryland, USA, and required support via a transvenous extracorporeal oxygenation (VV ECMO / Veno-Venous Extracorporeal Membrane Oxygenation). During this period eighteen patients required VV ECMO. Their mean age was 28.5 years, 15 (83%) were male and 12 (67%) patients had blunt injury, while mean Injury Severity Score (ISS) was 27, median PaO₂/FiO₂ (P/F) before ECMO support was 61, median time from injury to intubation was 3 days, and median duration of ECMO support was 266 hours. Fourteen (78%) patients were successfully weaned from VV ECMO and four (22%) patients died while still on ECMO. The cause of death in three patients was shock due to the injury, and one patient died of primary neurologic injury. Of the 14 patients weaned from ECMO, 12 (86%) were transferred to a rehabilitation center in good neurological condition. Two (14%) patients were discharged directly from the hospital. The average time on ECMO for those successfully

weaned was 277 hours and six (43%) had 14 documented bleeding complications. When comparing survivors to non-survivors, survivors had significantly higher injury severity, longer ICU and hospital length of stay, more time on ECMO, and more total ventilator days ($p < 0.05$). Survivors were intubated at a later time (post-injury) compared to non-survivors. In summary, data showed that trauma patients treated with VV ECMO for acute respiratory failure and ARDS had higher survival rates [26].

3.4 Role of Nurses

A prospective, cross-sectional study using descriptive and correlational analyses was conducted in the city of São Paulo, Brazil between 2010 and 2011. The study included 200 trauma patients admitted to the ICU. Results of the study showed that from the 200 patients admitted to the ICU, most were male (82%), the mean age was 40.7 years, and most were blunt trauma patients (94.5%). The most common external causes of injury were traffic accidents (57.5%) followed by falls (31%). Regarding injury severity, the mean values of ISS (Injury Severity Score) and NISS (New Injury Severity Score) were 19.3 and 27.1 respectively. All victims had at least one injury, and on average 2.7 body regions were affected, while 65.5% of patients had injuries to the head or neck area; Regarding the severity of the condition, it was found that pulmonary failure and neurological disorders were detected in most patients within the first 24 hours of admission to the ICU. According to the nursing activity score (NAS), two groups were created: medium/low workload and high workload. Nurses' workload was found to be quite high during the first 24 hours after patients were admitted to the ICU, and was associated with gender, pulmonary insufficiency, number of affected body regions, and imminent risk of death [27].

Finally, a non-interventional, cross-sectional study with retrospective data collection was carried out in 4 ICUs of three military hospitals in Attica, Greece in 2019. 108 patients participated in the study and were asked to answer questions about their experiences inside the ICU. Most patients were admitted for pathological reasons (73.1%), while the rest were multi-trauma (10.2%) or underwent planned or non-planned surgery (9.3% and 7.4% respectively). Results showed that the majority of participants reported extremely positive experiences during their ICU stay. The percentage of patients who responded "always" to how often they had experienced positive experiences was at least 80%. 96.3% answered that they always had confidence in the staff, 97.2% answered that they always felt "human warmth", 99% that the staff provided them with information calmly and clearly, and finally 92.3% that the staff encouraged them to strive to become better. However, 47% of the patients stated that they could not always sleep at night and 32% that they were not always sufficiently relieved from pain [28]. Subsequently follows a table with the characteristics and consolidated results of the studies used in this literature review:

Table 1 Study characteristics

Type of study, country and year	Results and Conclusions
Observational study (Greece) 2011	24.7% of accidents involved an upper extremity fracture, 26.4% a lower extremity fracture, 30.2% had more than 3 fractures, 6.9% more than 5 fractures, and 75.7% a traumatic brain injury. Traffic accidents were identified as the most important cause of admission of young people to ICUs. The majority of these people were multi-injured.
Cohort Study (USA) 2013-2016	More wounds occurred on weekends. Higher trauma frequency was from April to end of October. Motorcycle accidents were more common in Summer, spring falls in Spring and automotive accidents in the Autumn.
Global Burden of Disease International Program Study (Spain, USA, Canada, Brazil, Switzerland) 2000-2017	In Spain, USA and Canada an increase in the length of hospitalization was observed in elderly people. An increase in fatal injuries was found internationally. In Brazil and Switzerland the most frequent causes were falls (41% and 40.4%) and traffic accidents (15% and 34.4%).
Ecological retrospective study (Brazil) 1998-2015	A decrease in length of hospitalization by 28.5% was observed, an increase in ICU admissions by 21.4%, a decrease in mortality by 25.1% while the length of hospitalization in ICU was twice as long in men.
Retrospective study (Switzerland) 2000-2017	The most common cause of injury for women was as pedestrians or from suicidal falls, while for men as motorcyclists. After ICU treatment, female patients spent significantly longer in the clinic than male patients [27.1 days and 20.4 days respectively].

Retroactive Cohort study (Shenyang, Northern China) 2014-2015	Acute intracerebral hemorrhage and brain injury were the most common causes of critical disease in ICU (26% and 16.8%) and the most common causes of death (42.2% and 36.6%). Their incidence increased at ages 55-64 and 65-74 respectively.
Retrospective study (Germany) 2015-2017	The mean age of the survivors was 50.3 years, the mean length of stay in the ICU was 6.3 days. 5,481 died in the ICU, while 972 died after leaving the ICU. The former were younger, more seriously injured and their length of stay in the ICU was shorter.
Retrospective study (Gyeongsang, South Korea) 2010-2015	45.5% developed ventilator-associated pneumonia (VAP) and had a longer ICU stay, as well as duration of mechanical ventilation. 100% of patients developed pulmonary contusion, with the VAP group having pneumonia 2.4 times more.
Retrospective cohort study (Breda, Netherlands) 2013-2018	24.6% developed delirium/confusion. They had more complications, longer ICU length of stay and twice the mortality rate.
Retrospective comparative observational study (Northwest England) 2012-2015	47 people underwent surgery, while 36 underwent non-surgical rehabilitation. 23 patients of the first group and 28 of the second were admitted to the ICU. The mortality rate was 2.1% for the first group compared to 13.9% for the second.
Meta-analysis (Australia) 2016	Early enteral feeding was shown to significantly reduce mortality, incidence of gastrointestinal bleeding, sepsis, pneumonia, and renal failure, as well as length of hospital stay.
Meta-analysis (Australia) 2016	Provision of early enteral nutrition was associated with a significant reduction in mortality.
Literature review (Canada) 2016	Enteral nutrition reduced the incidence of infectious complications and was associated with a reduction in ICU length of stay.
Retrospective cohort study (Alabama, USA) 2012	Early mobilization of multiple trauma patients is safe and feasible, and results in reduced rates of pneumonia and deep vein thrombosis, as well as in reduced incidence of airway, pulmonary, and vascular complications.
Retrospective study (USA) 2015-2016	During this period eighteen patients required VV ECMO. Fourteen (78%) patients were successfully weaned from VV ECMO. Four (22%) patients died while still on ECMO. The average time on ECMO for those successfully weaned was 277 hours. Survivors had higher injury severity, longer ICU length of stay and longer ECMO time. VV ECMO treatment was associated with high survival rates.
Prospective, cross-sectional study (São Paulo, Brazil) 2010-2011	Nurse workload was high within the first 24 hours of ICU admission and was associated with sex, pulmonary insufficiency, number of affected body regions, and imminent risk of death.
Non-interventional, cross-sectional study (Attica, Greece) 2019	The majority of participants reported extremely positive experiences while in the ICU. 80% experienced positive experiences, however 47% stated that they could not sleep at night and 32% that they did not always get adequate pain relief.

4 Discussion

It is a fact that multi-injured patients occupy a large number of ICU beds over time, as they usually suffer from brain damage, respiratory problems, organ failure, blood loss, or even permanent disability or loss of limbs, conditions that need providing increased and intensive care. This is clearly shown through a study by the international Global Burden of Disease (GBD) program and a study in Brazil that both found an increase in trauma hospitalization rates, as well as in ICU admissions. Of special interest was an American study whose results showed a higher frequency of trauma from April to the end of October and especially on weekend days.

Regarding Greece and Brazil, the most important cause of ICU admission was traffic accidents, while in Northern China it was acute intracerebral hemorrhage and brain injury. According to the results of a Swiss study, it was observed that the most frequent cause of injury for women was as pedestrians or from suicide falls, while for men as bicyclists. Similar

studies in Spain, Brazil and Switzerland found differences between the two sexes, with men showing an increase in ICU admissions and hospitalization rates, while women stayed longer in the clinic after ICU treatment. Finally, no significant difference was noted between them regarding injury severity and mortality.

Furthermore, the association between multiple injuries and mortality has been investigated worldwide. Specifically, in recent years in Brazil, a reduction in mortality was observed in patients with multiple trauma, while in the Netherlands, a double mortality rate was observed in patients with trauma and accompanying delirium. Surgical treatment appears to reduce mortality rates in multiple trauma patients as demonstrated by a relevant study in England. At the same time, in Germany there were more people who died during their stay in the ICU, compared to those who died after leaving it.

Regarding the nutrition of multiple trauma patients in the ICU, a study carried out in Australia showed that the provision of early enteral nutrition was associated with a significant reduction in mortality, while a more recent study in China demonstrated that in addition to mortality, it also significantly reduces the occurrence of gastrointestinal bleeding, sepsis, pneumonia, kidney failure as well as the length of stay in the hospital. In addition, enteral nutrition appears to significantly reduce ICU length of stay and infectious complications compared to parenteral nutrition.

It is also known that multiple trauma patients in the ICU can develop serious complications that need to be prevented. One way of prevention is the timely mobilization of patients as demonstrated by a study in the USA, which showed that this reduces the rates of deep vein thrombosis and pneumonia as well as the occurrence of airway, lung, and vascular complications. One of the major complications is ventilator-associated pneumonia (VAP). A related study showed that in patients with VAP, the length of stay in the ICU, the duration of mechanical ventilation and the rate of complications were significantly greater than in patients who did not develop this type of pneumonia. Another US study looked at a treatment approach with VV ECMO therapy, which was associated with high survival rates. Survivors had a higher degree of injury severity, a longer length of stay in the ICU, and spent more time on ECMO.

The care of the multi-trauma patient in the ICU requires also the immediate and continuous intervention of the nurses, a fact that is proven by their increased workload, as can be seen from a related study conducted in Brazil. Factors that add to workload are gender, pulmonary insufficiency, number of affected body regions, and patients' imminent risk of death. A recent retrospective study carried out in 4 ICUs in Greece concluded that the majority of patients had positive experiences such as trusting the staff, who provided them with information calmly and clearly and encouraged them to strive to get better. Based on the latter, it is concluded that, in Greece as well worldwide, the contribution of the nursing staff to the healing and rehabilitation of multiple injuries is most important, which makes it necessary, both by the state and by private bodies and institutions, to develop and sponsor both research and studies, as well as the adoption and certification of protocols for dealing with and managing multiple injuries in ICUs. At the same time, the organization and institutionalization of educational seminars and programs, both at the medical and nursing level.

Limitations of the study

The present systematic review is characterized by some limitations. Firstly, the electronic search included studies published only in Greek and English, and all studies published before the specified period (2007-2020) were excluded from this review. At the same time, included studies are characterized by a percentage by heterogeneity in terms of their design, data collection tools and the population under study. Finally, another limitation of this review is the lack of assessment of the quality of the majority of the studies used.

4 Conclusion

It is a fact that multi-injured patients make up a large percentage of beds in ICUs, both in Greece and worldwide. This is mainly due to the increased number of traffic accidents, which are also the main cause of multiple trauma, especially at younger ages. The need for these patients to be hospitalized in the ICU stems both from the type of injuries and from the occurrence of complications because of them. An important role is played by the nursing staff of the ICU, who is constantly alert for the prioritization of the patient's needs, the planning of interventions and their holistic approach. At the same time, the provision of comprehensive and effective care can reduce the increased cost and length of hospitalization of multiple trauma patients in ICUs. In terms of prevention, the application of early mobilization prevents the occurrence of complications in the circulatory and respiratory systems. In addition, it has been shown that appropriate treatment and prevention contribute to reducing the workload of nurses in the ICU and it was observed that their contribution to the outcome of the patients is efficient.

The timely management and treatment of multiple injuries in the ICU by health professionals, and especially nurses, is an active, interdisciplinary, and constantly renewed process. It is highly recommended to further increase and

strengthen the role of nurses in the future, mainly through educational programs and institutionalization of protocols internationally, not only in the management of multiple injuries but also in general in-hospital emergency health situations. This might hopefully lead to a reduction in mortality and an improvement in the prognosis of patients, but also in a future time to the limitation of health costs and the saving of resources, and thus their legitimate reallocation to health and welfare programs worldwide.

Compliance with ethical standards

Disclosure of conflict of interest

All authors declare no conflict of interest.

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