

International Medical Response to a Natural Disaster: Lessons Learned from the Bam Earthquake Experience

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Abbreviations:

FFH = foreign field hospitals
ICS = incident command system
MOHME = Ministry of Health and Medical Education
OCHA = Office for the Coordination of Humanitarian Affairs
OSOCC = On-Site Operations Coordination Centre
PTSD = post-traumatic stress disorder
SAR = search and rescue
UNDAC = United Nations Disaster Assessment and Coordination
UNICEF = United Nations Children's Fund
USAR = Urban Search and Rescue
UTC = Coordinated Universal Time
WHO = World Health Organization

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Abstract

An earthquake measuring 6.5 on the Richter scale devastated Bam, Iran on the morning of 26 December 2003. Due to the great health demands and collapse of health facilities, international aid could have been a great resource in the area. Despite sufficient amounts and types of resources provided by international teams, the efficacy of international assistance was not supported in Bam, as has been experienced in similar events in other countries. Based on the observations in the region and collecting and analyzing documents about the disaster, this manuscript provides an overview of the medical needs during the disaster and describes the international medical response. The lessons learned include: (1) necessity of developing a national search and rescue strategy; (2) designing an alarm system; (3) establishing an international incident command system; (4) increasing the efficacy of the arrival and implementation of a foreign field hospital; and (5) developing a flowchart for deploying international assistance.

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Introduction

The 2003 earthquake in Bam, Iran was one of the most significant natural events to result in disaster in recent years.¹ Responses to disasters primarily are the responsibility of local, regional, and national authorities.² The provision of international disaster relief, however, is critical in helping to meet the conditional health needs that result from the destruction of healthcare facilities as well as from the disaster itself.^{3–6} Generally, during a disaster, large amounts of humanitarian supplies of workers and goods arrive from multiple national and international sources. To a varying degree, international relief responds to the immediate, life-threatening needs of the affected country.^{7–9} Approximately 60 countries provided humanitarian assistance following the Bam earthquake.¹⁰ As has been reported in similar instances^{11–14} in spite of the adequate amounts of resources and materials provided into the disaster zone,¹⁵ the effectiveness of the international aid often is sub-optimal. A description of the event, needs, interventions, and drawbacks is described in this article. A detailed assessment of recent international medical response to the Bam earthquake can be used to improve the success of disaster medical responses in future disasters.

Pre-Event

The city of Bam is located in a vast plain between the Barez and Kabudi mountain ranges, to the east of Kerman Province in southeastern Iran. Prior to the earthquake, Bam had a population of 240,000 (97,000 urban and 143,000 rural). The city is famous for its ancient architecture and the 2,500 year-old citadel Arg-e-Bam. Health indicators of Kerman Province before the earthquake, are listed in Table 1.¹⁶

Bam faced epidemics of typhoid fever and cholera before the event and malaria and cutaneous leishmaniasis are the most common endemic diseases in the area.

Value	Indicator
2.36	Population Growth Rate
2.4	Gross Fertility Rate
4.3	Gross Death Rate
17.9	Infant Mortality Rate
35.4	Under-5 Mortality Rate
53.0	Maternal Mortality Rate
21.7	Percentage of stunting for 5-year-old children
88.8	Immunization coverage for >1 years of age
109.1	Prevalence of malaria per 100,000 in the year 2000
2.7	Prevalence of leishmaniasis per 100,000 population in 2000

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Table 1—Health indicators of Kerman Province¹⁶

In the city of Bam, 89% of residents had full access to potable water, and 42.8% of the residents had access to sanitation services. Healthcare services were provided by 95 “Health Houses”, which are first-level care providers staffed by primary healthcare workers (Behvarz), and 24 Health Centers (14 rural, and 10 urban) that are second-level care facilities. Third-level care services were delivered in three hospitals; two public and one private.¹⁶

The Event

On the morning of 26 December 2003, 05:28h local time, 01:57am Coordinated Universal Time (UTC), an earthquake measuring 6.5 on the Richter scale struck the city of Bam in the Iranian Province of Kerman.¹⁷ The earthquake resulted in the death of >40,000 people, rendered 30,000 injured, and left some 75,000 homeless. A total of 18,000 buildings (87% of all buildings), including 131 school buildings, and nearly every healthcare facility was destroyed.^{17,18} The water supply network, electricity, and telephone lines were disconnected.¹⁹ The 2,500 year-old historic citadel of Bam (Arg-e-Bam) almost was destroyed completely.¹⁰

Health Damage and Loss of Function

The healthcare facilities of the Bam District Health Care System as well as the percentage of damage by the earthquake are listed in Table 2.¹⁶ The health facilities in the area were destroyed almost completely, and approximately 50% of the health personnel were dead or missing. Due to the extensive damage and unavailability of local healthcare workers, no health facility was functional.

The first assessments revealed that the main causes of morbidity were direct injuries, including fractures from collapse of structures, and the main causes of mortality

Health Facility	Number	Percent Damage
Health House	95	100
Rural Health Center (RHC)	14	100
Urban Health Center (UHC)	10	100
Health Posts (Urban)	5	100
Maternity Facilities (as part of RHC)	5	100
Emam District Hospital (public)	136 beds	50
Mahdieh Maternity Hospital (public)	54 beds	40
Aflatoonyan Hospital (private)	65 beds	100
Emergency Station (115)	1	100
Behvarz Training Center	1	100
District Health Network Expansion Center	1	100
District Health Care Management Center	1	100
Faculty of Nursing and Paramedics	2000 mi	100
Dormitory of the Faculty of Nursing	1500 mi	100

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Table 2—District Health Care Delivery System and the damage due to the earthquake¹⁶ (mi = miles)

were traumatic injuries and suffocation.¹⁵ The great burden of caring for the injured and traumatized patients fell on the provincial health system. Treatment of blood loss, resuscitations, emergency surgical interventions, and medical, life-saving support activities consumed the capacities of neighboring hospitals and healthcare units.¹⁹ Many hospitals around the country received >12,000 injured patients.²⁰

Thousands of tents and large quantities of bottled water and canned food were distributed in the affected area in the first days following the event. Yet, thousands of residents were sleeping outdoors without adequate access to water, sanitation, and a supply network. Thus, the affected population faced increased risks for the development of communicable diseases.

Although there was a past history of endemic malaria and cutaneous leishmaniasis in the area,¹⁵ according to World Health Organization (WHO) and Ministry of Health and Medical Education (MOHME) reports, no epidemics of these diseases occurred.²¹ This may have been related to the decisions and relief attempts made by the local authorities during the first hours after the earthquake, such as the command to use bottled water and canned food, and immunoprophylaxis.

Based on the experience of the earthquake in Guilan in 1990, which caused 15–20% of the affected population to develop the post-traumatic stress disorder (PTSD), it was believed that PTSD could become a major health problem

in Bam.²⁰ Many residents consulted teams that provided psychological and psychiatric services within the first days of the disaster.

As the emergency phase of the disaster ended, the risks of morbidity and mortality from communicable and non-communicable diseases due to the breakdown of the health system grew.²⁰ Providing environmental, public health, and mental health services, managing the nutritional problems, and rehabilitating of injured survivors were the main priorities during the recovery phase.

Disaster Response

The first international notification of the earthquake was posted on the Virtual On-Site Operations Coordination Centre (Virtual OSOCC) at 03:42 h UTC. The initial assessments were not of concern. However, at 15:30 h, the Iranian authorities launched a request for international assistance.¹⁷

A 10-person United Nations Disaster Assessment and Coordination (UNDAC) team, deployed by the Office for the Coordination of Humanitarian Affairs (OCHA), arrived early the following day to assist in the coordination of relief efforts. Switzerland provided the first Urban Search and Rescue (USAR) team, which arrived at the Bam airport the morning of 27 December. They assisted with the registration of incoming international teams. Later in the morning, two UNDAC members arrived with the British USAR team at Kerman airport and opened a reception office to assist the arriving international teams.¹⁷ Search-and-rescue (SAR) teams from 10 countries arrived in Bam on 27 December.²³

Additional members of UNDAC team arrived very early on the morning of 28 December, and performed the first rapid assessments of the disaster zone. The OSOCC was established and operational by 13:00 h to coordinate the international rescue and relief efforts in close cooperation with the Government.¹⁷ Immediately after the earthquake, United Nation Children's Fund (UNICEF) sent emergency health kits and essential drugs that could be used to support a population of up to 120,000 persons, as well as emergency obstetric kits for up to 150 births. World Health Organization personnel arrived in Bam within the first 48 hours. Emergency funds were made available to the Ministry of Health by the WHO within hours of the earthquake.²⁰ In total, 34 USAR teams consisting of 1,345 personnel reported to the OSOCC. On 28 December, authorities announced that no additional international SAR teams were required.²⁴

By 29 December, approximately 1,600 international rescue workers (USAR, medical, and public health relief personnel) from 44 countries were registered by the OSOCC.¹⁷ By 05 January 2004, 85 SAR relief teams were operating in the Bam area in the following categories: 35 USAR teams, 26 medical and public health relief teams, 12 field hospitals, seven teams to provide logistical support to the disaster teams, five assessment teams, and one telecommunications team.²⁵

Besides the contribution of international teams in SAR efforts, they also were involved in the provision of medical and health services. A list of foreign field hospitals (FFHs) active in the disaster zone, their personnel and equipment,

and activities is in Table 3. The first FFH arrived on 29 December (Day 3) and the last arrived on 02 January. Due to the loss of functions of the local healthcare facility, these FFHs provided care for thousands of patients.

Discussion

All disasters, regardless of the cause, have some common medical and public health consequences. Disasters differ in the extent to which these consequences occur and disrupt the normal medical and non-medical infrastructure of the disaster scene. In such events, emergency assistance for health care includes erecting temporary, urgent treatment centers, air evacuation of the wounded away from the disaster zone, and activities to maintain public health (including establishing temporary public health facilities, effective disease surveillance, and provision of adequate shelter, and supplies of food and water). Since medical and health needs usually exceed the affected healthcare system's capacities in major earthquakes, it is important to consider a well-defined role for international aid in disaster relief strategies, particularly in the developing countries. To evaluate the assistance provided by the international medical response to the Bam earthquake, it is important to focus on three categories of activities: (1) search and rescue; (2) triage and initial stabilization; and (3) definitive medical care.

Search and Rescue

The local population at any disaster site provides the immediate SAR response. Unfortunately, in disasters involving large numbers of victims trapped in collapsed structures, the local responses lack the technical equipment and expertise to facilitate extrication. A review of major earthquakes throughout the world has shown that the success of extricating survivors drops dramatically 24 hours after the earthquake. Nearly 40 international teams provided SAR services in Bam, but only five of them arrived within the first 24 hours.²³ The most effective SAR efforts came from teams able to reach the site of the disaster within 24 hours. The delay in the start of activities by international SAR teams partly may be due to the delay in requesting international assistance, which is discussed below. Although some of the national teams responded to the disaster quickly, an important lesson learned is that countries such as Iran, must develop local capacities within the country for rapid response SAR teams to bridge the time gap between the arrival of the local population responses and international search and rescue teams.

On the morning of 28 December, it became apparent that, due to the nature of the collapsed buildings that mostly were constructed from mud, the international SAR teams were not being used optimally.¹⁷ Most of the equipment and personnel of the SAR teams were prepared for SAR in buildings constructed with brick. Therefore, it is necessary to develop a SAR strategy in accordance with geographical and architectural characteristics of different disaster-prone regions.

Triage and Initial Stabilization

Triage is arguably the most important mission of any medical response, especially in disasters such as the Bam earthquake. Field medical triage (disaster triage) must be conducted at

Field Hospital	Arrival Time	Time of Deployment	Personnel (n)	Doctors (n)	Beds	X-Ray	Lab	Pts treated (n)	Operations (n)	Comments
Belgium	31 Dec	N/A	17	7	25	No	No	153	2	4 surgeons 1 internist 1 gynecologist 1 anesthesiologist
Italy	30 Dec	N/A	28	8	10	No	Yes	100	N/A	3 surgeons 2 anesthesiologists 2 internists 1 microbiologist
Morocco	29 Dec	N/A	40	22	20	No	No	N/A	10	4 surgeons 1 anesthesiologist 1 emergency medicine
Japan ¹	28 Dec	31 Dec	14	5	5	No	No	N/A	N/A	--
Hungary ²	31 Dec	N/A	7	4	N/A	No	No	N/A	N/A	Primary health care
Jordan	29 Dec	31 Dec	41	11	25	Yes	Yes	N/A	N/A	Capable to treat 150 pts/day and 10 operations/day
United States	31 Dec	01 Jan	58	14	60	No	Yes	727	7	7 surgeons 7 anesthesiologists 3 pediatricians 3 emergency medicine
Ukraine	29 Dec	N/A	46	22	40	Yes	Yes	130/day	3	2 deliveries
France	29 Dec	N/A	60	9	60	Yes	Yes	152	N/A	1 surgeon 1 anesthesiologist 1 internist
IFRC	31 Dec	02 Jan	80	15	200	Yes	Yes	1808 ³	483	Capable to treat 100 pts/day
Saudi Arabia	N/A	01 Jan	74	10	45	Yes	Yes	1849	N/A	2 ICU beds
India	30 Dec	N/A	N/A	12	75	N/A	N/A	600/day (outpatients)	N/A	2 orthopedics 2 surgeons 2 anesthesiologists 1 internist 2 pediatricians 1 radiologist 2 GPs
India	N/A	N/A	Almost 60	8	75	Yes	Yes	N/A	N/A	2 ICU beds, 4 surgical teams
Pakistan	31 Dec	N/A	60	20	40	Yes	Yes	N/A	N/A	Capable to manage minor injuries

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Table 3—Foreign field hospitals operating in Bam^{16,21,30}

(Dec. = December; GP = general physician; ICU = intensive care unit; IFRC = International Federation of the Red Cross; Jan. = January; n = number; pts = patients)

¹Japanese team has been a field clinic²Hungarian team has been a field clinic³1,808 in-patient cases and >42,000 out-patients

three levels: (1) on-site triage; (2) medical triage; and (3) evacuation triage. *On-site triage* involves the rapid categorization of victims at the casualty site into acute and non-acute groups. Typically, the first responders are the local population and/or local emergency medical personnel. *Medical and evacuation triage* requires experienced medical personnel to identify the level of medical care needed and categorize casualties as red (urgent), yellow (delayed or expectant-survival unlikely due to extent of injury or limited resources), green (minor), or black (deceased).²⁶

Fortunately, due to the high level of medical care normally present in Iran, the effective triage of >12,000 injured patients to medical facilities throughout Iran was possible. International teams must respond to the region within the first 24 hours to be effective in this phase. International medical teams, unless in close proximity to the disaster site, usually are not deployed rapidly enough to impact this phase of the disaster response.

Definitive Medical Care

Although undamaged, well-equipped, local clinics and hospitals could provide definitive medical care most properly, collapse of local health capacities necessitates the deployment of FFHs in major disasters. Because of the need for FFHs in Bam, several were deployed. The competence of these FFHs can be assessed in three phases: (1) early emergency medical care (the first 48 hours); (2) from Day 3–Day 15; and (3) the last phase that may continue for ≥ 2 years.

A FFH must be operational on-site within 24 hours after the event to be effective in the early emergency phase.²⁷ None of the FFH operating in Bam opened within the first 24 hours. It is important to discuss two issues:

1. Iranian authorities launched the first request for international assistance about 13 hours after the earthquake. Designing an alarm system that could inform national authorities and international organizations in the shortest possible interval after such an event could enhance the timeliness and effectiveness of the assistance in the emergency phase; and
2. It is expected that foreign medical facilities available during the first 24 hours of a disaster will come from the closest countries to the host country. In addition to the short distance from the disaster area which would enable such teams to respond into the area before more distant teams could arrive; cultural similarities, language proficiency, and familiarity with the region health infrastructures, would result in a more effective response. Although field hospitals from Saudi Arabia and Pakistan were deployed during the second phase (Days 3–15), there were no field hospitals from any country, even the closest neighbors, operating in the zone within the first 48 hours. Establishing contracts with relief organizations of the different countries located in a disaster-prone region could be a good solution to this problem. Also, designing a well-coordinated international Incident Command System (ICS) could solve many difficulties about the coordination of international medical assistance. International ICS would provide a structure in which different international organizations

effectively participate in the response to a disaster. An international ICS organizational structure would implement five major management activities: (1) incident command; (2) operations; (3) planning; (4) logistics; and (5) finance/administration. The ICS is the same for all disasters, regardless of etiology. The difference is in the particular experience of key personnel. Not all activities, however, are used for every disaster.²⁶

The primary role of a FFH during the second phase (Days 3–15) is the provision of care for secondary needs of trauma victims, routine emergencies, and common medical problems. Although early arrival at the site is not as important as it is in the first phase, the FFH should be operational within 3–5 days after the event to be effective in this phase. It is critical to understand that the mobile surgical and medical teams must provide a graded, flexible response to the needs for definitive care in disasters. The definitive medical care that providers deliver during mass-casualty incidents is more austere than is the medical care provided on a day-to-day basis during normal times. All FFHs must be self-sufficient (staff, medicines, equipment, and supplies, orthopedic surgery and minor interventions, anesthesia, and accommodation for the FFH staff).²⁷ The FFH also must have the capacity for initial stabilization, surgical interventions, and critical care not only of earthquake-related injuries, but also to meet the day-to-day medical and surgical needs of the affected population, such as pediatrics and obstetrics. Maternal care and especially neonatal care represented a substantial portion of the activity in the field hospitals. A valid criticism of field hospitals has been the overemphasis on surgical specialties at the expense of primary care, pediatrics, and obstetrics.

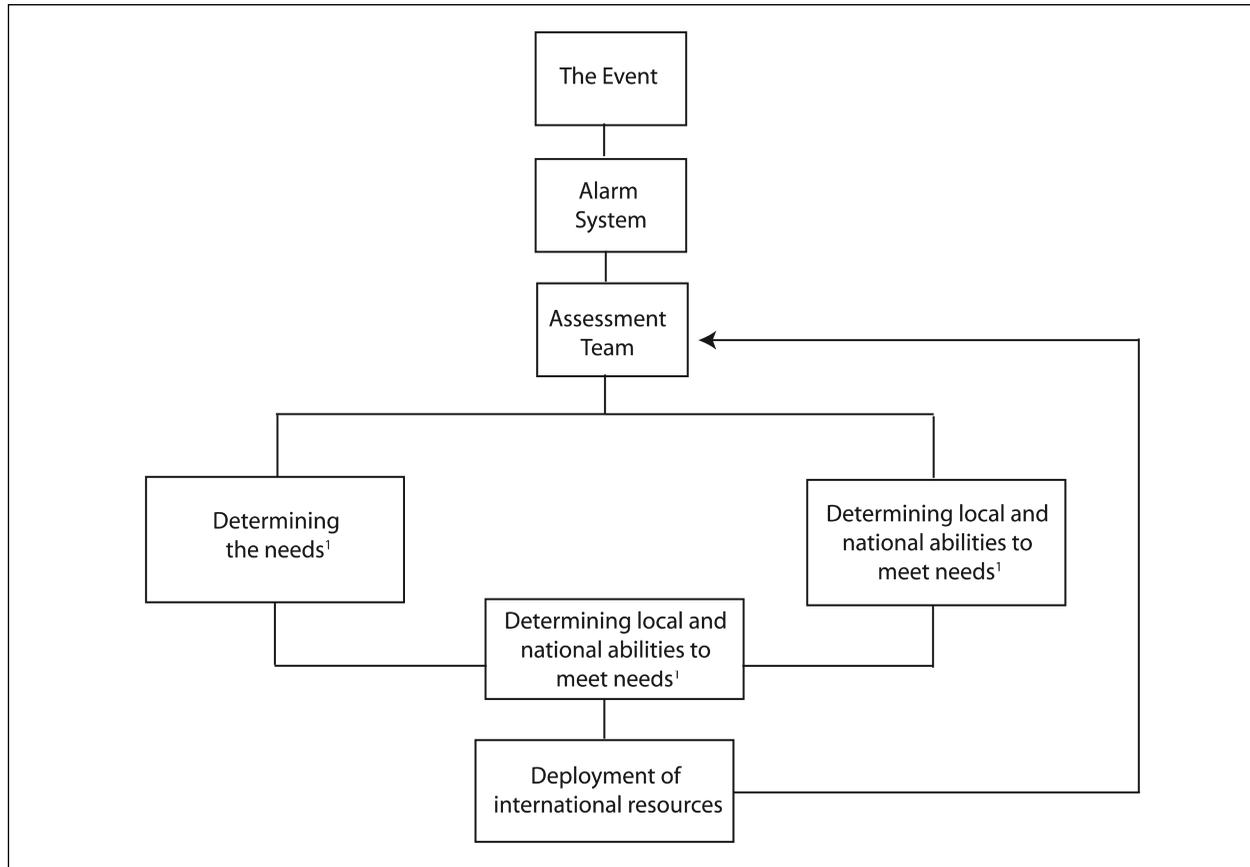
Regarding the diagnosis of trauma-related injuries, x-ray facilities are of great importance. Some of the field hospitals operated in Bam lacked x-ray capabilities and their effectiveness was reduced significantly. The lesson learned is that x-ray facilities greatly affect the efficacy of a field hospital deployed in an earthquake-affected area.

As it was clear from the Bam experiences, the availability of translators in FFH is another important factor that affects the relationships of health personnel with the affected people. Some of the FFH had an Iranian member with their team, which helped solve the problem. Another solution is that every disaster-prone country should assess which countries have had significant contributions during the previous events in the country and then, provide these teams with special translators.

During the third phase (2 weeks to ≥ 2 years), the health facilities of the host country are likely to be reconstructed. Therefore, the cost-effectiveness of the deployment of FFH in the third phase should be assessed even more strictly than for the second phase. Reconstruction of health facilities and providing baths and sanitation to the area are important aspects of international assistance, which were not sufficient during the recent Bam experience.

General Approach

A fundamental factor, which affects significantly the result of all mentioned activities and phases, are the activities of assessment teams.²⁸ Disaster-prone countries should estab-



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Figure 1—Flowchart for deploying international assistance after a disaster

lish and train damage and functional status assessment teams consisting of experts in different sectors. Assessment teams should attend the disaster area on the short notice.

Decisions made during all phases should be based upon the data collected by such assessment teams. These teams should estimate the needs of the affected area and determine if the national capacities meet these needs, in order to identify where international assistance should be directed. The contact person or the director of international medical teams should inform local authorities about the abilities of health professionals and its available equipment and supplies. Accepting international teams and FFH is cost-effective only when they are able to meet the needs that could not be met by the national capacities. An important lesson learned from the Bam earthquake experience is that the assumption that receiving greater amounts of relief items results in a more effective response, is false. As encountered in the Bam earthquake, extensive international assistance could be burdensome on the management and coordination of the activities, transport, storage, and distribution of relief items,^{19,29} particularly regarding the ineffectiveness of local coordination activities.¹⁵ Some of the international teams that lacked transport facilities had to wait for hours for transport facilities at the airport. For some of the teams and field hospitals, the site for establishment was not determined and caused a delay in the start of their activities.

A mechanism that can simplify making decisions about deployment of international assistance in critical situations is illustrated in Figure 1. Also, it should be noted that many aspects of medical needs necessitating foreign assistance in a certain disaster-prone region could be predicted before the disaster strikes the zone. Such a prediction will result in making more precise decisions about accepting the most suitable teams and FFH in future disasters.

Summary

Several important lessons have been re-enforced by this analysis of the use of international assistance following the earthquake in Bam, Iran in 2003. These include three categories of relief activities: (1) search and rescue; (2) triage and stabilization; and (3) definitive care. Search-and-rescue support should originate from neighboring or cross-border countries. Triage is conducted at three levels: (1) on-site; (2) medical; and (3) evacuation. To be effective, international teams and field hospitals must arrive early following such a sudden-onset event. The arriving teams must be self-sufficient and must have the capabilities to meet the actual needs of the affected population. These simple lessons usually are ignored.

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