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Advances in Diagnosis and Treatment of Multiple Injuries

Di Ke[1] and Xue Xiao[2*]

[1]*Emergency department of affiliated hospital of zunyi medical university, Zunyi city, Guizhou province, China*

[2]*Department of general practice, affiliated hospital of zunyi medical university, Zunyi city, Guizhou province, China*

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***Corresponding author:** Xue Xiao, Department of general practice, affiliated hospital of Zunyi medical university, Zunyi city, Guizhou province, China. Fax: 0851-28608728; E-mail: xxellen@163.com*

Abstract

As a common emergency and critical illness in emergency, multiple injuries have a high incidence and fatal complications. It has become one of the main causes of traumatic death and the leading cause of death among people under the age of 45. The diagnosis of multiple injuries should be based on its definition, specific to the location of the injury, the nature of the injury, the diagnosis of injury complications and the diagnosis of coexisting diseases. At present, the evaluation of the severity of multiple injuries mainly depends on the Abbreviated Injury Scale (AIS) and Injury Severity Score (ISS). With the deepening of the understanding of multiple injuries, the mode of triage and treatment by department, the mode of integrated treatment of trauma, the mode of multidisciplinary assistance led by trauma center, and the operation and postoperative monitoring treatment of most multiple injuries independently undertaken by emergency department (including trauma center). It has bought valuable time for the treatment of patients with multiple injuries. This paper reviews the research progress in the diagnosis and treatment of multiple injuries.

Keywords: Multiple injuries; trauma severity score; treatment model

Introduction

Multiple injury refers to the simultaneous or sequential injury of two or two upper tissue parts and organs under the action of the same mechanical injury factor, one of which can be life-threatening even if it exists alone. At present, the evaluation of the severity of multiple injuries mainly depends on AIS and ISS, which are defined as severe multiple injuries by ISS ≥ 20 [2]. Multiple injuries are common in traffic accidents, falls from high places, and so on. Multiple injuries are complex, involving multiple systems, multiple organs and multiple sites, serious tissue and organ damage, often accompanied by shock, secondary infection, multiple organ failure (MOF) and so on [3]. The patients with multiple injuries have sudden injuries, complex injuries, rapid progress, high mortality and poor prognosis, which often require multi-disciplinary cooperation and joint treatment, which is a major challenge for medical workers at all levels of hospitals in clinical work. In order to further improve the success rate of treatment of patients with multiple injuries, improve the prognosis of patients with multiple injuries, and reduce the burden of social and family medical treatment, this paper reviews the research progress in the diagnosis and treatment of multiple injuries.

General Situation of Multiple Injuries

Multiple injury is a major health problem in the world [4]. According to the statistics of the World Health Organization (WHO), there are more than 3 million to 9 million new injuries in developed countries every year [5]. In China, the number of patients with multiple injuries is as high as 62 million every year, and the number of deaths is 70 ~ 80 million, which is the leading cause of death for people under the age of 45 [6]. Multiple injuries are common in traffic accidents, falls from high places, and so on. In the relatively developed areas of China, the number of motor vehicles and non-motor vehicles is gradually increasing, resulting in a higher and higher incidence of multiple injuries [7]. Since the first fatal case of road traffic accident occurred in London in 1896, more than 30 million people have died from road traffic injury (RTI) [8]. According to incomplete statistics, about 1.2 million people worldwide die from road traffic injuries every year, and 20 million to 30 million people suffer varying degrees of injuries [9]. It has been found that the injury rate and mortality rate of traffic accidents in China from 2004 to 2015 increased by 1.24 times and 1.6 times respectively compared with those before 2004, which brought a heavy burden to the society and families [10].

Diagnosis and Score of Multiple Injuries

Diagnosis of Multiple Injuries

At present, it is generally accepted that the diagnosis of multiple injuries is as follows: (1) there are serious injuries with AIS ≥ 3 points in ≥ 2 different anatomical sites, and combined with the following pathological parameters: systolic blood pressure ≤ 90mm Hg; Glasgow coma scale (GCS) ≤ 8; Base excess (BE) ≤ -6 mmol/L; International standardized ratio (INR) ≥ 1.4 or Activated partial thromboplastin time (APTT) ≥ 40s [11]. According to the actual situation of our country, the expert Committee of the

Trauma Emergency and multiple Trauma Group of China put forward the definition of the diagnosis of multiple injuries as follows: under the action of the same mechanical injury factor, two or more tissue parts and organs are injured at the same time or sequentially. One of the injuries, even if it exists alone, can be life-threatening. As an independent diagnosis, multiple injuries should follow the principles of injury diagnosis (injury site, injury nature), injury complication diagnosis and coexisting disease diagnosis [12].

Score of Multiple Injuries

AIS is currently recognized as the injury severity scoring method based on anatomical injury and commonly used in the world, compiled by (AAAM) of the American Association for the Promotion of Motor Vehicle Medicine. According to the degree of injury in the body area, it divides each damage area into 6 grade sequences. ISS is derived from AIS and divides the body into six areas (head and neck, face, chest, abdomen, limbs, pelvis, body surface). Each region has a AIS value, with a score of 1 to 6 points. 1 was mild, 2 was moderate, 3 was severe, 4 was severe, 5 was critical, and 6 was extreme (untreatable at present). ISS is the sum of squares of the highest AIS values in the three most severely damaged areas of the body. The range of ISS score was 1~75, with ISS < 16 as minor injury, ISS ≥ 16 as serious injury, ISS ≥ 20 as severe injury, and ISS > 50 as severe injury, the survival rate was very low. In recent years, there have been many studies on the relationship between ISS score and prognosis of patients with multiple injuries. ISS score can be used as a reference index for predicting the condition and prognosis of patients with severe multiple injuries [13-14]. The higher the ISS score, the more serious the condition and the worse the prognosis of the patients with multiple injuries [15]. ISS ≥ 16 was an independent risk factor for death in patients with multiple injuries [16]. Although AIS and ISS can be used to classify the severity of injury, the modified trauma score (RTS) is a physiological score. Although AIS and ISS can be used to classify the severity of injuries, the Improved Trauma Score (RTS) is a physiological score that can be calculated by the sum of Systolic Blood Pressure (SBP), respiratory rate and GCS score when the pre hospital environment is not aware of the patient's injury Table 1. The score of RTS < 11 was serious injury. RTS > 11 was classified as minor injury [17]. It has been reported that RTS is superior to ISS in predicting the mortality of multiple injuries [18].

The American Trauma Society conceived in 1983 that the Trauma and Injury Severity Score (TRISS), ISS and RTS, derived by AIS could be used to calculate the comprehensive score TRISS, which has a higher predictive value for mortality [19]. In the field of trauma scoring system, TRISS is an international standard for predicting outcome and evaluating treatment, which is widely used in trauma research. However, the TRISS system itself has some shortcomings, such as lower severity evaluation, low energy injury patients, complete failure of RTS, failure to take into account the gender of patients and the impact of pre injury health status on the outcome of trauma.

Table 1: RTS rating form

Score	4	3	2	1	0
GCS	13 ~ 15	9 ~ 12	6 ~ 8	4 ~ 5	3
Breathing (times/min)	10 ~ 29	> 29	6 ~ 9	1 ~ 5	0
Systolic blood pressure (mmHg)	> 89	76 ~ 89	50 ~ 75	1 ~ 49	0

Pre-Hospital First Aid Mode of Multiple Injuries

Pre-hospital first aid for multiple injuries is the first and most important link in the treatment of multiple injuries. Its purpose is to save lives and reduce disability [20]. Therefore, timely, correct, scientific and reasonable treatment of multiple injuries is the basic requirement of emergency treatment of multiple injuries. Patients with multiple injuries have sudden injury, complex injury, trauma and hidden 3 secret trauma exist at the same time, rapid progress, poor prognosis, high mortality, often need multi-disciplinary cooperation and common treatment. At present, there are two main treatment modes in the world: (1) Franco-German model: it is characterized by "sending the hospital to the patient", which emphasizes the on-the-spot treatment of patients with multiple injuries. (2) American-British model: it is characterized by "taking patients to hospital", which emphasizes the rapid transport of patients with multiple injuries [4]. The two models are different in the concept of treatment, but both emphasize the smooth and effective connection of medical information in the process of pre-hospital treatment. Professor Jiang Baoguo team according to China's national conditions and current situation put forward the core concept of multiple injury treatment norms include: "1 region, 2 links, 3 teams." 1 region, that is, the local large third-class first-class hospital cooperates with the local government to establish a regional trauma treatment center to standardize the pre-hospital and in-hospital treatment process; The two links are to strengthen the information exchange between pre-hospital and in-hospital treatment, between emergency department and each specialty. Three teams, namely pre-hospital first aid team, in-hospital emergency team, specialist treatment team, three teams are closely linked and cooperate with each other in order to make the patients with multiple injuries get timely and appropriate treatment [21].

In-Hospital Treatment of Multiple Injuries

Scholars at home and abroad believe that the speed of treatment of multiple injuries is the soul of treatment of multiple injuries. Rapid transfer to hospital for advanced life support after early treatment at the scene of the incident is the key to save the lives of patients with multiple injuries. With the continuous progress of society and science and technology, a variety of new examination instruments and equipment, the continuous renewal and development of medical technology, the hospital treatment mode of multiple injuries is also constantly changing. At present,

the advantages and disadvantages of various treatment modes in multiple injury hospitals are analyzed as follows. Each medical institution chooses the appropriate treatment mode according to its own actual situation.

Divisional Diagnosis and Treatment Mode

Division and triage mode is a kind of treatment mode, which is led by neurosurgery, cardiothoracic surgery, general surgery, orthopedics and other related departments, which is divided by emergency doctors and led by neurosurgery, cardiothoracic surgery, general surgery, orthopedics and other related departments. The emergency physician first invites the relevant specialist consultation according to the injury condition of the multiple injury patient, and then carries on the evaluation, diagnosis and treatment by each specialist. At present, this model is adopted in most hospitals in China. Zhu Shuaike and others believe that this model for patients to implement pre-hospital first aid, in-hospital emergency, specialist diagnosis and treatment are three relatively independent links, each stage of treatment is easy to cause treatment time delay, and even mutual prevarication. No one is willing to take the lead in the overall rescue of patients, and finally by Intensive Care Unit (ICU) passive treatment, the treatment of patients with multiple injuries lack of real quality improvement [22]. Some scholars believe that under this model, specialists pay more attention to their specialist problems, often ignore non-specialist injuries, easy to lead to missed diagnosis, misdiagnosis and so on [23]. However, some experts at home and abroad believe that when multiple injuries involve different disciplines, they are consulted and dealt with by specialist doctors, and the level of specialist treatment is high [24].

Integrated Treatment Model of Trauma

The integrated treatment mode of trauma is a kind of treatment mode, which integrates pre-hospital first aid, in-hospital emergency, intensive care, stable treatment, rehabilitation after treatment and so on. This model requires a complete treatment system. First, the hospital should establish a treatment team composed of emergency, orthopedic, neurosurgery, cardiothoracic surgery, general surgery and other related departments. The team members must be headed by a deputy chief physician of each department. And on standby 24 hours a day. Secondly, strengthen the relationship between pre-hospital treatment and in-hospital emergency, facilitate pre-hospital doctors to understand the situation of patients at any time, and do the corresponding treatment preparation work in the hospital, so that patients in the "golden hour" get effective treatment. Finally, the local government should divide the medical area, form the regional treatment system, and shorten the time from the injured place to the hospital [25]. The pre-hospital first aid team carries on the emergency treatment to the patient at the scene and transmits the on-site situation to the hospital through the communication equipment. The doctor in the hospital notifies the relevant department staff to stand by according to the patient injury condition, and starts the green channel at the same time. After the patients arrived in the emergency department, the prepared emergency treatment team immediately assessed and resuscitated the injured organs of the patients. According to the theory of injury control, patients who need emergency surgery should actively improve the relevant preoperative preparation and perform emergency surgery; if they do not need emergency surgery, they will undergo deterministic surgery after their condition is stable [26]. This treatment model is implemented in a small number of large tertiary hospitals in China. Xiao Yongjian believes that the implementation of this model depends on the mutual- cooperation of various units and departments, especially the connection from the pre-hospital to the hospital, which involves the close cooperation of the urban transportation system, communication facilities and equipment, and the departments within the hospital [27]. Each link is more likely to disconnect, and it is more difficult to implement. However, some scholars believe that this model closely connects pre-hospital first aid with in-hospital emergency, grasps the concepts of "platinum ten minutes" and "golden hour" in the treatment of patients with multiple injuries, and reduces the treatment time to the limit [28]. To make the patients with multiple injuries get the most effective treatment, some studies have shown that the integrated treatment in the emergency time window has greatly improved the treatment rate and survival rate of patients with multiple injuries, which is beneficial to the promotion and implementation of the whole country [29].

Multidisciplinary Assistance Model Led by Trauma Center

Foreign studies show that patients with multiple injuries treated in trauma centers can reduce mortality, shorten hospitalization time, reduce post-injury complications and reduce re-admission rate [30]. Throughout the development of foreign trauma centers, the American Trauma Center is under the guidance of its core concept of "Golden Hour." The graded treatment system of trauma system and the early warning mechanism of trauma (seamless connection between pre-hospital and in-hospital treatment) were established to realize the change of the principle of trauma treatment from "nearby treatment" to "deterministic treatment" [31]. French pre-hospital first aid is completed with the full participation of the Emergency Medical Assistance Center (SAMU), medical rescue forces at all levels and fire brigades while the Trauma Centre further clarifies the pre-hospital grading assessment of patients with severe trauma [32]. To establish a unified and coordinated management of trauma treatment network, to achieve centralized treatment of trauma patients in the hospital, to ensure that various treatment measures can be implemented quickly and effectively [33]. In recent years, many large tertiary hospitals in China have set up trauma centers or established regional trauma treatment centers in cooperation with local governments. The composition of the trauma center is mainly composed of emergency departments, related specialties, auxiliary departments (such as laboratory department, radiology department, blood transfusion department). After the patient

with multiple injuries arrives in the emergency department, the patient's injury is evaluated by the emergency physician. If the ISS ≥ 16, the trauma center can be activated, and at the same time, the patient's administrative authority will be transferred to the competent physician of the trauma center. Under the unified coordination and command of the medical service, the specialist doctors of the trauma center consulted the patients in the shortest time, and the auxiliary departments opened the green channel for the patients. The trauma center team worked closely to make the optimal decision and improve the treatment rate [34]. The model is characterized by unified management and regional coordination, which is helpful to improve the quality of trauma treatment and further build a regional trauma treatment network.

The Majority of Multiple Injuries are Operated and Monitored Independently by the Emergency Department (Including the Trauma Center)

China has a vast territory, uneven development in different regions, and the level of medical treatment varies greatly, resulting in the construction of trauma centers lagging behind the development of trauma treatment level in China [35]. However, for the treatment of multiple injuries, hospitals around the world have established a new emergency medical model integrating pre-hospital first aid, in-hospital first aid, emergency trauma ward, emergency internal medicine ward and integrated ICU. It also independently undertakes the operation and postoperative monitoring treatment of the vast majority of patients with multiple injuries, which provides a continuous and reliable guarantee for the treatment of multiple injuries.

Summary and Prospect

At present, there are some problems in the treatment of patients with multiple injuries in most areas of our country, such as poor exchange of pre-hospital first aid and in-hospital information, weak comprehensive treatment ability and so on. This is one of the important reasons why the fatality rate and disability rate of patients with multiple injuries in China are much higher than those in developed countries in the world. How to maximize the success rate of treatment of patients with multiple injuries is still a hot, key and difficult point in the field of trauma first aid. At present, there is no unified treatment mode for the treatment of patients with multiple injuries, compared with the traditional division and triage treatment mode and the integrated treatment mode of trauma. The multi-disciplinary assistance treatment model dominated by the trauma center, the emergency department (including the trauma center) independently undertakes the treatment of the vast majority of patients with multiple injuries under surgery and postoperative monitoring because of its emphasis on the concept of continuity of treatment and survival chain. It is gradually valued and accepted by the majority of doctors. However, the implementation of the multidisciplinary assistance and treatment model led by the trauma center needs to be established in a certain area according to the characteristics of the region, area, population, road status and the level of medical resources. Each region can choose according to its own actual situation. And even develop their own treatment model.

Author Contributions

This research was finished by all the authors. Di Ke and Xue Xiao conceived the research project together. Di Ke drafts the manuscript. Xue Xiao revised and further processed the manuscript. All the authors read and approved the final manuscript.

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