

## The Field Hospital Setting in Earthquake

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### Abstract

**Background:** Natural and complex disasters such as earthquakes can cause a dramatic increase in the demand for emergency medical care. Local health services can be overwhelmed, and damage to clinics and hospitals can render them useless. Dispatching field hospitals, meeting the needs of the sufferers in earthquakes would seem to be the ideal response.

**Methods:** After a systematic search, critical appraisal, and selecting the valid and reliable articles, a systematic review of the scientific literature performed and accordingly the setting for the field hospital needed in the earthquakes proposed.

**Results:** The major affected groups were children, women and elders. The more important problems in the patients were extremity trauma, crush syndrome, acute renal failure, and other ensuing medical complications. The medical assistances provided by field hospitals in earthquakes were diverse which are discussed in the article comprehensively.

**Conclusion:** According to our findings, we strongly emphasize the imperative need for field hospitals in disastrous countries which can offer effective and efficient health care services for the injured people regardless of age or gender and especially cover the needs of fragile minorities. A multi-disciplinary, field hospital must include orthopaedics, general surgery and plastic surgery, anaesthesiology, internal medicine, gynaecology and obstetrics, and paediatrics specialities with enough paramedical and support staff. The presence of a nephrologist may be valuable. Outpatient treatment of post-earthquake burns should also be addressed. The presence of such field hospitals can decrease the mortality and morbidity of earthquakes to a great extent.

**Keywords:** Field hospital, Mobile Hospital, Earthquake, Bam Earthquake, Trauma, Injury

Multiple deaths and injuries at large public events such as the earthquakes have occurred consistently, over a wide spectrum of countries and types of events. It is recognized that no two events or situations are identical but preparedness for these events imitate the same rules <sup>1</sup>.

Both natural and complex disasters may produce a massive number of casualties that outstrip the ability of the local health care system to provide the required care <sup>2,3</sup>.

On the other hand, damage to the health care infrastructure –as we saw in Bam Earthquake –will further compromise the delivery of health services <sup>4</sup>. As a consequence, affected and collaborating countries are anxious to find ways to provide immediate medical care to victims. An obvious solution would seem to be the dispatch of mobile field hospitals to the stricken area <sup>2, 5, 6</sup>;

but the setting of the field hospital sent to the affected area should comply with the needs of the victims.

A field hospital is defined as a mobile, self-contained, self-sufficient health care facility capable of rapid deployment and expansion or contraction to meet immediate emergency requirements for a specified period of time <sup>2</sup>.

According to WHO recommendations, the field hospitals are useful in the aftermath of a disaster for three distinct purposes:

Provide early emergency medical care (including Basic and Advanced Life Support –BLS and ALS). This period lasts only up to 48 hours following the onset of an event.

Provide follow-up care for trauma cases, emergencies, routine health care and routine emergencies (from day 3 to day 15).

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Act as a temporary facility to substitute damaged installations pending final repair or reconstruction (usually from the second month to two years or more) that means moving from the Emergency to Rehabilitation phase <sup>7</sup>.

In this article, after investigating the previous earthquakes in all over the world, with focus on the major affected groups, types of injuries and required medical assistance, we are trying to propose the setting of the field hospital, meeting the needs of the sufferers in earthquakes.

## Materials and Methods

According to the keywords we planned a systematic search in the Medline, Elsevier, Blackwell, Ingenta, Proquest, Ovid and Oxford Journal Collections as well as search engines by choosing an appropriate search strategy. For instance, we scrutinized one hundred and forty four articles in Medline for finding out the types of injuries with the following search strategy: ("injuries" [Sub-heading] OR "wounds and injuries"[MeSH Terms] OR trauma[Text Word]) AND "earthquake"[All Fields] *Limits:* only items with abstracts, English, Human.

After a critical appraisal and selecting the valid and reliable articles, we performed a systematic review and proposed a suggestive setting for the field hospital needed in the earthquakes.

## Results

### *Affected groups in earthquake*

According to the studies done in previous earthquakes, for example in Gujarat Earthquake, the census showed a predominance of women, children, and young adults, with the average age of 28 years as the major affected group <sup>8</sup>. More than 25 per cent of patients requiring hospitalization were children, of whom greater than 20 per cent needed surgery <sup>9</sup>.

In Marmara Earthquake, of 151 injured patients hospitalized due to musculoskeletal trauma, 31 (20.5%) were under 16 years of age <sup>10</sup>.

In the Chi-Chi Earthquake in Taiwan, the results implied that *fragile minorities*, specifically the elders and children, require special consideration

and attention in regard to disaster rescue and emergency medical care allocation <sup>11</sup>.

In bam earthquake, according to reports from the State Welfare Organization, 1800 children lost both parents and at least another 5000 children lost a parent. Other children were also severely traumatized. Many children had been separated from their families, because the wounded had been transported to other cities. Therefore, providing care and protection for children deprived of primary care-givers, was a challenging issue. Underlying geographic and socio-economic conditions in the region of Bam might expose local women and girls to an even greater degree of physical and psychological harm. Providing care and rehabilitation for these women and girls therefore necessitated special efforts <sup>12</sup>.

### *Types of injuries in earthquake*

The more important problems in the patients in earthquakes -as we saw in Marmara -were extremity trauma, crush syndrome, acute renal failure, and other ensuing medical complications. The major associated injuries were in the lower extremities, upper extremities, and chest, respectively <sup>13, 14</sup>. Although the types of injuries resulting from the earthquake were similar in adults and children, the orthopaedic consequences of these injuries showed significant differences, especially in the rates of crush syndrome leading to acute renal failure and amputation, which is discussed in more details in the next section <sup>10, 13</sup>.

Analysis of 2,702 traumatised patients in the 1995 Hanshin-Awaji earthquake showed that Crush syndrome and injuries to vital organs were potentially life-threatening, and early transportation of such patients to undamaged hospitals with the ability to provide intensive care would have improved the survival rate (15). The important and severe medical complications in crush syndrome patients such as dehydration, oliguria, hyperkalaemia, etc. should always be anticipated <sup>13</sup>.

The studies on chest trauma imply that approximately 10 per cent of the casualties of a great earthquake may be expected to have thorax and lung injuries mostly caused by blunt trauma, that pneumothorax and rib fractures were the two most frequent pathologies, respectively <sup>16, 17, 18</sup>.

In the Chi-Chi Earthquake in Taiwan, 30 per cent of the victims died from head injuries caused by the collapse of dwellings<sup>11</sup>.

An experience from the IDF field hospital in Duzce, Turkey, showed that the circumstances of evening earthquake and non-industrialized area expressed a new post-earthquake burn syndrome: multiple scald burns due to hot liquid spills<sup>19</sup>.

Also the prevalence of infectious diseases often has an incremental pattern in the period after the earthquake. For instance, in Bam earthquake, upper respiratory tract infections were the most common problem; 792 cases occurred 3 weeks after the earthquake due to the freezing weather, particularly at night (20, 21). Animal bites are also considerable in the affected area<sup>20, 22</sup>.

As seen in many disasters, for example in Spitak earthquake in Armenia or Bam Earthquake in Iran, after exposure to severe trauma, adults were at high risk of developing severe and chronic post-traumatic stress reactions that are associated with chronic anxiety and depressive reactions<sup>12, 20, 23</sup>.

#### ***Medical assistance in Field hospitals prepared for earthquakes***

In Marmara earthquake, 18.5 per cent of children with crush syndrome required haemodialysis because of acute renal failure and 11.1 per cent required amputation. In contrast, haemodialysis was needed in 93.1 per cent of adult patients with crush syndrome and amputation was necessary in 20.7 per cent of them which implies a sound higher rate of haemodialysis among adults<sup>10</sup>. The most important and fatal medical complication in crush syndrome patients was hyperkalaemia that early detection and treatment of hyperkalaemia improved the final outcome of renal disaster victims to a great extent<sup>24</sup>.

Crush syndrome and injuries to vital organs were potentially life-threatening. Early transportation of such patients to field hospitals with the ability of providing intensive care would have improved the survival rate<sup>13, 15</sup>.

In a retrospective study on Crush syndrome patients after the Marmara earthquake, the medical interventions performed according to their frequency were: haemodialysis/haemoperfusion, mechanical ventilation, fasciotomy, amputation, ICU-care for Adult respiratory distress syndrome

as well as multiple organ failure and sepsis. Management of hyperkalaemia and oliguria was also important<sup>13, 14</sup>.

The field hospitals commonly face with paediatric surgical emergencies in the affected area, since approximately one quarter of patients requiring hospitalization in Gujarat Earthquake, for instance, were children, of whom greater than 20 per cent needed surgery. The operations fell into four categories: orthopaedics, soft tissue injuries, burns, and miscellaneous. There was an immediate need for orthopaedic and general surgery skills followed by a delayed need for plastic surgery skills<sup>9</sup>. In the management of post-earthquake burn syndrome, it seems that most of the patients suffering those burns could be treated successfully as outpatients with close follow up<sup>19</sup>.

In Adapazari Earthquake in Turkey, Medical and surgical services in the settled field hospital were supplied by general, orthopaedic, and plastic surgeons. The frequency distribution of the medical problems seen in this field hospital was 32 per cent for internal medicine, 13 per cent for general surgery including plastic surgery, 21 per cent for orthopaedic surgery, 23 per cent for paediatric disease, 10 per cent for obstetrics and gynaecology, and 1 per cent for major psychiatric disorders. 11.4 per cent of the patients treated by the field hospital sought aid for isolated soft-tissue injuries, 76 percent of which were earthquake-related. Plastic surgery patients occupied 13.6 per cent of the hospital beds<sup>25, 26</sup>.

The mentioned field hospital provided advanced surgical and medical facilities, including laparotomy, caesarean section, and intensive care surveillance by a team consisted of 102 personnel. These facilities required sophisticated laboratory and imaging services, including haematology, chemistry, microbiology, blood bank, and radiology and ultrasound<sup>25, 27</sup>.

After exposure to severe trauma, either in earthquake or violence, adults are at a high risk of developing severe and chronic post traumatic stress reactions that are associated with chronic anxiety and depressive reactions. Clinical evaluation and therapeutic intervention should include specific attention to these reactions. Early mental health intervention seems to prevent their chronicity<sup>23</sup>.

## Conclusion

The field hospital is designed for admittance, classification, and temporary hospitalization of the injured patients (in the emergency phase)<sup>28</sup>. The staff arrangement and equipment of the hospital should make it possible to perform major and minor surgeries of limbs, abdomen, thorax and skull as well as managing patients with medical emergencies<sup>27, 29</sup>.

According to the above-mentioned results, a multi-disciplinary, field hospital must include health professionals in areas other than orthopaedics such as general surgery and plastic surgery, anaesthesiology, internal medicine, gynaecology and obstetrics, and paediatrics with the paramedical and supportive staff to meet the type and variety of services they will be called on to provide<sup>2, 9, 26, 27, 30, 31</sup>. These skills must be complemented by those necessary to manage Crush syndrome, Acute Renal Failure, Hyperkalaemia, and other ensuing medical complications<sup>10, 13, 15, 32</sup>. Therefore the presence of a nephrologist may be valuable.

Outpatient treatment of post-earthquake burns should also be addressed in field hospital services<sup>19</sup>.

An elaborate mental health action plan might be designed (especially for the field hospitals in the rehabilitation phase) in anticipation of a large number of survivors with post traumatic stress disorder. The need for ongoing psychiatric and rehabilitative services underscores the importance of working closely with local physicians and medical personnel<sup>20, 25, 30</sup>.

Epidemiologic analysis can guide disaster response and preparation<sup>11</sup>; and epidemiologists, hygiene/sanitation experts, and mental health experts have proven to be valuable assets<sup>2, 11, 30</sup>.

The equipment and facilities should allow assessment and treatment of all patients regardless of age or gender<sup>2, 30</sup> and should provide enough care and protection for children and women<sup>4, 9, 10, 11, 25, 27</sup>.

The facilities should include enough paraclinical services for diagnostic purposes which require comprehensive laboratory and imaging services, including haematology, chemistry, microbiology, blood bank, and radiology and ultrasound<sup>25, 27</sup>.

In the emergency phase, we propose the use of New Emergency Health kit (NEHK) which is developed and recommended by WHO, UNICEF, UNHCR, Médecins sans Frontières (MSF), the League of Red Cross and Red Crescent Societies and many other Humanitarian organizations. This kit includes Drugs and medical supplies for 10,000 people for approximately 3 months<sup>33</sup>.

The proposed structure of a multidisciplinary field hospital is outlined in figure 1.

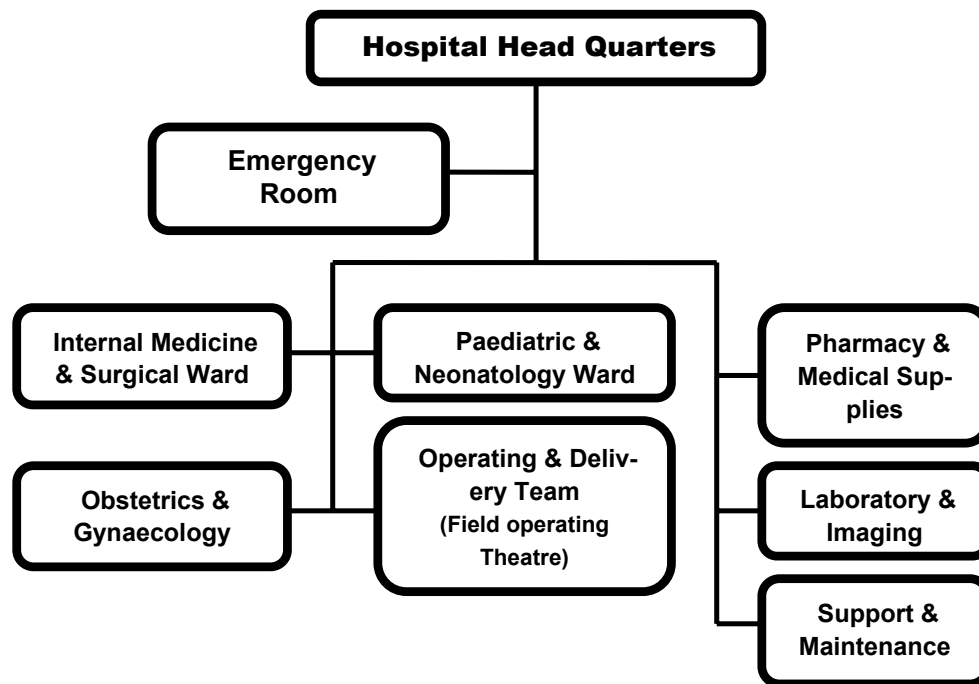
An integral part of a field hospital is the maintenance and support section (including the hospital supplies, kitchen, hygiene facilities, energy, communication systems and accommodations), rendering the entire project maximum independence<sup>34</sup>. Supplies of food and drinking water should be prepared for self-sufficiency and as a preventive measure against the development of intestinal infection of the patients and personal of the hospital<sup>3</sup>.

According to the WHO recommendations and current best evidences<sup>2, 17, 24, 35, 36</sup>, the field hospitals equipped to provide emergency medical care are useful only if they are available and on-site within the first 24 hours of a disaster<sup>2</sup>; But unfortunately, it is not frequently possible in practice; for example, all field hospitals sent to Bam arrived after three days or more<sup>7</sup>. This matter undoubtedly underscores the emergent need of disastrous countries to field hospitals which can be set up and fully operational within the first ours of the catastrophe.

Additionally, according to international consensus, once a field hospital is operational, it should stay at least for a minimum of 15 days, allowing for follow-up (secondary) care of trauma and routine medical attention<sup>2</sup>.

And the last thing we would like to mention is that the field hospitals with staff serving as temporary facilities pending reconstruction should be donated and not loaned<sup>2, 37</sup>.

Finally, in memory of the dead and injured people in Bam Earthquake, we strongly emphasize the imperative need for fully operational field hospitals in disastrous countries which can offer effective and efficient health care services to the injured people in the possible upcoming disasters, and decrease the mortality and morbidity of such ominous events.



**Figure 1.** Structure of the Multidisciplinary Field Hospital. (Adopted and modified from Amital et al, Pre-Hospital and Disaster Medicine; 2003)

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