

Review Article

**A REVIEW OF ASSESSMENT AND TREATMENT OF TRAUMA IN EMERGENCY DEPARTMENT**

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**Abstract**

**Background:**

Traumatic injuries are the major destructive causes of human disability and in some situations, they could cause mortality. Preparing an appropriate procedure for the management and treatment of trauma patients is still a big challenge. Anyway, through immediate diagnosis and management of trauma patients in emergency departments mainly in trauma golden hour most appropriate outcomes could be achieved. The initial examination of trauma patients should be carried out in the trauma golden hour by most appropriate diagnosis equipment prepared in the emergency trauma care unit.

**Objective:**

The present study was performed for reviewing the most appropriate techniques and equipment of diagnosis and management of traumatic injuries.

**Material and Method:**

For obtaining the most appropriate outcomes, a comprehensive review carried out through the general medical databases of PubMed, Embase, Google Scholar, MEDLINE, databases of Cochrane Library, Allied and Complementary Medicine Database and Allied Health Literature of CINAHL on care system of patients who suffer from various kinds of trauma were searched up to March 2020. Finally, the total number of 73 articles were selected for reviewing the newest available data around the main objective of the present study.

**Results:**

Trauma patients who detected with serious injuries in their vital organs should be managed through an appropriate standardized guideline. This comprehensive guideline is categorized into fourteen critical steps that provide general information about the importance, objective, initial actions, required equipment and staff and also the overall knowledge of any step in diagnosis and management of trauma patients.

**Conclusion:**

The prepared comprehensive guideline for appropriate management of trauma patients is a precise effective method for immediate management of trauma patients in trauma care units of emergency departments. The most critical situation such as severely injured patients, airway management, protecting breathing and circulation, major neurologic problems and the difficulties with clinical examination of whole-body could be managed through following the prepared guideline.

**Keywords:** Trauma patients, diagnosis, management, Emergency care unit.

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**INTRODUCTION**

Traumatic injuries are considered to be one of the most potential leading causes of mortality among children and adults mainly in their middle age. In adults older than 45 years, malignancies and cardiovascular events following traumatic injuries are the third leading cause of mortality [1]. All emergency departments may face with trauma patients. Due to the fact that various traumatic injuries are ranging from isolated lower extremity wounds to more complex injuries involving multiple organ systems, an appropriate standardized guideline should be available for achieving the most suitable outcomes and decrement of any potential undiscovered injuries [2]. Nearly 90% of traumatic injury-induced death happens in low- and middle-income countries and in accordance with the data presented by Ahmadi et al [3], it is predicted that the overall incidence rate of traumatic injuries will increase more and more in a near future. Anyway, by preparing a quicker assistance system and more accurate diagnostic equipment the incidence rate of any potential

consequences following the traumatic injuries will decrease significantly and then the patient's survival rate will be improved. Moreover, based on the available evidence any achieved improvement in the process of trauma patient care can enhance the overall health situation of patients following being affected even with serious but survivable injuries [4].

Nowadays one of the most serious worldwide challenges related to public health is trauma [1]. The rate of global deaths due to trauma injuries has increased to about 5 million deaths in 2013 [5]. Traumas caused by road traffic crashes (RTC) and violence between individuals are two of the main sources of worldwide mortality cases which could be prevented through appropriate training programs. As reported by Reihani et al [6] more than one million deaths happen worldwide each year due to RTC mainly among people aged between 10-40 years that consist of more than 15% of all deaths in the world. On the other hand,

traumas induced by road traffic accidents are estimated to cause more than fifty million deaths each year in the world [6].

Based on the reports represented by Hafezi-Nejad et al [7] for both sexes and all ages of Iranian people about 15% of deaths happened due to traumas. Moreover, one of the main leading causes of happening these kinds of traumas in Iran are RTCs. On the other hand, based on the results represented by Reihani et al [6] the annual rate of incidence of all kinds of traumas among Iranian people is estimated to be about 90% of all populations.

One of the main training programs for medical providers in the term of management of acute trauma cases is advanced trauma life support (ATLS) which is the most common communication language for educating the process of evaluating and management of initial trauma worldwide [8]. Some researchers demonstrated that the application of ATLS training instruction in various countries can provide more development in the future of initial trauma assessment and management [9,10].

Anyway, for achieving an adequate systematic, safe, and appropriate treatment procedure for the management of trauma patients the overall knowledge of emergency medicine should be enhanced that could help in decreasing the potential risks of consequences and mortality following the trauma [5,6]. In this regard, all the emergency department staff and its associated specialists should be capable of giving appropriate and adequate medical services to the trauma patients for helping them remaining in a safe situation. Anyway, all safety and care procedures should result in the reduction of any potential kinds of destructive harms and/or possible physical damages [11]. As a consequence, the staff and specialists of the emergency medicine department should have precise knowledge of providing high-quality and professional care and as a result, being capable of providing complex health care services and responding sensitive medical requirement of trauma patients [12].

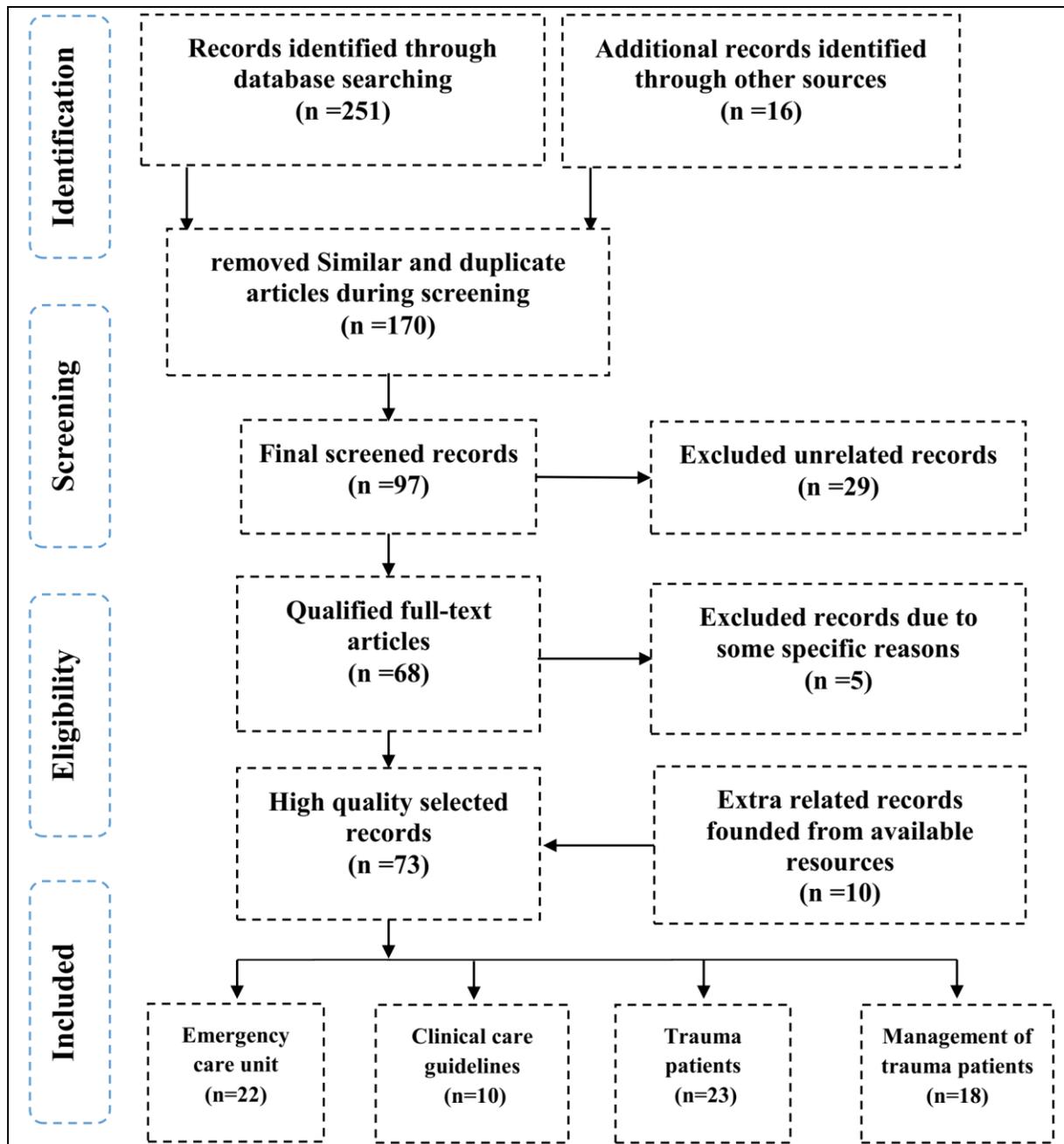
Consequently, there is a high demand for developing an appropriate correlated healthcare system mainly in form of emergency medical department services for improving the health care quality in trauma patients. In this regard, a general model for evaluating the health quality of trauma patients based on three principles of structure, procedure, and outcomes was developed by O'Reilly et al [9]. Their developed general model had the capability of management of trauma patients with various financial resources for improving the overall quality of the

healthcare system. The main aspects of medical procedure guidelines could easily make the association of trauma patients and healthcare staff of the emergency care department for achieving the most appropriate diagnosis, management, treatment, and adequate care services [13]. The achieved outcomes have the main responsibility for providing an appropriate healthcare system by conducting productive and efficient actions of healthcare professionals and managers and also satisfaction level trauma patients. Therefore, one of the most critical aims of providing such an appropriate guideline is to achieve the highest level of quality of the emergency care system department to be carried out on trauma patients in various traumatic injury situations [10,14].

Due to the fact that some kinds of traumas that cause disability and mortality could not be prevented easily among adults, there is a high demand for being informed about more clear indications of these traumas, the present study was carried out for assessment and treatment of trauma mainly in emergency medicine departments [6]. In this regard for achieving the most appropriate algorithms for assessment and treatment of various kinds of possible traumas in the emergency department situations, the rules, training programs, and medical techniques should be modified regularly. Within the present study, the authors are trying to represent the newest knowledge about the overall specifications of all available traumas in emergency departments and ways to assess and treat them.

#### **MATERIAL AND METHODS**

The present study was carried out mainly based on the most appropriate related articles with the subject of trauma management and treatment in emergency medicine departments. These articles were recovered by a voluntary search carried out in PubMed, Embase, Google Scholar, MEDLINE, databases of Cochrane Library, Allied and Complementary Medicine Database and Allied Health Literature of CINAHL on care system of patients who suffer from various kinds of trauma were searched up to March 2020. The obtained data from reviewed articles were classified based on the kind of trauma, assessment of trauma, special services of emergency departments and available treatment methods. The overall process of the article selection is shown in Figure (1). As could be seen a total of 267 articles were searched; finally, 73 articles with the closest subject were reviewed precisely.



**Figure 1.** The schematic procedure of choosing the most appropriate articles in the present study, based on the PRISMA method

**Trauma epidemiology**

One of the main leading causes of mortality in the world is trauma. For instance, in the United States, trauma is one of the major leading causes of death for people who are younger than 35 years. However, about 10% of all accrued death among women and men in the United States is induced by trauma. Moreover, about 50 million people in the world will be injured due to accidental trauma each year which may cause moderate to severe disabilities among injured people [15]. Based on the reports represented by Ali and Richard [16], more than 30% of all admissions to the emergency department unit are related to trauma. On the other hand, in accordance with the World Health Organization (WHO), motor vehicle accidents are most possible affecting factors for traumas which induce deaths annually and

their share in road fatality will increase to the third most possible causing factors of disability in the world by 2030 [17].

Penetrating traumas induced by armed conflict are responsible for more than 10% of traumatic deaths in the world that would vary from one country to another [18]. As reported by Ali et al [2014], more than 40% of deaths in Los Angeles happen due to murder but in Norway, the percentage of deaths induced from penetrating traumas is less than 15%. On the other hand, based on the data presented by Evans et al [19], nearly 50% of traumatic deaths happen due to injuries of the central nervous system (CNS) and about 30% of them result from exsanguinating hemorrhage. In the situation when patients with traumatic injuries are treated at an equipped trauma center, the rate of morbidity or mortality would be lower [20]. Moreover, as

reported by Ditillo et al [21] and Donnelly et al [22] some major prevalent comorbidities such as heart failure, ischemic heart disease and hypertension, obesity and older age would worsen the overall outcomes after being affected with various kinds of traumas. In patients with traumatic injuries who have considerable hemorrhage disorder, older age and a lower Glasgow Coma Scale (GCS) the rate of mortality will be higher [23]. Moreover, in accordance with Dosssett et al [24] studies, using warfarin medicine could considerably increase the risk of mortality following trauma.

As reported by Reihani et al [6] the most well-known preventable causes of morbidity are intravascular catheter-related infections, significant missed injuries, technical surgical failures and unintended extubations (UE). Moreover, the most well-known preventable causes of mortality induced from trauma are abnormally heavy hemorrhage, sudden cardiac arrest and multiple organ failure (MOF) [6]. Based on the studies carried out by Ali and Richard [16] in the subject of trauma-induced death, trimodal distribution of trauma-related death would occur these ways; at the scene, 3-4 hours following the trauma and few weeks following the trauma. Anyway, further studies have reported that the rate of patients who die following the first 24 hours of trauma are not so high, so the more accurate statistical rate of dead patients is a bimodal mortality distribution [25]. In accordance with the latest performed studies, the majority of deaths happen either at the scene or in the first 3-4 hours when the trauma patients could reach an emergency center of trauma [16].

#### **Trauma golden hour**

The first hour following trauma injuries is called the golden hour [26]. The main concept of the golden hour that conclusive trauma care must be carried out in the first hour has been started from more than three previous decades. As described by the American College of Surgeons Committee on Trauma (ACSCT) [27], the general concept of golden hour emphasizes on the increment of death risk and demand for swift intervention during the initial hour of care after being affected with trauma. This comprehensive concept is described in the initial studies of trauma and has been declared in various courses related to the trauma. It should be noted that performing rapid intervention within the golden hour period could improve the overall outcome of trauma patients. Moreover, the association of mortality rate and golden hour in the treatment of trauma patients is one of the most complex issues in health care systems. In a study carried out by Afsaneh et al [28] for assessment of pre-hospital time intervals in trauma patient transportation by emergency medical service, there was not any recommendation like pre-hospital time intervals among trauma patients should not be restricted, since restricting time intervals for transforming trauma patients to the emergency department still seems to be prudent task.

On the other hand, performing a more precise golden time protocol in any kind of trauma injuries could increase the confidence threshold of trauma patients' assessment and treatment. However, performing the golden hour protocol appropriately will decrease the needed time for definitive care and also will improve the quality of medical care and emergency medical services (EMS) within the emergency department. It

should be noted that for enhancement of the available evidence on the effectiveness of carrying out appropriate golden hour techniques, more and more detailed studies should be performed [28,29].

#### **The procedure of development of an appropriate trauma care system**

For achieving the highest level of development in most appropriate guidelines of the trauma care system, researchers should create and define applicable inexpensive and practical standards that could be applied effectively in the world. Moreover, the researchers should try to identify the easiest ways of improving available medical trauma care systems in the world. In this regard, a comprehensive list of feasible medical goals should be prepared for satisfying nearly all requirements of trauma patients worldwide [30]. For assuring that the achievements of performed researches, all the inputs of trauma patients and physical resources should be applied within the appropriate procedures. In this regard, precise templates should be developed for any utilized resources based on critical requirements [31]. For instance, in their study Ahmadi et al [3] through working on the effect of Advanced Trauma Life Support program, demonstrated that the training protocol of advanced trauma life support (ATLS) could play a significant role in improving the clinical knowledge and performance of practical skill of trauma care among emergency department staff.

Utilizing any standardized template may need legal adaptation for being applied in individual countries. Anyway, in such situations, all responsible clinicians and emergency department staff should be involved in the assessment and care process of trauma patients. This specified category of emergency department staff and corresponding clinicians include both groups of generalist and specialist species such as general surgeons, emergency physicians and anesthesiologists also and who are primarily assigned to the traumatology field. Known as one of the main parts of the national-level adaptation and implementation procedure, the role of assessment and treatment services of patients with trauma injuries should be reasonably defined nationwide [32].

Achieving this critical factor requires a comprehensive survey of the capabilities of the major range of facilities caring for patients with trauma injuries. Carrying out this procedure would simplify the process of identification of any possible deficiencies in human and physical resources, and organization which would be selected as the aim of assessment and treatment by subsequently achieved improvements [33].

#### **Crucial guidelines of trauma care**

The majority of available programs prepared for the management of trauma patients should appropriate to an average person. Anyway, based on the unpredictable nature of the traumatic injuries, it's not possible for adopting and applying just one appropriate approach to all trauma patients. As a general, the process of care of patients with trauma injuries contains fourteen main categories that are summarized in table (1).

<b>Table 1.</b> Standardized guidelines for diagnosis and management of trauma patients for achieving the most appropriate outcomes in emergency medicine departments					
<b>Categories</b>	<b>Importance</b>	<b>Objective</b>	<b>Initial steps</b>	<b>Equipment and staff</b>	<b>Knowledge</b>
Airway management [26, 32,34;35]	<ul style="list-style-type: none"> <li>- One of the most important key components of emergency care</li> <li>- The lack of medical emergency care threaten life immediately</li> </ul>	<ul style="list-style-type: none"> <li>- Diagnosis a possible obstructed airway</li> <li>- Keeping the airway clear</li> </ul>	<ul style="list-style-type: none"> <li>- Immediate assessment and management of any suspicious patients with the difficulties of the airway, breathing, and circulation</li> </ul>	<ul style="list-style-type: none"> <li>- Oral or nasal airway equipment, special bag-valve-mask and suction</li> <li>- Cricothyrotomy and tracheal intubation</li> <li>- Hospitals with specialist-staff</li> <li>- Basic trauma pack</li> <li>- Laryngoscopy</li> <li>- Esophageal detector device (EDD)</li> <li>- Magill forceps</li> <li>- Capnography</li> </ul>	<ul style="list-style-type: none"> <li>- Airway compromise assessment</li> <li>- Manual maneuvers</li> <li>- Oral or nasal airway insertion</li> <li>- Suction skill</li> <li>- Endotracheal intubation</li> <li>- Cricothyrotomy</li> </ul>
Breathing Management of Acute respiratory distress [16,36]	<ul style="list-style-type: none"> <li>- One of the most critical steps in the management of trauma patients with acute respiratory distress is the ability to assess a patient for respiratory distress.</li> </ul>	<ul style="list-style-type: none"> <li>- Appropriate management of trauma patients with acute respiratory distress</li> </ul>	<ul style="list-style-type: none"> <li>- Immediate detection of tension pneumothorax</li> <li>- Supplying adequate oxygen to trauma patients with acute respiratory distress syndrome (ARDS)</li> </ul>	<ul style="list-style-type: none"> <li>- Availability of basic trauma pack, underwater seal drainage bottles, and chest tubes</li> <li>- Bag-valve-mask</li> <li>- Pulse oximetry</li> <li>- Oxygen supply</li> <li>- Chest tubes</li> <li>- Nasal cannula, associated tubing, and face mask</li> <li>- Syringe and needle</li> <li>- Underwater seal chest drainage</li> <li>- Arterial-blood gas (ABG) test measurements</li> <li>- Mechanical or assisted ventilation</li> </ul>	<ul style="list-style-type: none"> <li>- The knowledge of primary treatment by needle thoracostomy and definitive treatment tube thoracostomy and</li> <li>- The capability of detection of tension pneumothorax</li> <li>- Having the capability of performing the needle thoracostomy procedure</li> <li>- Chest tube insertion</li> <li>- Three-way dressing</li> </ul>
Shock assessment and control of external hemorrhage [16,26,37]	<ul style="list-style-type: none"> <li>- Assessment of trauma patients for detection of the presence of shock is a very important task.</li> </ul>	<ul style="list-style-type: none"> <li>- Appropriate control of external hemorrhage</li> </ul>	<ul style="list-style-type: none"> <li>- Immediate investigation of patients for detection of the presence of shock and any potential external hemorrhage</li> </ul>	<ul style="list-style-type: none"> <li>- A second hand watch</li> <li>- Stethoscope</li> <li>- Sphygmomanometer</li> <li>- Well trained staff</li> <li>- Availability of arterial tourniquets</li> <li>- Gauze and bandages</li> <li>- Availability of arterial tourniquet in critical situations</li> </ul>	<ul style="list-style-type: none"> <li>- Manual and visual assessment of circulation</li> <li>- Heart rate</li> <li>- Venous insufficiency test</li> <li>- Skin temperature</li> <li>- The staff should be trained about arterial tourniquet device</li> <li>- Control of hemorrhage with pelvic wrap</li> <li>- The knowledge of Arterial tourniquet</li> <li>- Severe hemorrhage control with splinting of fractures</li> </ul>
Fluid replacement [37-39]	<ul style="list-style-type: none"> <li>- The capability of fluid replacement among trauma patients could decrease the number of potential complications and treat them.</li> </ul>	<ul style="list-style-type: none"> <li>- Controlling the rate of possible complications following trauma injuries</li> </ul>	<ul style="list-style-type: none"> <li>- Immediate insertion of peripheral intravenous (IV) cannulation, through a percutaneous procedure and application of crystalloid fluids.</li> </ul>	<ul style="list-style-type: none"> <li>- Crystalloid fluid</li> <li>- Colloids D should be available</li> <li>- Formal intraosseous needles</li> <li>- The capability of intraosseous access by any suitable large-bore metal needle</li> <li>- Blood transfusion capabilities</li> <li>- Availability of blood bank</li> <li>- Set of intravenous (IV) therapy</li> <li>- Intraosseous infusion equipment</li> </ul>	<ul style="list-style-type: none"> <li>- Volume expander</li> <li>- Fluid resuscitation knowledge</li> <li>- Venous cutdown access</li> <li>- Peripheral percutaneous intravenous access</li> <li>- knowledge and skills of transfusion</li> <li>- Fluid administration by central venous catheter (CVC)</li> </ul>

<p>Monitoring of circulation and shock management [16,36,37]</p>	<p>One of the main critical steps in controlling trauma patient in shock is monitoring</p>	<p>Monitoring the trauma patients in shock condition for controlling their response to intravenous therapy</p>	<p>The initial step is to understand immediate the hemorrhagic shock stage.</p>	<ul style="list-style-type: none"> <li>- Right heart catheterization</li> <li>- Watch with second hand</li> <li>- Stethoscope</li> <li>- Blood pressure monitor</li> <li>- Urinary catheterization</li> <li>- Cardiac monitoring</li> <li>- Central venous pressure monitoring</li> <li>- Laboratory facilities for hemoglobin (Hb)</li> <li>- Laboratory facilities for lactate, arterial blood gases (ABG), and electrolytes</li> </ul>	<ul style="list-style-type: none"> <li>- Resuscitation parameters knowledge</li> <li>- The knowledge of cardiac monitoring</li> <li>- Central venous pressure monitoring</li> <li>- The capability of right-heart cardiac catheterization monitoring</li> <li>- The capability of monitoring of pulmonary wedge pressure</li> <li>- The capability of hemoglobin (Hb) monitoring</li> </ul>
<p>Management of head injury [20,34,40,41]</p>	<p>One of the most dangerous traumas that could cause disability and death worldwide.</p>	<p>Minimizing the rate of secondary traumatic brain injury (TBI) by the maintenance of cerebral perfusion pressure and oxygenation.</p>	<p>Immediate determination of consciousness level by Glasgow coma scale (GCS), determination of clinical lateralizing signs and pupil size and reflexes. - Trauma patients should be promptly scanned within two hours of arrival to the hospital</p>	<ul style="list-style-type: none"> <li>- Computerized axial tomography scan of the head</li> <li>- Computerized tomography (CT)</li> <li>- Availability a major subset of neurosurgical procedures</li> <li>- More advanced neurosurgical procedures</li> <li>- Availability of American Association of Neurological Surgeons (AANS) guidelines for head trauma injuries</li> </ul>	<ul style="list-style-type: none"> <li>- The knowledge of providing hydration for preventing hypotension</li> <li>- The knowledge of estimating the Glasgow Coma Scale (GCS)</li> <li>- The capability to treat increased ICP by means of cerebrospinal fluid drainage, paralysis, osmotic diuresis, sedation</li> <li>- The capability to treat hyperventilation syndrome</li> <li>- Craniotomy technique</li> <li>- The neurosurgical procedure of decompressive craniectomy</li> <li>- The knowledge of hemorrhagic stroke treatment</li> </ul>
<p>Management of neck injury [6,42]</p>	<p>The presence of blunt trauma injuries in the neck area could cause severe spinal injury.</p>	<p>Appropriate recognition and treatment of platysmal penetration.</p>	<p>Immediate recognition of penetrating neck trauma and any potential caused spinal injury</p>	<ul style="list-style-type: none"> <li>- Balloon tamponade</li> <li>- Angiography</li> <li>- Barium swallow test</li> <li>- Esophagography</li> <li>- Endoscopy</li> </ul>	<ul style="list-style-type: none"> <li>- Surgical skills to explore neck</li> <li>- The knowledge of detection of penetrating neck injury (platysma muscle)</li> <li>- Having the capability of controlling external hemorrhage</li> <li>- Initial application of intrauterine balloon catheters</li> <li>- Recognize platysmal penetration</li> </ul>
<p>Management of chest injury [16,43]</p>	<p>Nearly all chest injuries are life-threatening and should be managed immediately.</p>	<p>The main objective of chest injury management is to collect blood from the output of the chest flexible tube for autotransfusion.</p>	<p>Immediate chest tube insertion, performing the oxygenation process and ventilatory support</p>	<ul style="list-style-type: none"> <li>- Availability of regional/spinal anesthesia and epidural analgesia</li> <li>- Skills and equipment for intermediate and advanced thoracotomy</li> </ul>	<ul style="list-style-type: none"> <li>- The knowledge of management of blunt or penetrating chest injuries</li> <li>- The capability of controlling pneumonia and atelectasis complications</li> <li>- The capability determining the respiratory status</li> <li>- The capability of controlling pain</li> <li>- Capabilities for rib blocks</li> <li>- The capability of ligation of chest wall bleeding</li> <li>- The capability of pulmonary resection and pulmonary tractotomy</li> </ul>

<p>Management of abdominal injury [44-46]</p>	<p>Performing physical examination for being sure about the overall health condition of the trauma patients is very essential.</p>	<p>Performing accurate physical examination and also with special medical diagnostic equipment for appropriate management of any potential abdominal injuries.</p>	<p>Immediate recognition of shock in trauma patients who suspected to be with an abdominal injury</p>	<ul style="list-style-type: none"> <li>- Blood Pressure Cuff</li> <li>- Stethoscopes</li> <li>- Ultrasonography (US)</li> <li>- CT scan</li> <li>- Diagnostic peritoneal lavage (DPL)</li> <li>- Paracentesis</li> <li>-</li> </ul>	<ul style="list-style-type: none"> <li>- The capability of performing diagnostic peritoneal lavage</li> <li>- The capability of performing paracentesis procedure</li> <li>- The capability of recognition of hemoperitoneum with the technique of ultrasound imaging.</li> <li>- The capability of performing the procedure of trauma laparotomy</li> <li>- The capability of performing hepatectomy</li> </ul>
<p>Management of extremity injury [16,47,48]</p>	<p>Exerted trauma injuries to extremities are the primary causes of disability in the world.</p>	<p>Through immediate recognition and modifying of these injuries, the rate of potential disabilities will decrease significantly.</p>	<p>Immediate recognition and modifying of this kind of injuries</p>	<ul style="list-style-type: none"> <li>- Immobilization devices</li> <li>- Spine boards</li> <li>- Radiography</li> <li>- Skeletal traction</li> <li>- Metal implants</li> <li>- Operative equipment</li> <li>- X-ray facilities</li> <li>- Availability of orthopedic surgical specialists</li> <li>- Fluoroscopy</li> <li>-</li> </ul>	<ul style="list-style-type: none"> <li>- The capability of recognition of major limb traumatic injuries and their related neurovascular compromise.</li> <li>- The capability of immobilizing limb traumatic injuries</li> <li>- The capability of management of spinal injury</li> <li>- The capability of providing suitable immobilization to the trauma patient</li> <li>- The capability of providing fundamental techniques of splinting fractures of the femoral shaft</li> <li>- The capability of management of tendon lacerations and injured hands.</li> <li>- The capability of utilizing skeletal traction</li> <li>- The capability of measurement of compartment pressures</li> <li>- The capability of utilizing fasciotomy for compartment syndrome</li> </ul>
<p>Management of spinal injury [42,49,50]</p>	<p>The presence of traumatic spinal cord injury may cause severe hypotension, severe respiratory problems, and further neurological deterioration.</p>	<p>Preventing the most common complications such as urinary retention, urinary tract infection (UTI), deep venous thrombosis (DVT) and pressure sores.</p>	<p>Immediate recognition of the presence of any possible spinal injuries</p>	<ul style="list-style-type: none"> <li>- Immobilization devices</li> <li>- Long spine board (LSB)</li> <li>- Cervical collar</li> <li>- Head blocks</li> <li>- X-rays</li> <li>- Computerized tomography (CT)</li> <li>- Magnetic resonance imaging (MRI)</li> <li>- Cervical spine braces</li> <li>- Halo devices</li> </ul>	<ul style="list-style-type: none"> <li>- The emergency staff should be capable of handling patients with spinal injuries appropriately</li> <li>- Preparing similar guidelines for the management of head injury</li> <li>- The capability of utilizing traction of the spine</li> <li>- The capability of management of selected spinal injuries non-operatively</li> <li>- The capability of management of complicated spinal cord injuries</li> </ul>

<p>Management of burns and wounds [51-53]</p>	<p>Burn injuries that may be very threatening and deadly and cause respiratory tract damages, fluid loss, and hypovolemic shock</p>	<p>Assessment and treatment the depth, thickness and extent of any kind of burn wounds</p>	<p>Immediate assessment of any kind of burn injuries and cleaning or sterile dressing of the burn wounds</p>	<ul style="list-style-type: none"> <li>- The availability of basic clean or sterile dressing materials</li> <li>- Sterile dressings</li> <li>- Topical antibiotics</li> <li>- Topical antibiotic dressings</li> <li>- The availability of a variety of topical preparations such as <b>silver nitrate, mafenide</b> and <b>silver sulfadiazine</b>.</li> <li>- Basic surgical supplies such as <b>antiseptics, anesthetic</b>, and further surgical instruments like <b>surgical suture</b>.</li> <li>- Availability of <b>tetanus antiserum</b> and <b>tetanus toxoid</b></li> <li>- Availability of <b>tetanus prophylaxis</b></li> </ul>	<ul style="list-style-type: none"> <li>- The emergency department staff should be trained about burn injuries appropriately</li> <li>- The capability of performing appropriate guidelines for essential burn injuries care</li> <li>- The capability of debridement of external debris or necrotic tissue from burn wounds</li> <li>- The capability of performing escharotomy procedure</li> <li>- The capability of performing skin grafting of non-healing burn wounds</li> <li>- The capability for early excision and grafting</li> <li>- Having sufficient anesthetic capability</li> <li>- Having basic expertise in splinting and physiotherapy</li> <li>- The capability of performing reconstructive surgery</li> <li>- The capability of repair of injured structures and performing extensive debridement</li> <li>- The capability for tetanus prophylaxis</li> </ul>
<p>Rehabilitation [36,54]</p>	<p>Physical medicine and rehabilitation are very essential for appropriate management of injury-related disability, mainly due to burns and fractures or the extremities.</p>	<p>Rehabilitation measures are carried out for maximizing the recovery of independent function</p>	<p>Immediate efforts for preventing any potential disabilities induced from happened traumas.</p>	<ul style="list-style-type: none"> <li>- Availability of adequate equipment of physiotherapy and occupational therapy</li> <li>- Providing appropriate dressing and feeding services</li> <li>- Availability of the full spectrum of physiotherapy especially for patients with injuries of the head and spinal cord.</li> <li>- Prosthetic implant services</li> <li>- Availability of additional specialized rehabilitative services include speech pathology and neuropsychology</li> <li>- Electromyography (EMG)</li> <li>- Psychological counseling</li> <li>- Speech pathology services</li> </ul>	<ul style="list-style-type: none"> <li>- The capability of performing basic occupational therapy and physiotherapy</li> <li>- The capability of utilizing splints for preventing burn scar contracture</li> <li>- The capability of utilizing strengthening exercises</li> <li>- The capability of providing psychological consulting services</li> <li>- The capability of management of people with severe disabilities</li> <li>- The capability of management of neurogenic bladder</li> <li>- The capability of prevention of pressure ulcers</li> <li>- The capability of monitoring for nosocomial infections</li> </ul>

<p>Pain control and medicines [55,56]</p>	<p>The availability of pain relievers is very essential for reducing pain severity of trauma patients.</p>	<p>The major objectives of detection and management of various kind of pain is to control and reduce the amount of trauma-induced pains</p>	<p>Immediate detection of the accurate sources and causes of pains induced from trauma</p>	<ul style="list-style-type: none"> <li>- Availability of adequate pain killers in appropriate dosage forms with assured quality</li> <li>- Bupivacaine</li> <li>- Nitrous oxide</li> <li>- lidocaine</li> <li>- Thiopental</li> <li>- Anesthetics agents like diazepam</li> <li>- Anticonvulsant drugs</li> <li>- Antimalarial agents</li> <li>- Anti-tuberculosis medications</li> <li>- Appropriate blood products and plasma expanders</li> <li>- The capability of management of cardiovascular disorders</li> <li>- The capability of preventing body electrolyte imbalance</li> <li>- Isotonic crystalloid solutions</li> <li>- Dopamine</li> <li>- Splinting and immobilization Devices</li> <li>- Morphine</li> <li>- Acetylsalicylic acid</li> <li>- Ibuprofen</li> <li>- Paracetamol</li> <li>- Dexamethasone</li> <li>- Magnesium sulfate</li> <li>- Phenobarbital</li> <li>- Sulfadiazine</li> <li>- Disinfectants</li> </ul>	<ul style="list-style-type: none"> <li>- The capability of preparing appropriate narcotic-level pain-relieving medications</li> <li>- The capability of management of anaphylaxis</li> <li>- The capability of management of poisonings</li> <li>- The capability of controlling respiratory depression</li> <li>- The capability of applying dopamine Hydrochloride Injection</li> <li>- The capability of conducting immobilization and splinting techniques</li> </ul>
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<p>Diagnosis and monitoring [36,49]</p>	<p>Availability of medical equipment and associated expertise are very essential for diagnosis and monitoring of trauma patients</p>	<p>For more appropriate management of trauma patients, their trauma-induced injuries should be diagnosed and monitored appropriately</p>	<p>The initial step in diagnosis and monitoring of any kind of happened trauma injuries is performing a clinical examination adequately.</p>	<ul style="list-style-type: none"> <li>- Stethoscope</li> <li>- Blood pressure (BP) cuff</li> <li>- Pocket torch</li> <li>- Thermometer</li> <li>- Fetal Stethoscope</li> <li>- Urinary catheter</li> <li>- Central venous pressure (CVP)</li> <li>- Right-heart catheterization (cath)</li> <li>- Plain-film radiography</li> <li>- Basic radiographic system (BRS)</li> <li>- Mobile radiography units</li> <li>- CT scans</li> <li>- Angiography</li> <li>- Fluoroscopy</li> <li>- Image Intensification</li> <li>- MRI</li> <li>- Nuclear medicine exams</li> <li>- Ultrasound imaging</li> <li>- Broselow tape</li> <li>- Stryker devices</li> <li>- Electronic cardiac monitoring</li> <li>- Pulse oximetry</li> <li>- Intracranial pressure monitoring</li> </ul>	<ul style="list-style-type: none"> <li>- The capability of diagnosis and monitoring of injured patients</li> <li>- The capability of appropriate invasive monitoring and electronic monitoring and</li> <li>- The capability of utilizing portable plain X-rays</li> <li>- The capability of diagnosis and controlling of haemoperitoneum</li> <li>- The capability of measurement of mean corpuscular hemoglobin concentration</li> <li>- The capability of performing microbiological culture</li> <li>- The capability of electrolytes measurement</li> <li>- The capability of measurement of arterial blood gases (ABG)</li> <li>- The capability of measuring the level of serum lactate</li> <li>- The capability of utilizing pediatric length-based tape</li> <li>- The capability of performing otoscopes and ophthalmoscopy tests</li> <li>- The capability of measuring compartment pressures</li> <li>- The capability of arterial blood gas measurements</li> <li>- The capability of measurement of blood urea nitrogen</li> </ul>
<p>Safety for health care personnel [57,58]</p>	<p>Following safety principles for health care personnel could easily enhance their overall health safety and reduce potential consequences</p>	<p>Improving the overall health condition of any personnel of the health care unit</p>	<p>The initial most important step is to provide and follow up adequate standardized health and safety guidelines</p>	<ul style="list-style-type: none"> <li>- Sanitary gloves</li> <li>- Goggles</li> <li>- Protective resistant clothing</li> <li>- Disinfectants</li> <li>- Antiretroviral medications</li> <li>- Johnny gown</li> <li>- Medical patient gowns</li> </ul>	<ul style="list-style-type: none"> <li>- Being informed about human immunodeficiency virus</li> <li>- Preventing from any possible contact between discharged blood and other body secretions with the skin of personnel of the health care unit</li> <li>- The capability of performing universal precautions</li> <li>- The capability of utilizing antiretroviral medications</li> <li>- Biological waste disposal</li> </ul>

**Fundamental elements for more appropriate care of trauma patients**

The main elements of providing appropriate trauma care are consisting of associated knowledge and skills, equipment and supplies as mentioned previously in the table [1]. The majority of knowledge and skills that the emergency staff should have are essential training for performing associated diagnostic and remedial activities successfully and safely. The majority of knowledge and skills that the emergency staff should have are essential training for performing associated diagnostic and remedial activities successfully and safely [59]. For achieving

these objectives special fundamental training from basic education to academic continuing education should be applied. Associated medical equipment and special supplies should be prepared in nearly all true life-threatening emergencies adequately. However, these kinds of equipment should be available immediately in all situations mainly in trauma golden hour [60].

The major sources of guidelines for essential trauma care should be prepared to be utilized in all levels of application of essential equipment. These guidelines should be applied immediately in

life-threatening trauma injuries such as management of circulation, breathing, and airway. The capability of precise application of laparotomy procedure for trauma patients is one of the main general services that should be performed in any emergency medical centers that need some specific skills or physical materials [61]. The prepared guidelines for essential trauma care should contain adequate and precise details of operating room surgical instruments, equipment, infrastructure and supplies and the capacity for anesthesia in the medical departments should be specified. The availability of standardized clinical services in these guidelines for essential trauma care implies the existence of some special expertise and physical materials for performing associated services safely and successfully [62]. In this regard, as some fundamental guidelines WHO [63] published some broader issues on surgical and anesthetic principles such as the most recent released surgical care at the district hospital [63].

#### **Challenges of trauma severity detection within the emergency department**

In accordance with the data presented by Spahn et al [64], there is not any standardized classification for different kinds of traumas such as severe and multiple traumatic injuries, and intensive trauma. Therefore, based on the European guideline on management of major bleeding and following trauma, trauma patients with a medical score of trauma severity bigger or equal to sixteen are considered to have a severe trauma injury. In this regard, if there were several distinct traumas in a trauma patient which detected to be threatening to the patient's health condition, it is considered to be a multiple trauma. In accordance with the researches carried out by Sorani et al [65], two of the most important groups associated with the emergency department are the staff and permanent employment of medical care who are involved with the procedure of management and treating of traumatic intensive injuries worldwide.

Nearly all standardized remedial education programs that prepared based on scientific evidence are required to be capable of providing sufficient knowledge about the adequate levels and structures of useful staffing needed in the emergency medical departments related to trauma injuries for contributing initial management and treatment of traumatic injuries [66]. Due to the nature of trauma injuries, the process of management and treatment of trauma patients should be carried out immediately for preventing any destructive potential consequences. During providing essential medical services mainly in trauma golden hour special attention should be paid to the shock room as the key link between patients' hospitalization stage and emergency department center of management of trauma patients [3]. The major features demanded for performing an appropriate therapeutic procedure for the management of trauma patients are mentioned comprehensively in the table (1). Nearly all specialists in the emergency department have special and associated responsibilities to various kinds of traumatic injuries that must be applied exactly based on their capabilities for achieving the most appropriate outcomes. Moreover, the process of diagnosis of trauma should be carried out based on a standardized guideline and special algorithms associated with the special diagnostic equipment. On the other hand, for reducing any potential error and delay in the treatment of patients, the diagnostic procedure should be carried out immediately after admission of trauma patients to the emergency department [3,67].

#### **The novel system of hybrid emergency room**

As mentioned before, one of the most dangerous life-threatening hemorrhagic events and considered to be a kind of surgical disease is trauma. In the process of care management of trauma patients who are not stable hemodynamically, the medical technique of interventional radiology (IR) could be applied as a useful non-operative procedure for the management of trauma patients, especially in the cutting-edge trauma care system [68].

Preparing the most accurate diagnostic technique and a better understanding of the trauma mechanism are two of the main key options for achieving a more appropriate trauma care system. In this regard, having a more exact identification of bleeding point by means of contrast-enhanced computed tomography (CECT) scan has effectively improved the detection process of symptom identification and strengthened the productiveness of interventional radiology (IR). Consequently, immediate access to these two introduced imaging techniques is one of the most important steps in achieving further development and innovation in trauma care systems [69,70].

For achieving the most accurate and suitable diagnosis and management of traumatic injuries, some centers of emergency management of trauma patients have designed such a building that has a computed tomography (CT) scanner, angiography room and operating room near each other [71]. All these equipment are installed in a line for saving time in the clinical examination of trauma patients in the first golden hour of happening trauma. Anyway, this concept significantly could decrease any potential delay in transferring patients to CT scanners and also improve the quality of bleeding control procedure. Moreover, the ultimate procedure of management of trauma patients should provide the possibility of an appropriate time-consuming life-saving procedure in just one room of trauma resuscitation. The concept of a Hybrid emergency room system (HERS) was established in 2011 in Japan first [6].

In general, the term hybrid pointing out to something that consisted of a combination of some various things. In the terminology of the Hybrid emergency room system (HERS), a mixture of examinations and treatment procedures in a single unique space could be performed that could result in a new hybrid concept of acute medicine and medical care of trauma patients. This novel system could easily provide the potential of performing all life-saving emergency procedures such as CT examination of the whole body, damage control surgery (DCS), chemoembolization (TACE), and transcatheter arterial embolization (TAE) through interventional radiology in patients who injured severely without transferring the patients to any other departments [72]. HERS is specified to be a specific integrated system that includes an equipped emergency room, interventional radiology (IVR) room, operating room and an emergency computed tomography (CT). Patients who detected with severe traumatic injuries can directly be examined with various imaging equipment for more accurate diagnosis without being transferred to any other places [73].

#### **CONCLUSION**

One of the main leading causes of increment of worldwide mortality rate is trauma. All trauma patients need a systematic procedure to be managed for decrement of the risk of undiscovered injuries and then achieving the outcome with the highest quality. The process of diagnosis and management of trauma patients is precise teamwork that demands special equipment and specialized staff that could capable of providing healthcare services based on an appropriate standardized guideline. Due to the fact that providing all the specialties in just one person is impossible, people with various specialties should be available in any emergency health care department. One other critical aspect of the health care department is the capability of providing nearly all associated equipment in the diagnosis process of trauma patients. Moreover, it should be noted that all diagnostic and management measures should be performed immediately in trauma golden hour based on the standardized guideline. In this regard, the emersion of the novel system of the hybrid emergency room could be an obvious example of increasing special attention to the management issue of trauma patients.

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