A Public Health Evaluation of 2008 Sichuan Earthquake in China

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Preface

Whilst Asia is ranked as the most disaster-prone region in the world in terms of both natural and manmade disasters, research and training in the Asia-Pacific region is limited. Better understanding of the disaster epidemiological profile and human health impact will enhance response, preparedness and mitigation of the adverse human impacts of disaster. The concept of case-teaching method has been used extensively in research and teaching of disasters and humanitarian studies at schools of public health around the world, including Harvard School of Public Health, Johns Hopkins Bloomberg School of Public Health and London School of Hygiene and Tropical Medicine. Through the existing partners and networks of The Jockey Club School of Public Health and Primary Care, the Public Health Humanitarian Initiatives of The Chinese University of Hong Kong, and the Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response (CCOUC), this disaster and humanitarian relief monograph series composed of eight case study reports has been developed using a standardised analytical and reporting framework. Methods for case study including literature reviews, stakeholder interviews and retrospective data analyses have been employed.

This case study series aims at highlighting the key lessons learnt in disaster medical and public health response in the Asia. The goal is to develop Asia-specific teaching materials for public health and medicine in disaster and humanitarian response.

The "Guidelines for Reports on Health Crises and Critical Health Events" framework has been adopted as a reference for the literature search and the identification of key areas for analysis (1). We acknowledge that disaster management is a multidisciplinary area and involves much more than health issues, but we believe that the public health impact of all interventions should be appreciated across all disciplines.

This report is developed from a research conducted by Emily Ying Yang CHAN, Polly Po Yi LEE, and Kevin Kei Ching HUNG in 2011 with the support of CCOUC fellows. Dr Hung was then

Research Manager of the Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response (CCOUC).

Authors

Professor Emily Ying Yang CHAN (陈英凝教授) *MBBS (HKU), BS (Johns Hopkins), SM PIH (Harvard), MD (CUHK), DFM (HKCFP), FFPH, FHKAM (Community Medicine), FHKCCM* Director, Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response (CCOUC) Associate Director (External Affairs and Collaboration) and Professor, JC School of Public Health and Primary Care (JCSPHPC), The Chinese University of Hong Kong (CUHK) Honorary Research Fellow (Emerging Infectious Diseases and Emergency Preparedness), Nuffield Department of Medicine, University of Oxford, United Kingdom Visiting Scholar, François-Xavier Bagnoud Center for Health and Human Rights, Harvard University, United States Convener, Public Health Humanitarian Initiatives, JCSPHPC, CUHK

Ms Polly Po Yi LEE (李宝仪)

RN, BN, MPH (CUHK)

Project Manager, CCOUC

Senior Research Assistant, JCSPHPC, CUHK

With the support of CCOUC fellows

Contact point: Professor Emily Ying Yang CHAN

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Executive Summary

The 2008 Sichuan earthquake was one of the most deadly and devastating natural disasters for both China and the world in recent years. While the preparedness and resilience at the central level was quite high and kept improving after the earthquake, the local community-level vulnerability, preparedness and resilience had much room for improvement. The key public health lessons learnt in disaster response and recovery could be discussed from physical health, mental health and social health perspectives. From a physical health perspective, relevant protocols and guidelines should be made available to increase the awareness of addressing chronic diseases among medical teams and the general public. It is also necessary to have continuous training on preventive measures against common infectious diseases such as influenza. Moreover, adequate tetanus vaccine coverage should be ensured, especially among the elderly. From a mental health perspective, there was a lack of experience and training to meet mental health needs. The technique of Psychological First Aid could be introduced to address mental health issues of both disaster victims and responders. From a social health perspective, social networks and the socio-economic burden of survivors should be considered when planning for relocation and reconstruction. Finally, international involvement, better communication at all levels and the employment of international relief standards should be considered to improve future disaster response.

1. Introduction/Material/Methodology

1.1 Introduction

As one of the most devastating natural disasters both nationally and globally in recent years, the high death toll and massive destruction of the 2008 Sichuan earthquake caught attention worldwide. The main objective of this case study is to identify the lessons learnt from the disaster response through the perspective of public health, with the aim of reducing impacts of natural disasters in the future. The study presents information about the earthquake and its impact, as well as discussions and recommendations on emergency relief and recovery. Evaluation of medical response is the focus of the study, while other related aspects are also discussed.

1.2 Material

This study draws mainly on secondary sources. Sources of information include academic literature from PubMed and Medline, major Chinese Medical database for the Chinese-language-based literature, as well as publicly available information from disaster information systems (e.g. the Emergency Events Database (EM-DAT) of Centre for Research on the Epidemiology of Disasters (CRED) at Université catholique de Louvain, Belgium), United Nations agencies dealing with disaster, health, and development (e.g. WHO, UNDP, UNICEF), NGO's, government sources, and news articles. Progress reports, government statements, government policy papers, field reports and documents from organisations providing information on preparedness and response are also reviewed in this study.

1.3 Methodology and a theoretical framework for an earthquake case study

To achieve a systematic examination of the case, major public health principles of disaster response and the disaster cycle model will form the theoretical framework for this analysis.

I. Public health principles of disaster response

According to the *Oxford Handbook of Public Health Practice*, the three main principles of public health response to disasters include securing basic human needs required to maintain health, determining the current and the likely health threats to the affected community, and acquiring and providing the resources to address the two issues above (2). The discussion in this case study will focus on the five basic human health needs.

The five basic requirements for health include food, health services, information, water and sanitation, as well as shelter and clothing. The access to these basic needs is often disrupted after a disaster. Compared with other major natural disasters, the short-term effects of earthquakes include a higher death toll, an overwhelming number of severe injuries requiring extensive medical care, and a relatively small increase in the risk of communicable diseases, while food scarcity or major

population displacements are comparatively rare (3). Securing the access to the basic needs is considered the main goal of the emergency relief.

As a global effort in setting the standard for emergency relief, the international Sphere Project hosted by the International Council of Voluntary Agencies (ICVA) in Geneva is "a voluntary initiative that brings a wide range of humanitarian agencies together around a common aim - to improve the quality of humanitarian assistance and the accountability of humanitarian actors to their constituents, donors and affected populations." The Sphere Handbook, *Humanitarian Charter and Minimum Standards in Humanitarian Response*, provides a level of standard that has been agreed upon by a multitude of front line agencies (4). It contains the minimum standards for most aspects of the basic requirements for health, specifically water supply, sanitation and hygiene promotion; food security and nutrition; shelter, settlement and non-food items; and health action. For each specific sector, it has distinct indicators to measure whether the minimum standards are being achieved.

II. Definition of health

Health is a state of complete physical, mental and social well-being instead of the mere absence of disease or infirmity (5). Specifically, public health is defined as "[t]he science and art of preventing disease, prolonging life and promoting health through the organised efforts of society", according to Sir Donald Acheson (6).

III. The disaster cycle model

Apart from the general public health principles, it is important to recognise the different actions required during the various phases of disasters. The disaster cycle model helps highlight the key stages in post-disaster emergency response. It can serve as a useful reference for different parties to take actions during disaster management.



Figure 1 Disaster cycle

Source: Chan EYY, Sondorp E. Natural disaster medical intervention: missed opportunity to deal with chronic medical needs? An analytical framework. Asia Pacific Journal of Public Health. October 2007;19(Special Issue):45-51.

2. Pre-Event Status

2.1 Background

China is located in East Asia. It borders with 14 neighbouring countries, namely Vietnam, Laos, Burma, India, Bhutan, Nepal, Pakistan, Afghanistan, Tajikistan, Kyrgyzstan, Kazakhstan, Russia, Mongolia, and North Korea. Sichuan Province is one of the 34 province-level administrative divisions (including Taiwan) in China. It is situated in the south-western part of China and ranks the fifth largest province-level administrative division in terms of territorial size.



Map by: <u>Central Intelligence Agency (CIA)</u> – Public domain (https://www.cia.gov/library/publications/theworld-factbook/docs/refmaps.html)

Figure 2 The location of China in Asia



Map by: <u>Central Intelligence Agency</u> (<u>CIA</u>) – Public domain (https://www.cia.gov/library/publications/ cia-maps-publications/China.html)

Figure 3 The location of Sichuan Province in China

The table below shows the statistics of Sichuan's population and health services around the time when the earthquake happened in 2008.

Information	Data
Population	81 million
Population residing in urban area	33%
Major ethnicity (Han)	94%
Minor ethnicities	6%
Territorial size	485,000 km ²
Population density	166 per km ²
Life expectancy	72 years
Illiteracy rate	8.3%
Average size of household (cities)	2.9
Average size of household (rural areas)	3.45
Maternal mortality rate	55.4 /100,000
Infant mortality rate	15.5/10,000
Hospital bed available	2.34/1,000
Health technician available	2.89/1,000
Registered physician available	1.03/1,000

Table 1 Sichuan's population and health services in 2008

Sources:

Dai X, Shen J, Zhao W, Jian Y, Jiang H. Phase repost of medical treatment in Sichuan Province,

China after the Wenchuan earthquake. J Evid Based Med. 2009;2:107-14.

National Bureau of Statistics of China. [2005 Sichuan Province economic and social development

statistical bulletin] (2005年四川省国民经济和社会发展统计公报) [Internet]. 2005 [cited 2014 Dec

19]. Available from: http://www.xbjcyc.cn/ShowArticle2008.asp?ArticleID=81378. Chinese.

National Bureau of Statistics of China. [Table 1-2 Gender and household registration status of populations in Provinces, Autonomous Regions and Municipalities] (表 1-2 省、自治区、直辖市的分性别、户口登记状况的人口) [Internet]. 2001. Available from:

http://www.stats.gov.cn/tjsj/ndsj/renkoupucha/2000pucha/html/t0102.htm. Chinese.

Sichuan Statistics Information Network. [Sichuan Province population censes bulletin] [Internet].

2010 [cited 2010 Sep 21]. Available from: http://www.sc.stats.gov.cn. Chinese.

Sichuan Statistics Information Network. [Sichuan Province population censes bulletin] [Internet]. 2005 [cited 2010 Sep 21]. Available from:

http://www.sc.stats.gov.cn/Select.asp?Tag=8041&File=Info/gb/2005_1.htm. Chinese.

Sichuan Provincial People's Government. [Sichuan population density ranks No. 22] [Internet]. 2011 [cited 2014 Jul 23]. Available from:

http://www.sc.gov.cn/10462/10883/11066/2011/6/22/10166472.shtml. Chinese.

UNICEF China. UNICEF China Sichuan earthquake one year report [Internet]. 2009 [cited 2014 Dec

1]. Available from: http://www.unicef.org/eapro/UNICEF-

China_Sichuan_Earthquake_One_Year_Report.pdf

Sichuan is located in the earthquake-prone southwest China where the Indo-Australian Plate meets the Eurasian Plate. Topographically, there is a great variation from east to west. Plateaus and mountainous regions are found in west Sichuan, at altitudes over 4,000 metres, while basins and hilly areas mark the east, at altitudes of 1,000 to 3,000 metres. The mountainous western part of the province forms the eastern part of the Qinghai-Tibet Plateau. Plate tectonics movement formed the Longmen Shan fault, which is the north-easterly mountain location of the 2008 Sichuan earthquake. The Sichuan Basin, the Sichuan Northwest Plateau and the Sichuan Southwest Mountains make up the three major parts of the province (7).

According to the sixth national census in 2010, Sichuan is the fourth most populous province-level administrative division with 81 million people, while its population density was 166 people / sq km,

which is 4 people / sq km less than in 2000, 23 people / sq km higher than the national average in 2010 and ranked 22nd nationwide (8)(9)(10). Demographically, 22% of the province's population were in the 0-14 age group, 69% between 15 and 64, and 9% were above 65 years old in 2009. The maternal mortality rate (55.4 per 100,000) and infant mortality rate (15.5 per 10,000) in Sichuan were both above the national averages of 33.6 per 100,000 and 15.3 per 10,000, respectively, particularly the former figure (11)(12).

2.2 Preparedness and resilience

In terms of early warning and long-term preparedness for earthquakes, the China Earthquake Administration established in 1966 is responsible for both making longer term predictions of earthquake occurrence and immediate warning and assessment when an earthquake strikes. Although the administration was not able to predict the 2008 Sichuan earthquake, longer term assessments might provide an opportunity for retrofitting old buildings.

Regarding preparedness for the immediate relief response as the second phase in the disaster cycle model, the China International Search and Rescue Team (CISAR) of the Chinese government was established on 27 April 2001 and belongs to the International Search and Rescue Advisory Group of the United Nations (INSARAG). It consists of 220 members and matches the major criteria of heavy teams under INSARAG External Classification Urban Search and Rescue (IEC USAR). Over the years, CISAR has responded to many local and international disaster relief needs (13). On the non-government side of disaster preparedness, while NGOs in China have paid some effort to promote community preparedness, there is limited documentation on the effectiveness of such interventions.

A more systematic development of China's disaster and emergency management system started in 2003 after the SARS epidemic, when emergency response plans, laws and regulations were introduced. In January 2006, the State Council issued the "National Master Plan for Responding to Public Emergencies". It is the overall framework applicable to government agencies at all levels to ensure public security in emergency incidence (14). One year later in 2007, the first nation-wide

"emergency response law" - "The Law of the People's Republic of China on Emergency Responses" came into force (15). It is an important milestone since this law is the legislative foundation of China's emergency response system (see Appendix I for the organizational chart of this system). Sectoral and local specific emergency plans were developed and issued in response to this national policy.

The local-level resilience in the rural area was low in terms of response capacity to handle any disturbances in function, due to weak health infrastructure. Local healthcare service professionals were in shortage in many rural areas. Emergency medical services, which were considered as the most important health relieving force post-disaster, were only stationed at the county level. The large service covering area and poor conditions of road complicated timely professional medical response to those communities after disasters struck. Due to this poor resilience at local level, the disaster rapid response work was mainly carried out by the People's Liberation Army (PLA) and the People's Armed Police (PAP). The excellent performance of PLA and PAP was acknowledged by many western countries in previous disasters such as the Yangtse floods in 1998. The centralised political system provides a certain level of resilience against disasters and ensures a very determined and efficient effort when the services are needed.

Compared to the strong capacity of government, the community coping measures and preparedness are considered inadequate. A very low proportion of the population is able to perform first aid and basic life support, which increases the vulnerability when external relief is not available. Sichuan is a province with a high proportion of ethnic minorities and low income communities. Low education levels and poverty result in both low resilience in terms of absorbing capacity and buffering capacity, as well as restricted efforts in enhancing local disaster preparedness level in terms of knowledge and resources.

2.3 Hazard, vulnerability and risk

China and its western provinces face high hazard of earthquake and its associated risks. According to the international disaster database of Centre for Research on the Epidemiology of Disasters (CRED), four of the 10 earthquakes with the highest death tolls for the past century occurred in China (16). Geographically, it was found that earthquakes regularly affected the vast Tibetan plateau, western Sichuan Province and southwest Yunnan Province where the Indian tectonic plate meets the Eurasian plate, but were relatively rare in central China and along the eastern seaboard.

Chinese population in the earthquake-prone provinces face high health risk resulting from the interaction between earthquake hazard and vulnerable local conditions. Previous earthquakes in China have caused large numbers of deaths at the extremes of age. As vulnerable conditions increasing the susceptibility of communities to the impact of earthquake, poor anti-seismic capacity of buildings and high population density were the leading causes of death in earthquakes of lower and higher intensities in China, respectively. Long-term health risks faced by earthquake victims include renal problems, mental health issues and even lower cognitive function among babies *in utero* in the second or third trimester during the earthquake (17).

Apart from historical geophysical disaster proneness, mountainous landscapes make Sichuan Province vulnerable to landslide, blockage of rivers and the formation of quake lakes, which expose its population to the risk of secondary disasters and create additional difficulties for relief and rescue. Moreover, the fact that buildings in the earthquake-struck areas of Sichuan were not properly reinforced with steel beams might have led to a high number of structural collapses, which resulted in high vulnerability to disaster risk (18). In addition, increased population due to immigration in recent years contributes to the province's exposure to natural hazards, and thus the increased disaster risk.

3. Health Crisis and Critical Health Events

3.1 Primary event

The earthquake occurred at 14:28 on 12 May 2008 as a result of a motion of a northeast striking reverse fault or thrust fault on the north-western margin of the Sichuan Basin. With a magnitude (M_w)

of 7.9 and a depth of 19km, the epicentre was located at 30.986°N, 103.364°E in Eastern Sichuan, 80km from the provincial capital Chengdu. The maximum local intensity was measured at XI in Wenchuan area (19). The onset of the earthquake was sudden, with a brief total duration of the rupture being around 120 seconds long and most severe in the first 80 seconds (20).

3.2 Secondary events

Secondary events were reported to be the major problems that hindered rescue and relief efforts after this earthquake. A total of 20,964 aftershocks varying in magnitude were recorded by 30 July 2008, the strongest one recorded a magnitude of 6.4 (21). With rain and adverse weather, there were 5,000 secondary geological disasters recorded, including landslides. Due to the terrain, quake lake formation and the fear of flooding had forced the evacuation of rescue teams early on in the post-disaster phase. It was reported that a total of 72,000 people were evacuated for quake lakes and landslides, which created further problems associated with the displaced population, including shelter and socioeconomic recovery (22).

4. Damage & Consequences of Damage

4.1 Damage and disturbances (human)

I. *The human toll* was reported to be more than 87,000 deaths and more than 45 million people, making it the eighth deadliest of all recorded earthquakes (23). Students accounted for 7% of the deaths in Sichuan Province. The table below shows that the number of deaths in this Sichuan earthquake ranks the third among the seven most deadly earthquakes between 2001 and 2011, and the total number affected is the highest.

Table 2 Seven most deadly earthquakes, 2001-11

Table: Seven most deadly earthquakes, 2001-11

	Date	Estimated death toll	Total number affected	Mortality rate	Estimated damage (US\$, million)
Léogâne near Port-au-Prince, Haiti	Jan 12, 2010	222 570	3700000	6.02%	8000
Off the west coast of Aceh, Sumatra, Indonesia*†	Dec 26, 2004	165708	532 898	31.10%	4451.6
Wenchuan county, Sichuan province, China	May 12, 2008	87 476	45 976 596	0.19%	85000
Muzzafarabad, Kashmir, Pakistan	Oct 8, 2005	73 338	5128309	1.43%	5200
Off the east coast of Tōhoku, Japan*	March 11, 2011	28050	492 000	5.70%	309 000
Bam, Kerman province, Iran	Dec 26, 2003	26796	267628	10.01%	500
Gujarat, India	Jan 26, 2001	20005	6321812	0.32%	2623
Each earthquake is defined by its epicentre people missing or killed. Mortality rate is p taken from EM-DAT, the International Disa †Data for this earthquake are for Indonesia India (16 389), and Thailand (8345).	e, but data are for th ercentage of people aster Database. ¹ *Da a only; other countr	e entire count e missing or de amage caused ies affected inc	ry. Estimated de ead of the total by tsunami rath cluded Sri Lanka	eath toll is nu number affect ler than by sha l (35399 miss	mber of ted. Data aking ground. sing or killed),

Source: Zhang L, Liu X, Li Y, Liu Y, Liu Z, Lin J, et al. Emergency medical rescue efforts after a major earthquake: lessons from the 2008 Wenchuan earthquake. Lancet. 2012;379(9818):853-861.

II. *Traumas and injuries* accounted for most of the medical problems present and were also the major causes of deaths. The prevalence of crush syndrome, which is a complication resulting from prolonged entrapment commonly seen in earthquakes, was reported to be around 1% (23).

III. *Infections* were suspected among some earthquake survivors and thus specimens were taken from wound secretions, sputum or blood for cultures (24). In addition to timely wound debridement and appropriate antibiotics, tetanus infection was a major health concern for earthquake victims who had not been immunised.

IV. *Chronic diseases* like stroke and heart diseases were among the top causes of deaths in Sichuan Province in 2008 (25). Chan found that 38% of those requiring operations within the first week of the earthquake needed management of their pre-existing, unstable chronic medical conditions. During the second week, over 50% of them required treatment for chronic disease exacerbation. (26)

V. *Maternal child health*: A study of the Sichuan earthquake showed an increase in the number of premature birth, low birth weight and newborns with low Apgar scores (i.e. scores calculated based on appearance, pulse, grimace, activity and respiration). According to a report from the United Nations Children's Fund (UNICEF) in China, a survey completed in August 2008 found 63% of children age 6-24 months in two of the affected counties Beichuan and Lixian had anaemia, which was twice the national average in rural areas. The prevalence of stunting among infants and young children was 13.9%, and that of underweight was 9.1%. Earlier surveys in 2006 found that less than 40% of infants in the poorest rural areas of Sichuan were exclusively breastfed during the first six months of life and only 32-55% of surveyed children in the earthquake-affected areas received the necessary vaccines, far below national averages. The vulnerable pre-existing health status of the population might deteriorate after the earthquake (27).

VI. *Mental health*: For the Sichuan earthquake, studies have found that the prevalence of posttraumatic stress disorder (PTSD) was 45.5% among survivors in Beichuan County, and that PTSD was associated with low family income, being a member of an ethnic minority, living in temporary housing, suffering from household damage and death in family (28)(29). In another study looking into PTSD among healthcare workers after the Sichuan earthquake, PTSD was found among 19% of them and associated with female gender, lower educational levels, being bereaved and witnessing deaths or seeing corpses (30).

4.2 Damage and disturbances (environment)

Total economic losses to both insured and uninsured properties arising from the earthquake were likely to exceed RMB 140 billion (USD 20 billion) (31). For the average household, direct losses were estimated at USD 3,500 per household, which amounted to 10-15 times of their annual household income. The Chinese government reported that at least 10 million people fell below the poverty line as a result of the Sichuan earthquake (22). It was estimated that 80% of the medical institutions in Sichuan were damaged. In some worst-hit areas, 67.5% of the medical buildings

collapsed. Moreover, infrastructures like roads and transportation, agriculture assets and mobile communications were severely affected. Around 28,000 base stations for mobile networks were damaged (22), which caused problems for the coordination of the relief response and the reporting mechanisms of the disease surveillance systems.

5. <u>Responses</u>

5.1 Relief responses

The Chinese government mobilised 137,000 soldiers and 150,000 volunteers for rescue actions. The People's Liberation Army often plays an important role in disaster relief as highlighted by a government white paper published in 2011 (32). Non-food items including 1.57 million tents, 4.86 million blankets, 1.46 megatons of fuel were distributed and 1 million temporary shelters were built. In contrast to other Asian relief settings, highway travel was well managed by troops, with no traffic or security problems (26).

A Lancet study published in 2012 has provided a general description of the response (23). Compared with other major disasters, there was not a major involvement of the United Nations in the Sichuan earthquake relief response. US\$ 230 million were raised from the international community including US\$ 8 million from the UN Central Emergency Response Fund. There were no cluster meetings and little international NGO participation. There was no evidence of employing SPHERE standards or other common humanitarian relief guidelines. There was strict traffic and supply chain management from the government authorities with efficient management of in-kind donations from the international community. Maintenance of security has been a key focus with a strict regulation of people movement (33), which hindered the involvement of international NGOs. This concerted relief effort from a centralised authority was what went well in the relief response, while more attention could be paid to employing international relief guidelines on the provision of basic necessities to ensure post-disaster health of disaster victims.

Because of the limited medical resources available in the disaster-affected areas, patients injured in the earthquake were triaged in frontline hospitals, stabilised and transferred to tertiary hospitals either in Sichuan or other provinces so as to achieve efficient care. But this has also raised issues with the care and the rehabilitation of the victims and their families. In the Children's Hospital of Chongqing Medical University, where injured children were transported from the quake areas for timely and optimal care (34), 50 of the 98 injured children admitted were diagnosed with wound infection. The high rate of wound infection was associated with prolonged extrication, heavily contaminated wounds, late treatment with poor debridement in the initial stage, poor environmental factors and an immune-compromised state. This suggests that more locally-based preparedness and medical response capacity should be developed in the future, which is an area that could be improved.

Although infectious diseases are feared in the aftermath of major earthquakes and lay people often associate the presence of dead bodies with the spread of infectious diseases, infectious diseases were not a major issue following the 2008 Sichuan earthquake. The Chinese government did implement extensive infectious control measures including spraying disinfectants, eradicating vectors and mass vaccinations of hepatitis A, Japanese encephalitis, etc. Infection control teams from hospitals outside the earthquake-struck areas were sent to carry out environmental measures and disease surveillance.

5.2 Recovery responses

Recovery in general can be divided into three categories including physical recovery, livelihood recovery and psychosocial recovery. The recovery process is not limited to health but a wide range of rehabilitation, which is at the last stage of disaster cycle model. It provides long-term strategic development, including economy, land development, transportation network and the associated physical infrastructure, as well as environmental matters including water bodies and waste management. This subsection will focus on two specific areas, while a more general discussion will be carried out in Section 7.

I. Pairing aid system

The Chinese government formed the National Post-earthquake Reconstruction Planning Group with a three-year master plan for rehabilitation and reconstruction involving 35 government departments. A special feature of the recovery process that went well was the twinning of the cities so that each disaster-hit city in Sichuan was directly supported in its development process by another city in another province or by the whole province. For example, Wenchuan County was paired up with Guangdong Province, not only in a symbolic way but also in terms of financial and technical supports.

II. The United Nations Development Programme

The United Nations Development Programme provided support in livelihood assistance early on after the earthquake. The adoption of the participatory approach in early recovery is to be praised, which involved villagers in the reconstruction of roads and infrastructures under a cash-for-work scheme, as well as training in basic safe building skills supplemented with micro credit mechanisms and village self-help funds for villagers to rebuild their livelihood (22).

6. Development

China's Actions for Disaster Prevention and Reduction

After the Sichuan earthquake, the determination of the Chinese government in enhancing disaster preparedness and disaster risk reduction was highlighted by the first white paper of its kind titled "China's Actions for Disaster Prevention and Reduction" published on 12 May 2009, the first anniversary of the Sichuan earthquake. That day was named the "Disaster Prevention and Reduction Day" and activities including drills have been held on this day subsequently to emphasise the importance of preparedness activities (35). Some schools reported that the importance of holding evacuation drills twice each term was demonstrated in the Sichuan earthquake, which helped minimise the time required for evacuating the students safely (36).

7. Discussion

The following discussion will look at the Sichuan earthquake response and recovery from physical, mental and social health perspectives.

7.1 Physical health

I. Addressing primary care issues and chronic diseases

Primary care issues and chronic diseases may not be directly caused by disasters, and are thus often neglected during emergency relief. The disease patterns of different disasters in recent years are summarised in the table in Appendix II (37)(38)(39)(40)(41). Findings in these studies echo research findings of developed nation-based rescue efforts in the United States. Most frequently applied treatments post natural disasters were antibiotics (20.2%), analgesia (17.1%), tetanus vaccine (15.5%) and wound care (14.2%) (42). These research-based studies confirm that regardless of the stage of economic development of a country, primary care and chronic illnesses are common aspects that must be covered post disasters, as local primary care services for the general population may be disrupted. This is also important from the perspective that chronic diseases may have been exacerbated after the occurrence of disasters, especially if survivors no longer have access to their usual medications in emergency settings.

As China was experiencing the double burden of disease post disasters, there was a great need for healthcare workers to manage chronic diseases and treat complications to prevent excess mortality of the disaster-affected population. To explore why chronic conditions were forgotten in relief response, a number of factors were identified in the Sichuan earthquake, including technical and recipient factors, as well as those related to relief responders. From the technical side, the medical relief team composition prevented effective management of chronic diseases (26). Apart from a lack of standard guidelines to support the frontline staff, there was also a lack of general internal medicine and primary care professionals, such as anaesthesiologists who assist operations or manage pain control, and generalist physicians who manage underlying common chronic medical conditions, especially in more remote areas (26). In some sites, although the patient to doctor ratio was 1 to 3, about 80% of them were orthopaedic surgeons (26). Regarding the recipient side, there was resistance to chronic conditions treatment due to the lack of understanding and financial barriers. From the responders' side, there was a lack of operation mandate, political pressure not to act, competing priorities in the field and a lack of awareness among the frontline responders.

Chronic diseases can lead to secondary diseases and pose a burden on the medical services. Medical rescue teams should prioritise chronic diseases handling. To deliver services for patients of chronic diseases effectively, protocols and guidelines should be made available, including assessment tools and the necessary equipment. Training to increase the awareness of these issues among the public, including the diet and family support for necessary target groups, would be essential in order to reduce complications from these diseases.

II. Realistic risk estimation for infectious disease and good precautionary measures

A review of more than 600 disasters since 1985 by Active Learning Network for Accountability and Performance in Humanitarian Action (ALNAP) found only three incidents of epidemic outbreak (43). However, deployment of precautionary measures remains important. Common infectious diseases such as influenza were often neglected during the relief process, while they can easily spread within the disaster region. The spread of a variety of infectious diseases could be controlled by continuous training on preventive measures including site planning, clean water and good sanitation, adequate nutrition, vaccination, vector control, personal protection and hygiene, health education and case management (44).

III. Ensuring good tetanus vaccine coverage

Apart from the importance of the vaccine coverage for infectious diseases, the need of adequate tetanus vaccine coverage is essential for post-earthquake injuries. The tetanus coverage was found to be inadequate especially for the elderly population after the Sichuan earthquake: 78% of the population older than 60 years old were not vaccinated (26). They faced not only the typical needs after an earthquake related to orthopaedic trauma, but also the continuing needs for clinical management of complex chronic conditions (26).

Tetanus in new-born is still a problem in rural China where the home delivery conditions are not satisfactory. The need of tetanus prevention in disasters was also highlighted in a study looking at the

health impact of the 2004 tsunami in Indonesia, which found low coverage for tetanus vaccination as well (45).

7.2 Mental health

Mental wellbeing is often a neglected area in the emergency phase of disasters because the treatment of physical injuries is usually prioritised. However, looking at the longer-term outcomes, the prevalence of PTSD among villagers who suffered from an earthquake in northern China was found to be 18.8% in three months and 24.2% in nine months. The diagnosis of mental diseases such as depression and post-traumatic stress disorder is also difficult as the Chinese more often present with somatic symptoms. Many studies found high prevalence of mental illness: as high as 49.6% of victims suffering from depression (23).

A study of the Sichuan earthquake found that residents living closer to the epicentre reported less psychological distress (46). This may be accounted for by better governmental and social support and mental health programmes, which have provided better recovery support. In contrast, the lack of experience and training in mental-health needs may limit patient care and sensitivity in this phase of the emergency response, especially in rural areas.

The use of Psychological First Aid (PFA) by community members has been promoted in disasteraffected communities (47), including a training course provided by some Red Cross societies. PFA or the model of "listen, protect and connect" promotes social connection and empowers victims with the knowledge of psychological stress and grief reactions. It is believed that resilience varies among individuals but most survivors with normal stress reactions do not require consultation with psychiatrists and clinical psychologists, but need good psychosocial support.

In addition, concerning victims under bereavement, it is advocated that rushing to bury the dead can be associated with worse mental health outcome, and thus giving time for the living to bury the dead is recommended (43).

7.3 Social health

Relocation and social health

Social network is very important from a public health perspective. It is found that relocation, which affects the social network, has a profound impact on the livelihood and psychosocial recovery. Frequently have survivors been relocated to areas well equipped with facilities and infrastructures but separated from their neighbours and social networks. These survivors usually move from their farmland to cities. They may also be isolated, with limited access to community facilities and support including schools and job opportunities. For instance, relocated farmers are often required to change their occupations and sources of income, which creates psychological and socio-economic burdens. Furthermore, land ownership issues might arise from temporary relocation and land development procedures. Two major public health related recommendations deserve attention.

• Detailed planning and support essential to livelihood recovery:

Livelihood recovery has a deep impact on psychosocial recovery. Micro credit and early livelihood assistance are essential to prevent further asset erosion for the survivors. Under the Chinese government policy, disaster victims who have secured employment would receive smaller amount of subsidies from the government, but the received salary is usually not enough to support their living. Cash-for-work, specific training and job opportunity provision for survivors will enable them to feel empowered without a sense of remaining victims requiring external support.

• Flexibility in shelter reconstruction:

It was observed that although the Chinese government provided subsides for housing reconstruction and prototypes for housing designs which could better withstand earthquakes, victims were not all satisfied with their shelter reconstruction. Rural victims of various family sizes may have different requirements according to their personal living conditions, and there was often a significant amount of reconstruction cost to be paid out of pocket by the victims.

Flexibility and the use of participatory approaches will increase the ownership and the satisfaction among the victims.

7.4 Others

7.4.1 Involvement of outside support

I. Armed forces and volunteer contributions in rescue

According to the disaster cycle model suggested above, there are five stages post disasters (48). During the phase of immediate relief response after the Sichuan earthquake, armed forces and a high number of volunteers played an important role in rescue. Through the deployment of the armed forces and the use of volunteers from all over the country, a coordinated effort ensured that the rescue was conducted and basic needs were met within the shortest time possible. However, it should be emphasised that there is no statistics showing how many soldiers and volunteers have actually contributed to post-disaster public health efforts. Therefore, it is difficult to evaluate the contribution of human resources towards health issues.

II. Little international involvement

Due to political and security reasons, there was little international involvement especially at the stage of emergency relief. However, international involvement in natural disaster response can help evaluate disaster management, which is important for future reference and improvement.

7.4.2 Communication

Information is one of the five basic human needs required to maintain health post disasters. Communication is a key factor to provide adequate information and maintain a comprehensive system of response. Firstly, good communication between the government and the public is necessary to pass on a wide range of information, such as safety issues, water usage and security, to the public during disaster response. Secondly, more guidelines should be passed from the government management team to volunteers. Chan mentioned that dozens of relief teams from other provinces were not given official facilitation to reach the relief sites (26). No civilian air travel was granted into the disaster area. Besides, volunteers had a lack of medical knowledge, and often found it difficult to contribute to public health issues. Lastly, media could be better used as a source to monitor the government, to prevent corruption and resources misuse, as well as to spread information to the general public.

7.5 Evaluation and limitations

I. Overlapping phases in the disaster cycle

The model of disaster cycle contributes to the management of disaster response. It could be used as a reference by the authorities to take actions in disaster response. However, it may not be entirely applicable in reality. Ideally, with a clear distinction between the emergency relief and the recovery and rehabilitation phases among the relief agencies, the survivors on the ground could also make such a clear division. However, the phases could be overlapping in reality, e.g. when farmers recover their assets after the earthquake and maintain their basic needs, they are restoring and improving their living conditions at the same time (43).

II. Public health principles and models

The public health principles of securing basic human needs required to maintain health have been generally discussed in the study, while the principles of determining the current and the likely health threats to the affected community, as well as acquiring and providing resources, can be further evaluated.

There are limited theories concerning the disaster management of earthquakes from the perspective of public health. Although the disaster cycle model suggests different stages in disaster management, the concrete description of each stage is unclear. It would help the government and management team to identify the phases of the situation and the required actions if there are better guidelines.

III. Framework for disaster report writing

The "Guidelines for Reports on Health Crises and Critical Health Events" framework was used as a reference in the report writing (1). However, the information available for describing a natural disaster

may not fulfil all elements required by the framework. Moreover, some parts are too general for discussion. For instance, "vulnerability" can include sub-sections such as "surge capacity", "building standard" and "human resources availability" in future studies.

8. Lessons Identified and Actions Recommended

8.1 Pre-event preparedness

The government's framework emergency response plan, law and regulations tend to be more theoretical than practical. Lack of detailed response schemes makes it difficult for local governments to execute them effectively. Disaster response is a complex operation, which requires close collaboration of different government agencies. The overall coordination was weak and led to a less-than-well-organised effort during the first few days after the Sichuan earthquake. Local mechanisms of receiving relief personnel and materials were not clear enough, and rescue teams were working separately without a unified dispatching platform (49). More detailed response schemes with action guidelines are needed for practical functioning and coordination of relief efforts in case of emergency response.

The publishing of a white paper titled "China's Actions for Disaster Prevention and Reduction" by the Chinese government on 12 May 2009 and the proclamation of this day as a "Disaster Prevention and Reduction Day" highlighted the Chinese government's increased determination and focus on disaster preparedness and reduction.

8.2 Physical health

Primary care issues and chronic diseases are often neglected during emergency relief. However, studies of disease patterns summarised in the Appendix II confirmed their commonness in disasters (37)(38)(39)(40)(41). Therefore, emergency relief should emphasise and prioritise service delivery for chronic diseases to avoid their exacerbations and their burden on the medical system, as well as to prevent secondary diseases. Protocols and guidelines should be put in place, coupled with policy support, in order to establish a solid operation mandate and to adequately compose medical relief

teams, allowing for effective chronic disease services. Training targeting the public as well as frontline responders would increase their awareness of the issue of chronic diseases and reduce complications leading to excess mortality.

Although incidents of epidemic outbreaks following disaster are rare (43), precautionary measures and training on preventive measures remain important and could control the spread of a variety of infectious diseases (44). Inadequately low tetanus vaccine coverage, especially among vulnerable populations (26), should be addressed.

8.3 Mental Health

As mental well-being in the emergency phase of disasters is often neglected and prevalence of mental illness among victims of the earthquake has been observed, mental health should be prioritised and integrated further into relief and recovery responses (23). The promotion of Psychological First Aid (PFA) and the training of community members in it should be advanced (47), as well as good psychosocial support created to deal with normal stress reactions. Furthermore, adequate time for proper burying of the deaths should be allowed for to improve the mental health outcome of survivors (43).

8.4 Social Health

Planning of relocations after disasters, if necessary, should take into account the effect on social networks and impact on the livelihood and psychosocial recovery of survivors.

Livelihood recovery has a strong influence on psychosocial recovery; micro credits and early livelihood assistance play an essential role to prevent further asset erosion for the survivors. Cash-for-work, specific training and job opportunities can be sources of empowerment for survivors.

Government-provided subsidies for housing reconstruction and prototypes for housing design should allow enough flexibility to accommodate individual living conditions and incorporate participatory approaches to increase ownership and satisfaction among victims.

Relevant guidelines should be communicated in a comprehensive and appropriate manner from the government management team to volunteers. Suitably skilled volunteers, able to contribute to public health issues, should be officially facilitated to reach relief sites.

8.5 Public health principles and models

One has to acknowledge and be aware of limitations when using the disaster cycle model as a reference and applying its theoretical framework in practice, since overlapping phases might not allow for a clear distinction among emergency relief, the recovery and rehabilitation phases. A concrete description of each stage in the disaster cycle model through more precise guidelines is needed to allow authorities to identify the phases of the situation and required actions.

9. <u>Conclusions</u>

In conclusion, key lessons learnt from the 2008 Sichuan earthquake are identified in this study. From a physical health perspective, protocols and guidelines should be made available to increase the awareness of addressing chronic diseases among medical teams and the general public. Apart from that, continuous training on preventive measures is necessary to prevent common infectious diseases such as influenza. Moreover, good tetanus vaccine coverage should be ensured, especially among the elderly. From a mental health perspective, there is a lack of experience and training in meeting mental health needs. Psychological First Aid can be employed when addressing these issues. From a social health perspective, social networks and the socio-economic burden of survivors should be considered when planning for relocation and reconstruction. Moreover, international involvement, better communication at all levels and the adoption of international relief standards can help promote a comprehensive system of disaster response. Finally, while the preparedness and resilience at the central level was quite high and kept improving after the earthquake, the local community-level vulnerability, preparedness and resilience had much room for improvement.

10. <u>References</u>

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- Kulling P, Birnbaum M, Murray V, Rockenschaub G. Guidelines for reports on health crises and critical health events. Prehospital disaster Med Off J Natl Assoc EMS Physicians World Assoc Emerg Disaster Med Assoc with Acute Care Found. 2010;25(4):377–83.
- Paul B. Responding to disasters. In: Oxford Handbook of Public Health Practice. 2nd ed. Oxford University Press, USA; 2006. p. 383–5.
- 3. Pan American Health Organization. Emergency Health Management After Natural Disaster. Washington, DC: Office of Emergency Preparedness and Disaster Relief Coordination; 1981.
- 4. The Sphere Project. Humanitarian charter and minimum standards in humanitarian response [Internet]. The Sphere Project. 2011. 402 p. Available from: http://www.spherehandbook.org
- 5. World Health Organization. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York. In: Official Records of the World Health Organization. 1946. p. 100.
- 6. Acheson D. Public health in England: the report of the Committee of Inquiry into the Future Development to the Public Health Function. Her Majesty's Stationery Office. London, England; 1988.
- 7. Sichuan Provincial People's Government. Geographic Location and Natural Condition. 2013.
- National Bureau of Statistics of China. Populous province, autonomous regions and municipalities sex, household registration status (省、自治区、直辖市的分性别、户口登记 状况的人口). 2001.
- 9. National Bureau of Statistics of China. Communiqué of the National Bureau of Statistics of People's Republic of China on Major Figures of the 2010 Population Census[1] (No. 2). 2011.
- 10. Sichuan Provincial People's Government. Sichuan population density ranks No. 22. 2011.
- 11. UNICEF China. Mothers of mercy. 2009.
- 12. World Health Organization. Global Health Observatory Data Repository: Probablity of dying per 1000 live births (China). 2014.
- 13. The International Serach and Rescue Advisory Group. Office for the Coordination of Humanitarian Affairs. United Nations (INSARAG). The INSARAG search and rescue directory. 2012.
- 14. Central People's Government of the People's Republic of China. National master plan for responding to public emergencies (国家总体应急预案). 2005.
- 15. Central People's Government of the People's Republic of China. The Law of the People's Republic of China on Emergency Responses (中华人民共和国突发事件应对法). 2007.
- 16. EM-DAT. The OFDA/CRED International Disaster Database. 2012.
- 17. Chan E, Gao Y, Griffiths SM. Literature review of health impact post-earthquakes in China. J Public Health (Bangkok). 2010;32(1):52–61.
- 18. Stone R. Sichuan disaster: Landslides, flooding pose threats as experts survey quake's impact.

Science (80-). 2008;320(5879):996-7.

- 19. U.S. Geology Survey. Earthquake: magnitude 7.9 Eastern Sichuan, China. 2008.
- 20. China Earthquake Administration. Analysis of the cause of Wenchuan earthquake (汶川8.0级 地震成因分析). 2008.
- 21. Sichuan Earthquake Information Network. News. 2008.
- 22. United Nations Development Programme in China. Early recovery and disaster risk management program: Sichuan earthquake, China, July 2008 [Internet]. 2008. Available from: https://info.undp.org/docs/pdc/Documents/CHN/00050752_PRODOC.pdf
- 23. Zhang L, Liu X, Li Y, Liu Y, Liu Z, Lin J. Emergency medical rescue efforts after a major earthquake: lessons from the 2008 Wenchuan earthquake. Lancet. 2012;379(9818):853–61.
- 24. Wang Y, Hao P, Lu B, Yu H, Huang W, Hou H, et al. Causes of infection after earthquake, China. Emerg Infect Dis. 2010;16(6):974–5.
- 25. Sichuan Statistics Information Network. Sichuan statistics yearbook 2008. 2008.
- 26. Chan E. The untold stories of the Sichuan earthqauke. Lancet. 2008;372(9636):359–62.
- 27. United Nations Children's Fund (UNICEF). UNICEF China Sichuan earthquake one year report. UNICEF China. 2009.
- Kun P, Chen X, Han S, Gong X, Chen M, Zhang W, et al. Prevalence of post-traumatic stress disorder in Sichuan Province, China after the 2008 Wenchuan earthquake. Public Health. 2009;123(11):703–7.
- 29. Kun P, Han S, Chen X, Yao L. Prevalence and risk factors for posttraumatic stress disorder: a cross-sectional study among survivors of the Wenchuan 2008 earthquake in China. Depress Anxiety. 2009;26(12):1134–40.
- Wang L, Zhang J, Zhou M, Shi Z, Liu P. Symptoms of posttraumatic stress disorder among health care workers in earthquake-affected areas in southwest China. Psychol Rep. 2010;106(2):555–61.
- 31. Shen-tu B, Lai T. The Wenchuan Earthquake. Air Worldwide Corporation. 2008.
- 32. Central People's Government of the People's Republic of China. China's armed forces play important role in disaster relief: white paper. 2011.
- 33. Hoyer B. Lessons from the Sichuan earthquake. Humanitarian Exchange Magazine. 2009.
- Ran Y, Ao X, Liu L, Fu Y, Tuo H, Xu F. Microbiological study of pathogenic bacteria isolated from paediatric wound infections following the 2008 Wenchuan earthquake. Scand J Inject Dis. 2010;42(5):347–50.
- 35. Central People's Government of the People's Republic of China. China's actions for disaster prevention and Reduction: white paper. 2009.
- 36. Li J. The improvement of public emergency response management system of schools: the experience of Sangzao school in Wenchuan earthquake. J Yibin Univ. 2011;11:81–2.
- 37. Salinas C, Kurata J. The Effects of the Northridge Earthquake on the Pattern of Emergency

Department Care. Am J Emerg Med. 1998;16(3):254-6.

- 38. Kwak Y, Shin S, Kim K, Kwon W, Suh G. Experience of a Korean disaster medical assistance team in Sri Lanka after the South Asia tsunami. J Korean Med Sci. 2006;21(1):143–50.
- Guha-Sapir D, Van PW, Lagoutte J. Short communication: patterns of chronic and acute diseases after natural disasters - a study from the International Committee of the Red Cross field hospital in Banda Aceh after the 2004 Indian Ocean tsunami. Trop Med Int Heal. 2007;12(11):1338–41.
- 40. Chan E, Kim J. Remote mobile health service utilization post 2005 Kashmir-Pakistan earthquake. Eur J Emerg Med. 2010;17(3):158–63.
- 41. Kim H, Han S, Kim J, Kim J, Hong E. Post-Nargis medical care: experience of a Korean Disaster Relief Team in Myanmar after the cyclone. Eur J Emerg Med. 2010;17(1):37–41.
- 42. Nufer K, Wilson-Ramirez G, Shah M, Hughes C, Crandall. CS. Analysis of patients treated during four Disaster Medical Assistance Team deployment. J Emerg Med. 2006;30(2):183–7.
- 43. Cosgrave J. Responding to earthquakes 2008: Learning from earthquake relief and recovery operations. 2008.
- 44. Connolly M, Gayer M, Ryan M, Salama P, Spiegel P, Heymann D. Communicable diseases in complex emergencies: impact and challenges. Lancet. 2004;364(9449):1974–83.
- 45. Guha-Sapir D, Van PW. Health impact of the 2004 Andaman Nicobar earthquake and tsunami in Indonesia. Prehospital Disaster Med. 2009;24(6):493–9.
- 46. Li S, Rao L, Ren X, Bai X, Zheng R, Li J, et al. Psychological typhoon eye in the 2008 Wenchuan earthquake. PLoS One. 2009;4(3):49–64.
- 47. National Centre for PTSD. Field Operation Guide, Psychological first aid. 2nd ed. 2006.
- Chan EY, Sondorp E. Natural disaster medical intervention: Missed opportunity to deal with chronic medical needs? An analytical framework. Asia Pacific J Public Heal Spec. 2007;(19):45–51.
- Sichuan Earthquake Information Network. Summarise lessons learned from Wenchuan earthquake, improve emergency response capacity (总结反思汶川地震,着力加强应急救援 能力建设). 2011.

11. Appendices

Appendix I: Organisational charts: China's health emergency response system and health emergency response joint coordination mechanism





Health Emergency Response Joint Coordination Mechanism

Source:

Division of Emergency Response, Health Emergency Response Office, National Health and Family Planning Commission. Health emergency management system and mechanism development in China. A presentation at the National Training Workshop for Disaster Health Emergency Management and Humanitarian Response, Tianjin, China. 23 September 2013.

Study	Salinas <i>et al</i> .	Chan and Kin	n (2010)	Guha-Sapir <i>et al</i> .	Kwak <i>et al</i> .	Kim et al. (2010)
	(1998)			(2007)	(2006)	
Disaster	US, Northridge	Pakistan, Kash	mir	South Asia	South Asia	Myanmar cyclone
	earthquake 1994	earthquake 200)5	tsunami 2004	tsunami 2004	2008
Setting	Emergency	Stationary	Mobile	ICRC field	Korean DMAT	Korean disaster
	Department of	clinic	clinic	hospital in Aceh,	team in Sri Lanka	relief team
	Northridge			Indonesia	(Clinic)	(Clinic)
	Hospital					
Disease	Musculoskeletal	Chronic	Infection	Respiratory (21%)	Respiratory (32%)	Musculoskeletal
pattern	(45%)	conditions	(51%)			(21.5%)
		(42%)				
	Respiratory	Infection	Trauma	Chronic (17.3%)	Injury (17.6%)	Respiratory
	(6.5%)	(35%)	(25%)			(15.3%)
	Obstetrics /	Trauma	Chronic	Trauma (9.8%)	Musculoskeletal	Gastrointestinal
	gynaecology	(15%)	condition		(11.6%)	(14.6%)
	(4.9%)		s (21%)			
	Eye (3.1%)	Others (8%)	Others	Psychiatric	Skin (10.9%)	Psychological
			(3%)	(9.7%)		(9%)
	Fever (2.9%)			Gastrointestinal	Gastrointestinal	Skin (7.4%)
				(9.2%)	(5.2%)	
	Skin (1.4%)			Infectious	Eye & Ear, nose	Eye (5.9%)
				diseases (8.4%)	and throat (4.2%)	
	Psychological			Musculoskeletal	Cardiovascular	Neurological
	(0.5%)			(6.4%)	(4.1%)	(4.7%)
				Neurological	Neurological	Cardiovascular
				(3.2%)	(2.6%)	(3.9%)
						Endocrine (2.5%)
						Ear, nose and
						throat (1.9%)
						Obstetric /
						gynaecological

Appendix II: Disease categories seen in various clinical settings post-disaster

Sources:

Salinas C, Salinas C, Kurata J. The effects of the Northridge earthquake on the pattern of emergency department care. American Journal of Emergency Medicine. 1998;16(3):254-256.

Chan EY, Kim JJ. Remote mobile health service utilization post 2005 Kashmir-Pakistan earthquake. Eur J Emerg Med. 2010;17(3):158-163.

Guha-Sapir D, van Panhuis WG, Lagoutte J. Short communication: patterns of chronic and acute diseases after natural disasters - a study from the International Committee of the Red Cross field hospital in Banda Aceh after the 2004 Indian Ocean tsunami. Trop Med Int Health.

2007;12(11):1338-1341.

Kwak YH, Shin SD, Kim KS, Kwon WY, Suh GJ. Experience of a Korean disaster medical assistance team in Sri Lanka after the South Asia tsunami. J Korean Med Sci. 2006; 21(1):143-150. Kim H, Han SB, Kim JH, Kim JS, Hong E. Post-Nargis medical care: experience of a Korean Disaster

Relief Team in Myanmar after the cyclone. Eur J Emerg Med. 2010;17(1):37-41.

Event	• 14.28 12 May 2008:
	Earthquake with magnitude 7.9 on the Richter scale
	• Epicentre:
	30.986°N, 103.364°E in Eastern Sichuan, 80km from the provincial
	capital Chengdu
Damages	• Deaths:
	87,000
	• Number of people affected:
	45 million
	• Medical problems present and major cause of deaths:
•	Trauma and injuries
	• Infections:
	Tetanus infection of significant concern
	Chronic diseases:
	Among top causes of deaths
	• Economic losses:
	> US\$ 75 billion
	• Homes destroyed:
	> 6.5 million
•	• Direct losses per household:
	USD 3,500 (on average)
	• No. of people that fell below poverty line:
	> 10 million
	• Medical institutions damaged:
	80%
	• Mobile network base stations damaged:

Appendix III: 2008 Sichuan earthquake chronological table

	28,000
Defined needs	Search and rescue
	• Timely wound debridement
	• Appropriate antibiotics
	• Management of pre-existing, unstable chronic medical conditions
	• Providing five basic requirements for health
Relief responses	Rescue action:
	137,000 soldiers; 150,000 volunteers
	• Non-food items:
	1.57 million tents, 4.86 million blankets, 1.46 megatons of fuel,1
	million temporary shelters
	• No traffic or security problems
	• USD 230 million raised from the international community
	• No cluster meetings
	Little international NGO participation
	• Guidelines:
	No evidence of employing SPHERE standards or other common
	relief guidelines
	• Triage and stabilisation in frontline hospitals, subsequent transfer to
	tertiary hospitals
	• Infection control teams:
	Environmental measures and disease surveillance
Recovery	Formation of National Post-earthquake Reconstruction Planning Group
responses	• 3-year master plan for rehabilitation and reconstruction involving 35
	government departments
	• Twinning of the cities: financial and technical supports

	•	United Nations Development Programme: support in livelihood
		assistance
Developments	•	Chinese government: Issued white paper titled "China's Actions for
		Disaster Prevention and Reduction"
	•	"Disaster Prevention and Reduction Day" on 12 May: run preparedness
		activities (e.g. drills)

12. <u>Keywords</u>

Crisis event management; crisis management; critical health event; disaster; disaster cycle model; disaster public health; earthquake; emergency; emergency medical service(s); health crisis; Sichuan earthquake

13. Abbreviations

ALNAP	Active Learning Network for Accountability and Performance in
	Humanitarian Action
CISAR	China International Search and Rescue Team
EM-DAT	Emergency Events Database
IEC USAR	INSARAG External Classification Urban Search and Rescue
INSARAG	International Search and Rescue Advisory Group of the United Nations
NGO	Non-governmental organisation
PFA	Psychological First Aid
PTSD	Post-traumatic stress disorder
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WHO	World Health Organization