

Management of multiple traumas in emergency medicine department: A review

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ABSTRACT

One of the main causes of adults' disability during their working age is multiple trauma. The process of medical care of patients who are injured seriously is still a challenging job. The primary treatment of these patients in the emergency medicine departments is the most required choice after the wilderness first aid and also would be very required before definitive care in the hospital. The main aim of emergency medicine departments is quick recognition and treatment of injuries which pose severe threat to patients' life in appropriate order of priority. The procedure of primary evaluation in emergency medicine department with the help of medical routine examination and ultrasonography is based on the concept of focused assessment with sonography in trauma (FAST) for identifying spontaneous intraperitoneal hemorrhage. Emergency patients who suffer from massive hemothorax, serious lung and heart traumas, and penetrating traumas to the chest would undergo thoracotomy and patients who have few symptoms of perforated hollow viscous will undergo emergency laparotomy. Based on the trauma severity, emergency treatment could be the way to fast recovery of the structure of injured organ and its function. The subsequent goal, in the acute phase, will concentrate on preventing and stopping bleeding and secondary injuries like painful compartment syndrome or intra-abdominal infections (IAIs). However, the main aim of emergency medicine department in taking care of severely injured patients is the management of airway, protecting circulation and breathing, identification of neurologic problems, and whole body clinical examination with the help of healthcare providers.

Keywords: Emergency care, emergency medicine, multiple traumas, traumatic injuries

Introduction

Globally, one of the most common causes of injuries that could pose threat to life is nonpenetrating trauma, also called as blunt force trauma, caused by road traffic accidents or various kinds of fallings.^[1] In addition, the occurrence of multiple trauma around the world is an important issue, and the process of management of these patients is still a challenge from medical, logistic, social, and economic points of view.

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In accordance to the report of Institute for Health Metrics and Evaluation (IHME), multiple trauma could cause acute inability of about fifty million people each year worldwide.^[2] Similarly, Lendrum *et al.*^[3] reported a worldwide mortality percentage of about 10% due to multiple trauma, the percentage being higher than that due to HIV/AIDS, mycobacterium tuberculosis, and malaria. In addition, the mortality rate due to multiple traumas in developed countries is less than 10%. Somehow, more than 90% of them would happen in less-developed countries.^[4] As a fact, it should be noted that primary medical therapies after the occurrence of trauma would reduce the probability of subsequent damages and patient morbidity and could increase the patient survival rate.^[4] However, organized, safe, and proper treatment of injured patients demands increasing emergency

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medicine knowledge that would help in reducing the risk of posttreatment consequences and death.^[5,6]

In this regard, the specialists of emergency medicine department should be able to help trauma patients to remain in safe situation properly. However, the process of safety and care is associated with the absence of various kinds of undesired harms or potential physical damages.^[7] Consequently, the emergency medicine department personnel have detailed knowledge of providing professional and high-quality care and, as a result, are able to provide complex care and to respond to sensitive medical demands^[8] Therefore, there is a need to expand correlated healthcare system in the form of emergency medicine services for improving the quality of care of patients especially who suffer from multiple traumas. In this regard, Alla *et al.*^[9] report the model of assessment of health quality based on three principles: structure, procedure, and outcomes. The structural aspect deals with patients and the financial resources spent for improving the quality of the healthcare system. The procedural aspect points out the association between the patients and healthcare personnel of the emergency medicine department for achieving proper diagnosis, treatment and suitable care. The outcomes are responsible for the proper healthcare provided through the efficient and productive actions of healthcare managers and professionals and the satisfaction level of patients.^[9] Accordingly, the proper quality of emergency medicine department services for patients with multiple trauma are essential.

The novel algorithms for the medical care process of multiple trauma are frequently modified for finding new remedial techniques. The authors of this comprehensive study are aiming to represent the available knowledge about the main features of management of multiple trauma. The introduced models for medical care of multiple trauma could enhance the health-related social requirements with the help of an organized system for preventing various kind of traumas. The procedure of trauma care requires a multidisciplinary healthcare team that could provide various medical care phases.^[10]

Materials and Method

The main sources of collecting the most related elements of the primary process of hospital care of patients who are injured seriously in accordance with relevant publications were recovered through an optional search conducted in PubMed, Google Scholar, Cochrane Library, MEDLINE, Embase, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Allied and Complementary Medicine (AMED), and Physiotherapy Evidence Database (PEDro) on the care of patients who had suffered multiple trauma up to August 2019 were searched. The search results were categorized based on trauma, multiple trauma, patients injuries, and emergency medicine department services. The study selection process is shown in Figure 1. A total of 229 articles were retrieved; finally, 58 articles met the inclusion criteria and were reviewed entirely.

Emergency medicine department related challenges

Unfortunately, there is not any special categorization for various kind of traumas like intensive trauma, severe traumatic injury, and multiple trauma. From an international point of view, patients with a medical score of 16 or higher for assessment of trauma severity are considered to be injured severely.^[11] Consequently, the recognition of existence of two or more distinct traumas which could threaten the health of patient are estimated as multiple trauma. Worldwide, high costs is spent for preserving the structures and permanent employment of medical care staffs for treating patients with intensive injuries. The interdisciplinary remedial guidelines which rely on scientific evidence could provide adequate knowledge about the sufficient structures and levels of effective staffing required in trauma centers for the primary treatment of severely injured patients.^[12]

The primary treatment of traumatic patients in the emergency medicine department is very important for the prospective purposes. The main link among the prehospital emergency medicine unit and the hospitalization unit is the shock room. The main specifications for therapeutic procedure within the shock room are mainly based on grade A and grade B recommendations which are presented in Table 1. Grade-A recommendations include the patterns of injury and the physiological parameters of the patient and grade B recommendation includes the mechanism of injury.^[13]

The shock room specialists have predefined responsibilities which should be performed based on the level of care of the hospital [Table 2]. The diagnostic process must be standardized and designing of remedial algorithms should be included for removing errors and delay in treatment and enhancing the quality of diagnosis.

Training of shock room staff

The shock room staff should have in-depth knowledge of the principles of advanced trauma life support (ATLS). The main objective of these trainings is to empower the shock room staff to quickly gather relevant information about the threatening risk and traumas of the patients. The efficiency of these training systems could enhance the productiveness of the shock room staff.^[15] While there are no evidences about the impact of these training systems on the overall mortality rate, Alshafi *et al.*^[16] reported that the death rate during the first hour of hospital reception decreased from 25% to zero. However, they cited that such standardized trainings could have a significant effect on the overall health of the patients. But unfortunately, there are not any high-quality statistical studies that have assessed the effect of training systems on the mortality rate of or other factors that affect the intensive traumatic patients.^[16]

The advanced trauma life support (ATLS) courses concentrate mostly on the simulations and practical exercises of the shock room processes. After initial consideration, all patients should be investigated in accordance with the steps defined as follows:^[17]

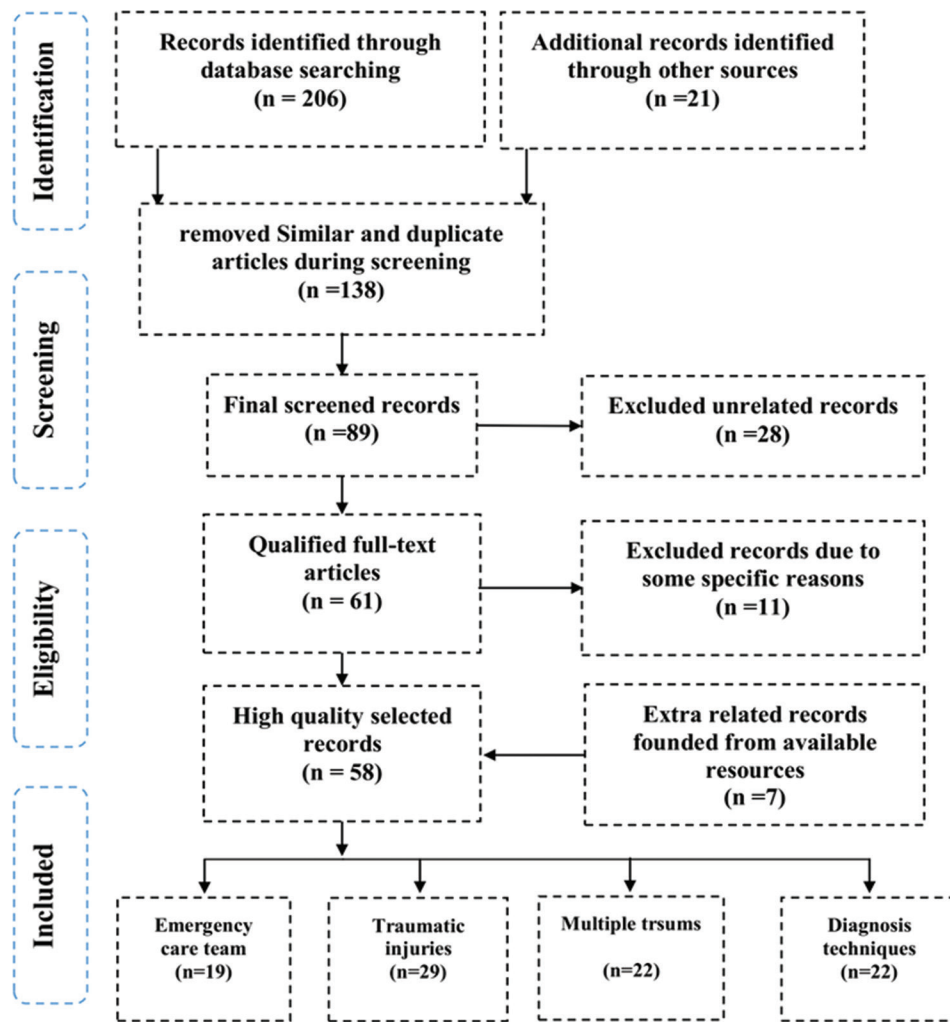


Figure 1: The schematic process of selection of article within the current study in accordance with PRISMA method

- I: Airway and breathing—cervical spine should be immobilized to establish a secure airway and sufficient exchange of gas
- II: Blood circulation—provide adequate perfusion of body tissues
- III: Disability—recognition of focal neurologic deficiency, alcohol intoxication, etc.
- IV: Environment— whole body examination of patient after undressing; keeping the patient’s body warm; and proper management of threatening traumas.

Management of massive traumatic bleeding

Worldwide, intensive trauma poses one of the biggest challenges to public health as it is responsible for about 10% of mortalities.^[18] Based on the World Health Organization (WHO) report, the three main causes of severe trauma and deaths related to violence are homicides, suicides, and road traffic accidents.^[19] Recently, mass casualty incidents have occurred due to the use of explosive weapons and wars and have resulted in a lot of intensive traumas and bleeding and have created massive challenges for national healthcare system.^[20] Improper control of massive posttraumatic bleeding could be one of the main preventable causes of death

of severely injured patients as about 33% of accident patients present with trauma-related hemorrhage and show signs of bleeding disorder when admitted to the hospital.^[21,22]

Patients with coagulopathy face multiple organ failure and high risk of death when compared to patients without the disorder.^[23] The primary acute trauma induced coagulopathy has recently been identified as a multifactorial disease due to the combination of the activation of fibrinolytic pathways and anticoagulants, generation of an endothelial cell thrombin receptor, tissue trauma associated thrombomodulin upregulation, and hemorrhagic shock [Figure 2].^[24]

The intensity of the clotting disorder (Thrombophilia) could depend on the therapeutic and environmental factors which would cause dilution, hypothermia, acidemia abnormality, and consumption and hypoperfusion of clotting factors.^[25] In addition, the extent of bleeding disorders could depend on the trauma- and patient-related factors such as traumatic brain injury (TBI) and comorbidities, genetic background, inflammation and applied remedies before the trauma, direct

Table 1: The recommended situations in which the team of shock room should be activated. Derived in accordance with^[14]

The mechanism-of-injury Falling from over three meters	The patterns of injury Trunk and neck penetrating traumas	Physiological parameters of the patient The presence of less than 90 mm Hg systolic blood pressure after trauma
Traffic collision	Trunk and neck traumas caused through gunshot	Glasgow Coma Scale (GCS) less than 9 after trauma
A head-on collision with an intrusion at the range of 50 to 75 cm	Several proximal bones fractures	The disorder of respiratory system which requires tracheal intubation after trauma
Variations in delta velocity over than 30 km/h	Chest wall instability	
Motorcycle and pedestrian accident	Unstable fractures of pelvis	
Passenger death	Feet/hands proximal amputation	
Accidental passenger ejection	Traumas with neurological symptoms of paraplegia disorder	
	A penetrating head injury	
	More than 20% of patients represents grade 2 and higher burns	

Table 2: Various medical specialists needed at emergency centers for management of major traumatic injuries. Derived in accordance with^[14]

Demanded specialists	Specialized local and regional trauma centers	More specialized trauma centers
Anesthesiologist	Essential	Essential
Visceral and digestive specialist	Essential	Essential
General Surgeon Specialist	Essential	Essential
Radiologist	Essential	Essential
Neurosurgeon	Essential	Essential
Vascular surgeon	Essential	Essential
Cardiothoracic surgeon	Essential	Essential
Otorhinolaryngologist	-	Essential
Ophthalmologist	-	Essential
Maxillofacial surgeon	-	Essential
Urologist	-	Essential
Pediatric surgeon	-	Essential
Gynecologist	-	Optional
Plastic surgeon	-	Optional

oral anticoagulants (DOACs), and also the application of fluid before hospitalization.^[26,27]

The process of diagnosis

Focused assessment with sonography for trauma (FAST)

The main challenge for the shock room specialists of an emergency medicine department is the quick recognition and treatment of traumas that need immediate intermediations. Along with the swift treatment of intrathoracic hemorrhage traumas with suggestions for the proper function of the heart, identification and remedy of intra-abdominal traumas are the most important steps in the care process of patients who are injured seriously.^[28] The initial technique for recognizing the injuries through imaging is focused assessment with sonography in trauma (FAST). FAST is a quick, sensitive technique for recognition of idiopathic spontaneous intraperitoneal hemorrhage to obtain accurate knowledge on the presence

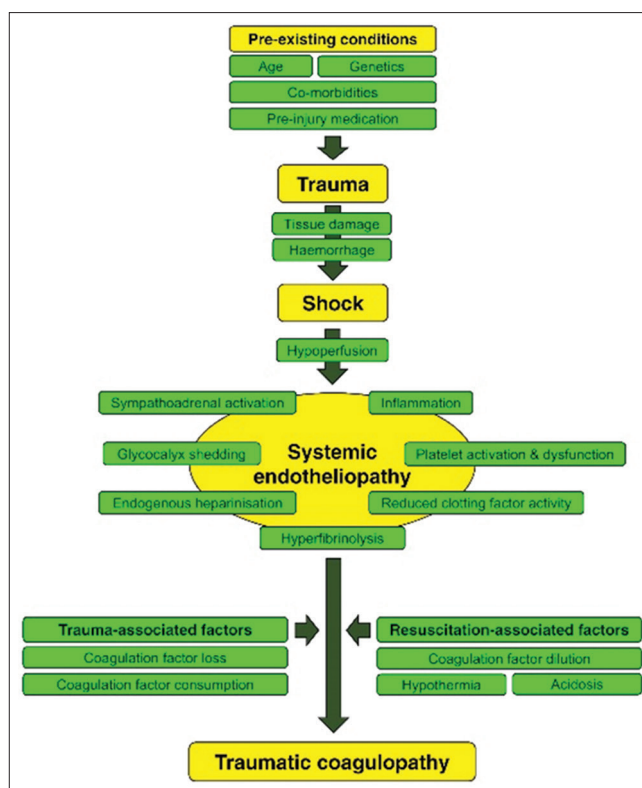


Figure 2: A presentative schematic of the effective factors with the earlier factors along with the factors related to both resuscitation and trauma measures, which would provide the condition for acute traumatic coagulopathy. Derived in accordance with^[11]

or absence of hemothorax or clinical syndrome of cardiac tamponade. The application of assured underwater sealed drains (UWSD) is the most essential remedial intervention when the patients present with acute blunt chest trauma, large blood accumulation, acute cardiovascular injury, and traumas of the cardiorespiratory organs.^[29] The presence of blood in the peritoneal cavity should be prevented through laparotomy. However, in situations when FAST response is negative, other sources of bleeding should also be eliminated.

Portable radiography

Plain X-ray radiography has a significant role in the initial assessment of the trauma patients who are not stable.^[30] Radiographic screening must be prepared in the operating theater or the emergency medicine department. This essential stage should be carried out in hemodynamic patients whether they are stable or unstable and should be sent immediately to the operating theater while they are surveying.^[31] Swift imaging of lateral projection of the cervical spine, pelvis, and chest could discover life-threatening traumas which could be missed otherwise. However, lateral projection of the cervical spine is just about 75% and some duverney and sacral fractures could be missed by ordinary radiography of pelvis. Some special rules of clinical research should be applied for specifying the requirement for imaging of the c spine in trauma patients who are hemodynamically stable.^[32]

Computed tomography (CT)

One of the most significant processes in the primary detection of intensive trauma is computed tomography (CT) imaging through intravenous contrast agent in patients who are hemodynamically stable. In spite of definite restrictions in the visualisation of traumas of the hollow organs of abdomen, the diaphragm and the pancreas, computed tomography imaging could represent an accurate and extensive drawing of traumas of the patient. Correspondingly, CT imaging is an essential part of the current medical diagnosis procedure [Figure 3].^[32] Huber *et al.*^[33] have shown that full-body CT scan could easily enhance the survival rate of patients who have blunt trauma. Also, they reported that CT imaging could significantly decrease the mortality rate. This reduction would be due to the number of related assessments which would be detected correctly, along with the accurate overall trauma pattern depiction.^[33]

Computed tomography at emergency medicine departments

Trauma dynamics of blood flow patients who have suffered from a physical injury would be unstable during the initial survey. When the main source of abnormal flow of blood in patients with unstable trauma cannot be diagnosed by application of available imaging tools existing at the emergency room immediately and/or when extra information is required for patient care directly,

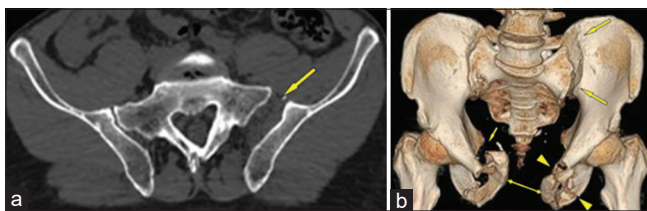


Figure 3: Anteroposterior compression type C fracture of pelvic in a middle aged man who fell from the height. Derived in accordance with^[34]
 a: Axial computed tomography scan describes the extent of traumatic aortic disruption of right SI joint (SIJ) due to the anterior ligament tear.
 b: Three-dimensional CT scan showing multiple trauma of left superior pubic ramus

the specialists of emergency department should decide between performing emergency CT scan or taking the patient to the operating room directly.^[35] This decision should be taken based on the quality of patient's response to primary resuscitation, the vicinity of the computerized tomography tool to the resus bay and the patient's potential traumas and predicted operative intervention. In conditions when patients need extra levels of intervention, the process of taking images should not take long specially, when fast transfer is required. Rarely, patients would have possible allergies which could threaten their life. In these cases, required evaluation options are such as computed tomography without contrast, ultrasonography, diagnostic exploratory surgery, radionuclide-labeled red blood cells imaging and also magnetic resonance imaging (MRI).^[36]

The pelvis and chest simple radiography should be taken for any kinds of trauma but computed tomography (CT) it is not demanded. These images should be taken in accordance with the clinical findings and mechanism of trauma. The assessment of patients whose body have been torn through a sharp objects (penetrating trauma) is mostly done by means of imaging the penetration region. Additionally, in patients who have blunt force injury, if the presence of trauma detected, plain radiography should be taken.^[37] On the other hand, if there are no clinical symptoms or signs of trauma, X-rays imaging is not needed. A normal posteroanterior (PA) chest radiograph must be taken in patients who have penetrating traumas of the abdomen, back, or chest irrespective to of CT requirement. Plain radiography would detect the presence of free intraperitoneal gas, a hemothorax or pneumothorax or may be an exterior body.^[38]

Diagnostic peritoneal aspiration (DPA)

Diagnostic peritoneal aspiration (DPA) used to determine the existence of free floating fluid, mostly blood, within the large cavity of the abdomen. DPA is used in similar to FAST among unstable patients whose bleeding source is not specified. This procedure could be applied for discovering blood/liquid in the intraperitoneal space when FAST is not available or unspecified in patients whose dynamics of blood flow is not stable.^[39]

Electrocardiography

For trauma patients with blunt chest trauma due to accidents, electrocardiogram (ECG) is taken. Symptoms of injury to the heart after blunt chest trauma include variations of ST segment or considerable delaying electrical conduction and arrhythmias. On the other hand, detections which are compatible with cardiac tamponade include altered electrocardiographic phenomenon and abnormal tachycardia. For heart blunt traumas, echocardiography must be carried out. In addition, heart function must be monitored throughout the procedure of trauma assessment, resuscitation, and diagnosis as variations in blood pressure and heart rate would further worsen the clinical conditions.^[40,41]

Transfer of trauma patients

At emergency medicine departments which does not have enough resources for management of multiple trauma patients, clinicians

must consult with the closest trauma center immediately when the patient suffers from intensive injuries that is beyond the capabilities of their remedial center. But unfortunately, plenty of patients who require to be transferred for assessment of their trauma injury are not sent. Zhou *et al.*^[42] have reported that just about 20% of patients immediately would not be carried to tertiary hospitals and properly transferred to professional trauma centers based on guideline criteria. They cited that the mortality risk for patients who were not transferred to upper grade trauma centers is higher.^[43] The main criteria for patients transfer are based on clinical findings, trauma mechanism, and the demographic characteristics of patients. It should be noted that, delaying transfer for taking laboratory tests could postpone or fail the process of deterministic treatment.^[44]

CT scan must be taken especially in patients who would be treated appropriately at their primary attendance to the trauma center. In situations when the result of CT scan test is negative and proposes the discharge of patient, the patients must be discharged. In other respects, when the results are positive, the patient should be transferred to the related advanced trauma centers without any delays. The most frequent samples of required emergency interventions are such as stabilization of a suspected pelvic fracture, thoracostomy, and tracheal intubation. In patients with unstable blood flow, blood transfusion must be carried out. This process could be done immediately after initial reception at emergency medicine trauma department or during the transport to the advanced trauma centers through the emergency transport team.^[45]

Management of patients without surgical approaches

Due to the considerable development of diagnostic radiology, treatment of traumas through nonsurgical approaches can be successful in patients whose dynamic of blood flow are not stable but do not have any symptoms of blunt trauma. However, the surgical procedure of exploratory laparotomy is still the best choice for traumas of perforated abdomen and in patients who have clinical symptoms of inflammation of the peritoneum. Unfortunately, there is not any special theoretical consensus on the significance of symptomatic or surgical laparoscopy in patients with severe trauma. Moreover, laparoscopy is not still standardized clinically for treatment of abdominal injuries. Johnson *et al.*^[46] have reported that diagnostic laparoscopy could be used effectively in about one percent of trauma patients with severe injuries. In patients whose dynamics of blood flow is not stable and have symptoms of perforation of hollow organs, emergency laparotomy could be performed as the main form of surgical treatment. Based on the extent of systemic and local trauma, the doctor should decide between the application of two techniques—Damage Control Surgery (DCS) and Early Total Care (ETC).^[47]

However, the main goal of ETC is to definitively treat the trauma with instant amendment of organ structure and function. The main function of DCS acute phase trauma is limited to prevent

bleeding and secondary damages with the aim to reduce trauma surgery and operating time. The conclusive treatment of trauma should be tracked for about one week after the treatment for stabilizing the patient and reduction of posttraumatic inflammatory response.^[48] Some samples of initially treatment in accordance with principles of DCS including the usage of an external fixator for surgical treatment of traumatic injuries and applying blind closure for treatment of damaged sections of the bowel after abdominal surgery for treatment of abdominal trauma. In situations when the traumas of the pelvis and extremities are complex, application of an external fixator provides a swift, low reposition of traumatic fracture, preventing subsequent bleeding and also reducing further soft tissues trauma [Figure 4].^[49]

Some comparative researches have demonstrated benefits of trauma management based on principles of DCS for both abdominal and musculoskeletal system traumas.^[51] Anyway, the advantages of this procedure appears to be restricted to the patient's surgical care with some risk factors including acidosis, hypothermia, bleeding disorder of coagulopathy, persistent bleeding, hypovolemic shock of bleeding, intensive trauma of head and multiple traumas which require much time for rehabilitation.^[52]

Due to the fact that liver is at an open position, about 15% to 25% of patients with multiple trauma have lesions in their liver. The extent of liver damage is a significant prognostic factor.^[53] In spite of the restricted evaluation of pancreas and abdominal organs, both CT scan and sonography could powerfully visualize the organs of the body and provide an accurate evaluation of the hepatic trauma extent. Additionally, Boese *et al.*^[54] demonstrated that in patients whose dynamic of blood flow is not stable, both liver lacerations and contusions in higher grades could be treated by means of nonsurgical treatments.^[54] One of the main requirements for protected nonsurgical treatments of multiple trauma is the probability of operative intervention and the



Figure 4: The type C fractures of the pelvis with fracture in the socket portion of the "ball-and-socket" hip joint that is fixed via external fixation on acetabulum and pelvis with fixation of posterior acetabular rim using the screw which are conducted through the skin. Derived in accordance with^[50]

instant accessibility to blood products, if needed. Margot *et al.*^[55] have categorized the most risk factors which affect nonsurgical management of blunt hepatic trauma as follows:

- I: Blood pressure reduction
- II: Further demands for packed red blood cells
- III: Irritation of peritoneum
- IV: High injury severity score
- V: Further blunt abdominal trauma

Owing to the poor outcome and high mortality when nonsurgical management fails, primary surgical treatment should be considered in patients with these risk factors 22). The success rates of management of liver traumas with nonsurgical methods have been noted to be over that 90%. But successful treatment of splenic lesions with nonsurgical remedies would not pass the rate of 60%. Intensive fractures of the bony pelvis are mostly correlated with damages to urogenital and intra-abdominal organs.^[56] Additionally, in patients who suffer from intensive traumas of the bony pelvis, the sudden uncontrollable blood flow especially from the presacral venous plexus (PSVP) would happen. Vascular embolization and interventional radiology and have been applied significantly for treatment of persistent abnormal bleeding. Afterwards, decisive surgical procedures should be applied for management of bony pelvis fractures ensues based on principles of DCS after the patient stabilization.^[57]

Conclusion

The process of healthcare management of patients who suffer from multiple traumatic injuries is a specialized teamwork. No individual could have all of the skills, knowledge, expertise, or the capability to completely manage traumatic patients. The initial management of multiple trauma patients requires several medical specialists for a special period of time. The process of collecting and sharing related medical information is a significant step for accelerating operations and also improving the process of healing patients. On the other hand, for enhancing the recovery of patients extra experimental document should be collected. For this reason, the process of emergency admission, diagnosis, patient care, and dealing with patients should be carried out based on standardized procedures. In this way, adequate education of healthcare providers for delivering organized, general knowledge to the trauma patients is very crucial.

As multiple trauma could significantly increase the mortality worldwide, all patients who suffer from multiple trauma need a systematized procedure for reduction of the risk due to undiagnosed traumas. Proper patient care needs impressive and organized transmission and specialized medical group work. One of the most frequent cause of death among trauma patients is hemorrhage that could be prevented if diagnosed early. Diagnostic imaging tools could have a significant role in management of multiple trauma patients. Finally, proper management of multiple trauma patient by improving the structure, procedure, and treatment consequences of emergency medicine department.

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Conflicts of interest

There are no conflicts of interest.

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