

Retrospective, Analytical Study of Field First Aid following the Wenchuan Earthquake in China

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Abstract

Field first-aid data from the Wenchuan Earthquake in China was analyzed retrospectively in order to probe into ways to develop field first-aid operations and provide a reference for future emergency rescue. Related documents about the Wenchuan Earthquake were collected and reviewed. The state of injury and leading causes of death during the disaster were identified. The presence of emergency medical resources on-site after the earthquake was relatively insufficient. Deaths mainly were due to cardiopulmonary arrest, severe craniocerebral injury, incurable hemorrhagic shock, and crush syndrome that caused multiple organ system dysfunction syndrome. Only by strengthening the on-site emergency medical resources, speeding-up triage, and equipping responders with professional, portable medical equipment, can field first-aid operations be delivered more efficiently.

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Introduction

The 8.0 Richterscale Wenchuan Earthquake in Sichuan Province, China occurred on 12 May 2008. The affected area covered 500,000 km², among which, the most severely affected area was 130,000 km². The event caused 69,227 deaths, 17,923 remain missing, and 15.1 million emergency transfers, with the total number of disaster victims reaching 46.24 million.¹ Of the injured, >4.3 million required treatment, among which, 370,000 required emergency treatment during the “golden emergency care period” of 72 hours following the earthquake. With 10,630 responding personnel from 32 provinces (cities) throughout the country rushing into the affected area, the medical teams played an important role in the major rescue operations, treating >2 million of the injured victims.^{2–4} Some of the medical teams providing rescue operation on-site played an indispensable role in mitigating the disability and fatality rate of the injured to the utmost minimum. This paper retrospectively analyses the data from the on-site treatment after the catastrophic Wenchuan Earthquake, in the hope of providing a source of reference for the on-site emergency care during future disasters.

Methods

More than 200 Chinese and English documentary articles about the Wenchuan Earthquake from the period of May 2008–September 2009 were collected. More than 20 concerned the provision of field first aid to the victims of the Wenchuan Earthquake.

Results

More than 100 teams provided on-scene emergency medical care. The Mianyang Urban Hospital Medical Team, China International Search and Rescue Team (CISAR), and the affiliated Southwest Hospital Medical Team of Third Military Medical University will be used as examples.

The Mianyang Urban Hospital Medical Team arrived in Beichuan County (an area severely affected by the Wenchuan Earthquake) 4.5 hours after the occurrence of the earthquake. In Qushan Town, only 4,000 people out of >20,000 escaped, and >900 people survived their injuries (>16,000 who were injured or trapped, died). On the day of the earthquake, first-aid personnel examined 520 injured victims.⁵ There were 23 cases of cardiopulmonary arrest, with immediate cardiopulmonary resuscitation

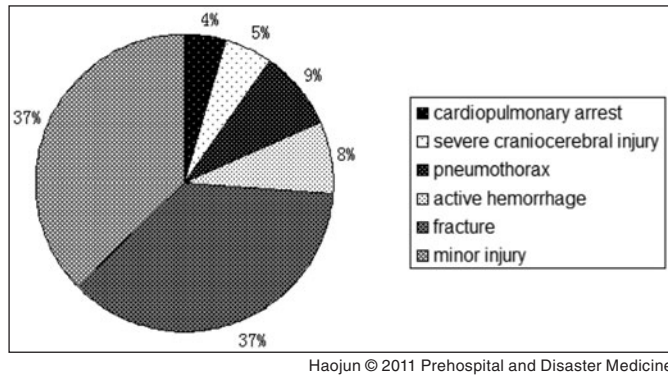


Figure 1—Distribution of traumatic conditions

provided, but without follow-up treatment due to the lack of manpower and medical supplies etc., only 11 successfully recovered and were transferred to hospitals. There were 27 cases of severe craniocerebral injuries. All had severe headaches, some had projectile vomiting, nine experienced worsening disturbances of consciousness, and five victims had bilateral anisocoria (Figure 1).

Patients were treated for dehydration and symptomatic treatment, then, after their vital signs stabilized, were transferred. Three victims died during transport.³ There were 46 cases of pneumothorax, most of which related to rib fractures. There were 28 cases with open pneumothorax. After sealing the wound and performing thoracentesis, suction, and decompression, the patients were transferred when their breathing difficulties had been eased. Among them, there were two cases of tension pneumothorax. Due to a shortage of thorax closing devices, a 1 cm incision was cut sideways in the midclavicular line of the second intercostals, a fountain pen container was inserted into pleural cavity, and the outlet was tied with a rubber-finger bag, the top of which being cut with a 1 cm opening, thus acting like a valve. These therapeutic measures had significant efficacy.⁴ There were >40 cases of active hemorrhaging. Hemostasis using compression bandages was applied to all openly wounded, bleeding limbs. Nine cases of suspected internal hemorrhage were transferred with priority.⁵ There were >190 cases of various kinds of fractures. Many of these fractures were immobilized with slabs, branches, towels, and cotton tapes. The injured with suspected spinal fractures were carried away on door panels, and those with suspected cervical vertebra fractures had their heads properly immobilized to the door panels with cotton tapes before transfer. As the site became relatively chaotic, the walking wounded began boarding the transfer vehicles, the critically wounded could not be sent away on priority, causing the deaths of the six seriously injured victims who were not transported in time. Four cases of middle school students failed to receive follow-up treatment and died on the roadside 1–2 hours after hemostasis and fracture immobilization were achieved.

The China International Search and Rescue Team in Juyuan Town of Dujiangyan City (a severely affected area), and commenced search-and-rescue operations on 12 May, at 03:00 hours. Then, they proceeded to Hanwang Town of Mianzhu City, Beichuan County, Wenchuan County and the suburbs of Mianyang City, all severely impacted areas, to search for and rescue survivors from the ruins, and provided emergency medical treatment.⁶ The team rescued and provided first aid to 49

survivors.⁷ Of the 49 survivors, 39 were trapped ≤ 72 hours, and 10 were trapped >72 hours. Eight people had head injuries, 12 had chest injuries, 15 had abdominal injuries, three had spinal cord injuries, five had pelvic injuries, and 48 had injuries to the limbs. Moderate or severe dehydration conditions were present in all cases. Survivors trapped in the ruins often had multiple injuries and were in critical condition, which would rapidly worsen or even result in death if no timely treatment was provided.^{8, 9} Based on past rescue experience domestically and abroad, the rescue team ascertained that all of the survivors suffered different degrees of dehydration after being trapped without water. Therefore, providing fluid resuscitation and fluid replacement was of the utmost importance. Due to on-site fluid replacement, oxygen therapy, bandaging, immobilization etc., 49 survivors were successfully resuscitated and sent to the base hospital. Five survivors with suspected cervical cord injuries were immobilized with cervical gear; three survivors with suspected spinal cord injuries were immobilized with a spine board before being transferred. The emergency rescue operation performed by the medical rescue team effectively laid the foundation for follow-up treatment, which reduced the disability and fatality rate.

The affiliated Southwest Hospital Medical Team of Third Military Medical University took the lead after arriving at the epicenter (Yingxiu in Wenchuan County) 52 hours after the earthquake, and performed 15 days of on-site rescue and emergency care. They successively treated 4,689 cases, including 413 severely injured victims. More than 90% of the 4,689 wounds were fractures, mostly of to the extremities. They directly rescued 10 victims from the ruins. Among them, one person had been buried for 68 hours, five persons 100–110 hours, one person 126 hours, one person 145 hours, one person 160 hours, and one person 178 hours. Treatments mainly included sustaining vital signs, debrident and open decompression of an osteofascial compartment. There were nine cases of crush syndrome; two victims died within 0.5 hours after being rescued.¹⁰ The team did not encounter any victims with brain injuries. It was considered that victims with prolonged brain injuries did not survive.

The main causes of on-site deaths included: cardiopulmonary arrest, severe craniocerebral injury, incurable hemorrhagic shock, and crush syndrome. The Mianyang Urban Hospital Medical Team provided emergency treatment to 23 cases of cardiopulmonary arrest, of which, only 11 were transferred to the hospital. A total of 27 cases of severe craniocerebral injury were given symptomatic treatment such as dehydration, and were transferred after their vital signs stabilized, but three victims died on the way to the hospital.¹¹ Situated in the central zone of the earthquake, Dujiangyan People's Hospital was given the forefront task for emergency treatment, triage, and evacuation after the earthquake. One week after the earthquake, 81 victims died, with head injuries accounting for 50.6% of the deaths. Victims with wounds often had various degrees of hemorrhagic shock that would cause direct death from shock or shock-induced, multi-organ failure if they had not been given timely emergency treatment. There also were cases of successful emergency treatment provided on-site, but the failure of timely transfer for further treatment resulted in death.

Crush syndrome also was one of the causes of death on-site after the earthquake. The Southwest Hospital Medical Team rescued nine crush syndrome survivors from the ruins, two of whom died within 30 minutes of their extrication.¹⁰ Reportedly,



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Figure 2—Field First Aid: Wenchuan (Color online)

the China International Search & Rescue Team treated six cases of crush syndrome during their post-earthquake rescue mission in Banda Aceh, Indonesia and Pakistan, where one female died on the way to the hospital.¹²

Mianzhu was one of the hardest hit areas. The People's Hospital of Mianzhu lost its medical treatment function as a general hospital after the earthquake, and only could provide emergency medical treatment. It provided emergency medical treatment to 1,376 victims within 24 hours after the earthquake, and after preliminary clinical determination, there were 499 cases requiring emergency surgical operations, among which, 253 cases were transferred to the base hospital. The remaining 246 cases (except 12 who discontinued treatment and went home) died within 2–3 days. Therefore, the mortality rate of victims reached 46.9%,¹³ due to the fact that although necessary, emergency surgical operations were unable to be performed.

Discussion

Crush syndrome refers to the limbs or the muscular portion of the trunk being compressed for a prolonged time, and is characterized by limb swelling, myoglobinuria, hyperkalemia, and after being relieved from the compression metabolic acidosis.

After prolonged compression, when the compressed portion of the survivor's musculature is released, the survivor rapidly can appear hyperkalemic. Toxins flow backward through the body, and cause poisoning and acute renal failure, resulting in rapid death. In order to revive more victims with crush syndrome, new mobile medical equipment, such as mobile hemodialyzer, should be developed.

From the perspective of the distribution of medical rescue resources during the earthquake disaster, the earthquake emergency rescue capabilities on-site were inadequate. According to the characteristics of earthquakes, and with reference to the successful experiences of the military emergency treatment triage, Hou Shike and associates put forward a proposal of a three-stage Medical Rescue Plan;¹⁴ Stage 1—Medical Rescue (Field First Aid); Stage 2—Medical Rescue (Frontline hospital medical rescue); and Stage 3—Medical Rescue (Base hospital medical rescue), as shown in Figure 2.

Stage 1: Field First Aid—Providing emergency treatment to the injured on-site as soon as possible (usually <72 hours after the earthquake), performing triage and observation, and transferring patients. This is the “golden stage” of medical

rescue for the injured, giving the survivors the timeliest treatment, greatly reducing the fatality and disability rates. This was demonstrated by the medical teams rushing to the disaster site during the Wenchuan Earthquake rescue operation.

Stage 2: Frontline Hospital Medical Rescue—Hospitals in the proximity of the disaster site and reachable within one hour's drive, such as the medical establishments in Mianzhu, Deyang, Mianyang, etc., which were closest to Wenchuan Earthquake ruins.

Stage 3: Base Hospital Medical Rescue—The large general hospitals, relatively further from the disaster site than the Frontline Hospitals, such as the 3A Chengdu South Hospital, Chengdu Military Region General Hospital, and Chongqing Third Military Medical University. They greatly eased the pressure on on-site medical rescuers.

In the three-link set up, field first aid was the weakest link in the Wenchuan Earthquake rescue operation. This also was the weakest link of China's disaster rescue operation, due mainly to the lack of professional teams, equipment, and training.¹⁴ Participating in the on-site medical rescue operation in response to the call of "combat earthquake and relieve disaster" were only 397 military medical troop units comprising of 7,061 health personnel,² and local medical teams participating in post-earthquake first aid on-site were limited. Confronted with >370,000 injured persons in need of emergency treatment 72 hours after the earthquake, the capabilities of providing on-site emergency treatment were far from sufficient. Moreover, the rescue teams being unable to reach the disaster site due to paralyzed traffic and communications interruptions at the disaster site was one main causes of field first aid" being the weakest link.

Normally, many medical personnel treat a single patient in a hospital, which is "many-to-one"; while an earthquake instantly injures a large number of persons, when medical rescue capabilities are limited, and one rescuer must treat many wounded victims, which is "one-to-many". In "one-to-many" circumstances, it is imperative to speed up triage in order to ease the contradiction between insufficient medical rescue capabilities and the needs of the injured, the contradiction between shortages of first aid supplies and the needs of supplies in bulk, contradiction between the injured with severe injuries and those with minor injuries, and the contradiction between the treatment of the portion wounded and all wounded.¹⁵ Moreover, the speed of on-site emergency treatment directly affects the possibility of the injured being rescued. Field first aid following earthquakes should abide by the principle of rescue before diagnosis, which is first saving "life" and then saving "person". Follow the rescue sequence of "rapid evaluation of patient's condition→treat fatal wounds with priority→support vital signs→stabilize patient's condition→rapid and safe transfer".¹⁶

There are many ways to classify catastrophic disasters at home and abroad, such as the simple classification and rapid treatment method, the Baker Method,^{17, 18} etc. In performing on-site medical rescue according to international rules and the *Disasters Medical Rescue Operations Management Method* released by the Ministry of Health, patient cards marked in red, yellow, green, and black are used to classify patients' conditions into minor, moderate, severe, and deceased. The card (made of

non-setting adhesive and measuring 5 x 3 cm) is placed on the victim's left chest or other obvious location, so that medical rescue personnel easily can recognize and provide relevant emergency treatment. The Jiangyou-stationed medical team of the Second Military Hospital University divided the injured into three categories:¹⁹ Category 1—patients requiring immediate treatment, (victims who would face life-threatening danger at any moment, such as severe shock, massive hemorrhage due to organ rupture, severe multiple injuries, and open pneumothorax); Category 2—patients requiring emergency treatment, with no life-threatening danger within 2–4 hours, such as limb fracture, with perforations in cavum; and Category 3—patients requiring delayed treatment, with moderate and minor injuries, such as joint dislocation, bruises, etc. The wounded in Category 1 were the focal point for the on-site emergency rescue personnel, who also would treat Categories 2 and 3 patients. Thus, the highly efficient rescue operations were performed in an orderly fashion. Currently, military medical personnel in China gain knowledge of medical treatment triage either in the university or from work, but personnel from local medical institutes lacked knowledge of triage, because they did not have triage in the curriculum of their medical universities, and have had no relevant training.

The shortage of special portable equipment was a major hindrance to providing highly efficient emergency medical rescue. As noted, The People's Hospital of Mianzhu lost its medical treatment function as a general hospital after the earthquake, and only could provide emergency medical treatment. Therefore, the emergency surgical platform was purposely established in the early post-earthquake phase, as performing life-saving surgery was effective in reducing the early mortality rate of the injured, thus improving the efficiency of the on-site emergency care in the disaster area.

The China International Search and Rescue Team possesses a field hospital system with rack-type army tents and field ambulances. During the tsunami rescue in Indonesia, the team successively provided medical rescue to the 10,828 injured victims, performed 284 surgical operations, and treated 440 critically ill patients,^{20, 21} significantly increasing the efficiency of field first aid. In summarizing the on-site search-and-rescue, and emergency medical care operations during past disasters and the Wenchuan Earthquake disaster, it was determined that if the on-site medical teams were allocated with search-and-rescue equipment and the on-site portable-type first aid equipment to perform the three-in-one task of "search-rescue-emergency treatment", they would have been able to achieve more with less effort.^{22, 23}

Conclusions

After careful analysis, the three key factors affecting on-site rescue operations in the aftermath of the Wenchuan Earthquake are:

1. Inadequate on-site rescue resources, poor on-site resource management, and lacking field first-aid knowledge indicate that all responsible departments must enhance on-site rescue resources management and distribution. Furthermore, since military disaster rescue capabilities are superior to civilian disaster response capabilities, so the medical institutions or the military should provide regular emergency training to civilians so that the general public is familiar

with proper first aid and can perform basic self-saving procedures after catastrophes;

2. With respect to the large numbers of injured persons, complex traumatic conditions, and shortage of rescuers, rapid triage should be implemented so that medical resources can

be used more efficiently. Therefore, seriously ill patients could be treated first; and

3. Severe on-site circumstances and the lack of portable medical agents and heavy diagnostic equipment caused misdiagnosis and delayed medical treatment for the injured.

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