

# Public health care system's preparedness to combat epidemics after natural disasters

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## ABSTRACT

Disaster management is the execution of various resources and responsibilities that deal with all civilized aspects of tragedies in the consequences of natural or human hazards. There are multiple factors that lead to the outbreak of epidemics after natural disasters, but often the association between natural calamity and the outbreak of epidemics is misconstrued. The health care system of any country has an imperative role in combating the disaster-related epidemics. In developing countries like India, where resources are limited, the public healthcare system plays a vital role against battling epidemics after a natural disaster, hence, preparedness of public health care system to combat epidemics after natural disasters is considered as a narrative review.

**Keywords:** Communicable diseases, epidemics, disaster risk reduction, epidemiology, outbreaks

## Introduction

The term “disaster” designates as a high-impact incident that is responsible for a large number of persons to turn out to be ill, injured, or dead. The International Federation of Red Cross and Red Crescent Societies defines a disaster as an event that causes more than 10 deaths, affects more than 100 people, or leads to an appeal for assistance by those affected.<sup>[1]</sup> Earthquakes, floods, landslides, volcanic eruptions, tsunamis, and drought are some of the common calamities that cause the loss of health and also have socioeconomic consequences.<sup>[2]</sup>

Various disasters such as earthquakes, landslides, and tsunamis are responsible for the spread of communicable diseases.<sup>[3,4]</sup> Diarrhea, acute respiratory infection (ARI), measles, malaria, and malnutrition are the leading causes

of death in any disaster.<sup>[5]</sup> Uttarakhand flash floods in 2013, Sikkim earthquake in 2011, Leh cloudburst in 2010, Karnataka and Andhra Pradesh floods in 2009, Kosi floods in 2008, Kashmir earthquake in 2005, Indian ocean tsunami in 2004, and Bhuj earthquake in 2001 are the examples of few destructive debacles that India faced in the past few years. These disasters are responsible for the explosion of communicable diseases and the occurrence of epidemics.<sup>[6]</sup> The foremost grounds of contagious infections in disasters are contaminated food and water, vector-borne diseases, respiratory infections, and infections due to injuries or wounds. The diarrhea and ARIs are the common causes of morbidity and mortality following disasters. So, disasters give rise to infectious diseases that are of public health concern, but timely and well-coordinated interventions can effectively reduce morbidity and mortality due to infectious diseases.<sup>[7,8]</sup> The public health care delivery system of any country plays an essential role to combat epidemics after a disaster. In developing countries like India, where resources are limited, community health care services should be strong enough to fight against the epidemics of communicable diseases. Hence, this article is considered as a narrative review.

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## Various Disasters and Their Associated Health Risks

Disasters are divided into natural disasters and man-made disasters. As the names entail, natural disasters typically occur by the earth's natural processes while man-made disasters occur due to human error, negligence, or intent.

### A. Cyclone

Air masses that spin around a strong center with low atmospheric pressure generate cyclones. The majority of cyclones arrive from the Bay of Bengal, hit to the east coast of India, and are responsible for a heavy rainstorm in intercostal areas. It is estimated that about 8000 km long seacoast of India is open to 10% of tropical cyclones of the world. Kerala, Gujarat, Andhra Pradesh, Karnataka, Maharashtra, Odisha, and Tamil Nadu are some of the Indian states that are more commonly affected by tropical cyclones.<sup>[9]</sup> Tropical cyclones are associated with the threat of communicable diseases, for example, infectious diarrhea, leptospirosis, dengue, malaria, cholera, ARI, and pulmonary tuberculosis.<sup>[10-12]</sup> For instance, the epidemic of acute diarrhea happened after cyclone "Thane" in India.<sup>[10]</sup> The escalating cases of acute gastroenteritis are reported in Kananga, Leyte, when their residents came back to their home 2 days after Haiyan typhoon.<sup>[13]</sup>

### B. Flood

Floods are a widespread natural calamity happening globally and have a vast range of health impacts with the transmission of various contagious diseases. In 2016, more than 74 million citizens impinged by flooding globally, which lead 4720 demises.<sup>[14]</sup> The flood causes the displacement of people in camps, which are generally overcrowded, which increases the risk of disease outbreaks following the flood. Also, there may be contamination of water with chemicals or fecal material.<sup>[15]</sup> Health effects that are frequently associated with floods are gastrointestinal and respiratory contaminations which are primary sources of death following floods. The lack of personal hygiene and overcrowding enhances the risk of these infections.<sup>[16]</sup> Flooding increases breeding sites for mosquitoes, which leads to rising in mosquito-borne diseases. The spread of viral infections, vector-borne diseases, water-borne diseases and air-borne infections increase during flooding.<sup>[17,18]</sup> Other risk associated with flooding includes drowning and trauma. As tetanus is not generally faced following any injury from flooding, thus mass tetanus vaccination is not required. Hypothermia sometimes is reported predominantly in children, due to being trapped in floodwaters for a longer period.<sup>[19]</sup>

### C. Earthquakes

The main earthquake-prone regions in India are Jammu, Kashmir, the northern region of Bihar, Himachal Pradesh, Uttarakhand, Gujarat, and Andaman and Nicobar Islands. The whole Himalayan region also is exposed to high concentration earthquakes exceeding a magnitude of 8.0 on the Richter scale.

As India has densely populated cities and the buildings in these cities also not have any kind of resistance from the earthquake, thus trembling in these cities would go round into a colossal disaster.<sup>[20]</sup> Kouadio *et al.*<sup>[21]</sup> mention that the building collapse following earthquakes causes trauma or injuries to the people which may lead to the death of the affected population. Also, earthquakes cause displacement of the population, where there is limited availability of safe water and food. Following the earthquakes, water and sanitation system get damaged, which ruins the sanitary conditions of the affected area. The epidemic of various communicable ailments occurred after earthquakes. A study by Sapir *et al.* found an outbreak of cholera, tetanus, trauma, wounds, respiratory infections, malaria, and dengue that occurred after the Andaman Nicobar earthquake in 2004. These diseases have the destructive potential for humanity and recovery from them poses a challenge for every country.<sup>[22]</sup>

In addition to the above three disasters, in the event of a tsunami, major communicable diseases arise such as waterborne diseases including diarrhea, cholera, and measles<sup>[21]</sup> and vector borne diseases namely malaria and dengue. Landslides are significant natural hazards worldwide that is related to the loss of living, individual settlement, agriculture lands, and also spoil the communication systems. In India, the Western Ghats, Himalayan region, and Nilgiri range are mainly affected by landslides. However, no significant documentation is available that shows the association of landslides with infection transmission.

## Types of Communicable Disease After A Disaster

The chief cause of transmissible diseases in disasters is contagious unhygienic food and water. The vector-borne diseases are also common following the disaster. Various routes for the transmission of certain endemic diseases and epidemic-prone diseases are as follow:

### 1. Waterborne diseases

- a. **Diarrhea:** The outbreak of diarrhea occurs due to contaminated drinking water, usually reported after flooding and the displacement resulted from the flood. The risk of diarrhea epidemic after natural disasters is higher in developing countries than in developed countries.<sup>[23]</sup> After flooding in Bangladesh in 2004, an outburst of the diarrheal disease reported that involved more than 17,000 cases, with the isolation of *Vibrio cholerae* (O1 Ogawa and O1 Inaba) and enterotoxigenic *Escherichia coli*.<sup>[24]</sup>
- b. **Hepatitis A and E:** The transmission of these diseases occurred by the faecal-oral route, in liaison with the absence of safe water and cleanliness. Hepatitis A is habitually prevalent in the majority of the developing countries and its outbreaks frequently follow heavy rains and floods.<sup>[25]</sup> An outbreak of hepatitis A and E were recorded among the affected in Banda Aceh (Indonesia) after the tsunami in December 2004.<sup>[26]</sup>

c. **Leptospirosis:** It is a zoonotic disease which is contracted through the mucous membrane or skin by direct or indirect contact (through water or sludge) with the urine of infected rodents.<sup>[27]</sup> Flooding creates favorable situation for leptospirosis infection because due to flooding the urine of animals does not get absorbed in soil or not get evaporated, which leads to the passage of leptospire into the surface water or mud. In India, the outbreaks of leptospirosis occurred following flooding in Mumbai, in 2000.<sup>[28]</sup>

2. **Vector-borne diseases:** Disasters such as flood, hurricane, cyclones increase vector breeding sites and result in an increase in vector-borne diseases after a disaster. In addition to this, there are favorable conditions for the spread of vector-borne diseases exist such as cessation or weakening of ongoing public health activities, displacement, overcrowding, sleeping outside in relief camps, etc.<sup>[2]</sup> Malaria, rabies, dengue, and cutaneous leishmaniasis are some of the vector-borne diseases. The spread of malaria was reported after the earthquake in Costa Rica's Atlantic region in 1991.<sup>[29,30]</sup>

3. **Diseases associated with crowding:** An ARI is a disease that results from crowding, and it is the chief source of illness and death among unsettled people. In disaster situations, there is hampering of routine health care service delivery, and also there is a lack of access to antibiotic drugs, which makes the disease outcome worst. The cases of ARI have been observed in increased number following hurricane Mitch in Nicaragua (1998) and tsunami in Aceh (2004).<sup>[2]</sup> Similarly, measles and meningitis are also transmitted from one person to another in overcrowded conditions.<sup>[31]</sup> Measles outbreaks have been observed after displacement caused by Mt. Pinatubo in the Philippines (1991) and after the South Asia earthquake in Pakistan (2005).<sup>[2]</sup>

4. **Diseases due to wounds:** The potentially noteworthy intimidation to people's suffering any cut, laceration, or abrasion is tetanus, streptococci, and staphylococci.<sup>[32]</sup> The mortality and morbidity associated with tetanus are higher, where routine immunization coverage is low.

5. **Dead bodies and the hazards of transmissible diseases:** Several numbers of demises are allied with any natural disaster. Although no evidence of dead bodies carrying risk of epidemics, but dead bodies carry health risks if death occurred from cholera<sup>[33]</sup> or hemorrhagic fevers.<sup>[34]</sup>

## Epidemiologic Triad

The factors influencing communicable disease transmission after disasters can be explained by the epidemiological triad model. The epidemiological triad model gives rationalization about the relationship and prudence of any diseases. This triad consists of three dynamics—agent, host, and environment. The interfaces between these factors are responsible for the initiation and spread of diseases.

## Agent

In the model of the contagious disease, the term “Agent” denotes microorganism (e.g. virus, bacterium) that is competent to initiate a disease. For the disease to occur, the disease agent must be there. On the other hand, only the presence of the agent is not adequate for the disease to occur.

## Host

“Host” is referring to any inherent factors that influence the immunity of an individual in the revelation, and increase individual's vulnerability for a contributing agent. These causation factors include socioeconomic status, lifestyle, behaviors, psychological characteristics, education, occupation, etc.

## Environment

“Environment” act as the extrinsic feature that influences “Host” and “Agent” for the initiation and spread of any communicable disease. The environmental factors can be physical (e.g. floods, climate, tsunamis), biological factors (e.g. vectors, dead bodies), or socioeconomic factors (e.g. access to health services, sanitation).<sup>[35]</sup>

## Phases of Outbreak and Classification of Infectious Disease

The diffusion of contagious disease occurs in several days, weeks, or even months after the commencement of any calamity. Here, three scientific phases of natural catastrophe are summarized with their public health effects to the injured survivors:

*Phase 1:* It is called the impact phase which lasts up to 4 days, and in this period, victims are rescued and the preliminary phase of the treatment starts.

*Phase 2:* This phase is called the post-impact phase, which lasts from 4 days to 4 weeks. In this period, the initial strength of contagious ailments (airborne, foodborne, and/or waterborne infections) might develop.

*Phase 3:* This last phase is called recovery phase that occurs after 4 weeks of any disaster. It is the period when the fatalities who suffered from infectious disease with long incubation episodes or latent-type illnesses may be converted into clinically apparent individuals. All through this period, the transmittable diseases that are previously widespread in the region may lead to an epidemic.<sup>[36]</sup>

## Vulnerability of Public Health System to Disasters

In the event of a disaster, the health system itself becomes vulnerable and its capacity to provide quality care affected severely. There may be issues related to geographic accessibility, human resource availability, the infrastructure of health facilities, and electricity availability. Health workers who act

as the first responders in such situations are also vulnerable in the post-disaster situation. Their vulnerability increases due to psychological distress, heavy work pressure, higher infection-proneness due to the lack of protective equipment.<sup>[37]</sup>

### Strategies for preparedness against post-disaster epidemics

Before planning to combat epidemics, knowledge regarding the epidemiological triad and clinical phases of epidemics is very important. For initial prevention from calamities, need assessment is necessary, and the identification of dynamics of communicable diseases is needed. Movement and displacement of the population play a significant role in the outbreak of epidemics.<sup>[2]</sup> Apart from that, overpopulation, poverty, environmental destruction, poor quality of water supply, lack of sanitary measures, and malnutrition are also responsible for the outbreak of infectious diseases post-disaster.<sup>[38]</sup>

The following priority events are decisive in reducing the impact of contagious diseases after natural disasters:

#### A. Site planning, safe water, sanitation, and vector control

Site planning and providing of shelters is the first phase of disaster management and if done appropriately, it can effectively reduce the epidemics. Safe water, solid waste management, sufficient space per person, and security of food stores are essential things that should be taken care of in shelters. The geographic location system is helpful for the verdict of a suitable place for refugees.<sup>[39]</sup> Chlorine is a universally accessible and economical way to diminish waterborne diseases.<sup>[40]</sup> Overcrowded places following natural disasters can lead to the transmission of vector-borne diseases such as malaria, dengue, yellow fever, Japanese encephalitis, typhus, etc. In the anticipation of vector-borne diseases, spraying of insecticides or distribution of long-lasting insecticidal nets is mandatory, according to the local context.<sup>[41]</sup>

#### B. Primary health care services

Primary health care services and health workers are the first responders for the people who need care from infectious disease or illness caused by a disaster. Ease of access to fundamental primary care is a key factor in the prevention, early diagnosis, and treatment of communicable diseases following natural disasters. Often policymakers are more focused on national or central level institutions and their activities, and primary health care remains a neglected area.<sup>[37]</sup>

For the management of communicable diseases following interventions are required at primary health care level:

- Make sure that essential health kit such as ORS solution for the management of diarrheal diseases and antibiotics for ARI is accessible.
- In malaria endemic areas, diagnosis as well as treatment of malaria should be done within 24 hours of onset of fever.

- Make sure for appropriate wound cleaning and care after the disaster, in which tetanus toxoid has an imperative role.
- Provide basic laboratory facilities.
- Sharing of health-tutoring messages such as good hygienic practices, safe water, and food-making skills, encourage early treatment in case of fever and the use of insecticide also have a significant role in combating the epidemics.<sup>[42]</sup>

#### C. Immunization

Immunization is essential to fight against outbreaks following any disasters. Mass measles immunization and vitamin A supplements are an instantaneous approach for health following any natural disasters. Besides, stipulation with tetanus-diphtheria (TD) vaccine and tetanus antitoxin is also essential.<sup>[38]</sup>

#### D. Surveillance

For the early detection of epidemics, surveillance and early warning are very much needed. The arrangement should be speedily established and urgency should be determined for the prevention of epidemics. A comprehensive communicable disease risk assessment should be done to prevent the occurrence of rare communicable diseases such as tularemia, plague, and viral hemorrhagic fever. For better surveillance, a key aspect is the training of health workers, so that they can detect and report the infectious diseases, and outbreak can be prevented.<sup>[42]</sup>

In addition to the abovementioned things, the health workers play important role in post-disaster situations. Their roles and responsibility should be defined and they should be trained for increasing capacity for the risk management. If a health system has large number of vacancies of health workers, then the health system cannot combat health risks associated with a disaster. So, effective recruitment and retention of health workers should be continuing activity at local level.<sup>[37]</sup>

## Conclusion

This review concluded that anticipation and attentiveness are essential to warfare against the health hazards of disaster. It has been observed that the risk of epidemic diseases after disaster are not due to disaster itself, but due to resultant displacement, overcrowding, and sanitation issues. For the prevention of infectious disease outbreaks, epidemiological information and surveillance system are indispensable that can identify early warning signs of possible outbreaks. The health systems should be strengthened in such a way that sampling and transportation of the samples are possible, and necessary stock of medicine is accessible in post-disaster situation. There should be a routine assessment of public health system for resilience in the event of disaster. Capacity-building of health workers in prevention and management of disaster is important aspect of strengthening public health care system. To conclude, public health care system has a vital role to play in preparation, response, and recovery from the epidemics after any natural disaster.



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## Conflicts of interest

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