www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2020; 9(2): 282-287

www.thepharmajournal.com
Received: 04-12-2019
Accepted: 06-01-2020

Vaishali
Ph.D. Scholar, Department of Veterinary Public Health and Epidemiology, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

Punit Jhandai
Ph.D. Scholar, Department of Veterinary Public Health and Epidemiology, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

Anu Malik
M.V.Sc. Scholar, Department of Veterinary Microbiology, Lala Lajpat Rai University of Veterinary and Animal Sciences Hisar, Haryana, India

Saurabh Jyoti Talukdar
M.V.Sc. Scholar, Department of Veterinary Microbiology, Lala Lajpat Rai University of Veterinary and Animal Sciences Hisar, Haryana, India

Parul Singh
Assistant Professor, Department of Veterinary Public Health DUVASU, Mathura, Uttar Pradesh, India

Corresponding Author:
Vaishali
Ph.D. Scholar, Department of Veterinary Public Health and Epidemiology, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

Emergence and containment of zoonoses after disasters

Vaishali, Punit Jhandai, Anu Malik, Saurabh Jyoti Talukdar and Parul Singh

Abstract
Disasters can never be predicted and they cause heavy economic loss and also loss to lives of humans as well as animals. It destroys the place it strikes and it become difficult for affected population to cope up with the losses with their own resources. Amongst various adversities faced by affected population, the burden of zoonotic diseases is matter of great concern due to their long-term impact. The main predisposing factor and primary cause of concern for the spread of disease is the population displacement. In addition, lack of preparedness, sanitation, safe drinking water and primary health care facilities are also contributory factors for post disaster outbreak of zoonotic diseases. The environment after disasters give ideal conditions for the endemic disease already present in the area to grow into an epidemic proportions. The diseases which are linked to post-disastrous situations can be categorised into water-borne, vector-borne, related to overcrowding and other non-specific causes. This review presents concise information of zoonotic diseases that occurred under various disastrous situations. The containment measures of such diseases are also discussed.

Keywords: Flood, earthquake, tsunami, disaster, zoonoses

Introduction
Disaster always hits a place unannounced. It is a severe catastrophic event which disrupts the basic functioning of a society or community that comprises of collaborative loss of human, economic, material or environmental factors. The disaster can be of sudden or gradual origin and it causes material damage and affects the health of mankind and livestock, disrupts the ecosystem and creates an emergency situation which people affected in an area are not able to cope with the limited resources available with them. The developing countries are more affected than the developed country as they lack infrastructure, resources and disaster preparedness plan strategies. The origin of disaster can be hydrologic, atmospheric or geologic. The disasters are broadly classified as detailed in Table 1.

Table 1: Classification of disasters

Disaster	Examples
Natural	Hydrometeriological: Floods, storms, typhoons, hurricanes and tornadoes
	Geophysical: Earthquake, tsunamis and volcanic eruptions
	Geomorphic: Landslides and avalanches
Man made	Bioterrorism, Nuclear power plant tragedy, House fires; building fires

The common reported disasters are hydro-meteorological disasters and flood being the most common amongst all constituting 40%. The majority of life loss is because of crush related injuries, drowning and blunt trauma. The second most commonly reported are the geophysical disasters, earthquakes being the most common. Another geophysical disaster, tsunamis can occur as a result of underwater lanslides caused by powerful volcanic eruptions. On December 22 last year, Indonesia was hit by a deadly tsunami where *Anak Krakatau*, locally known as the "Angry Child of Krakatoa" erupted and damaged local seismographic equipment and produced 10 feet high waves. The tsunami killed at least 437 people and 1,459 were injured. Disaster is containment of three elements i.e. hazards, vulnerability and insufficient ability to cope up with negative consequences. Besides loss of life and property during disaster, the post-disaster situations create unique health problems to the survivors. Amongst various health related problems, the introduction of various zoonotic diseases in affected population has long term impact on the society. The increasing frequency of disaster has been seen in a few past decades due to the climatic change and is drawing more attention towards the cause and

consequences of disaster and various responses from private sector, government and non-governmental organisations (NGOs) [1]. A zoonotic disease can be defined as infection or infectious disease transmissible under natural conditions between lower vertebrate and humans under natural conditions. There is both a direct and indirect relationship between the natural disaster and infectious disease [2].

The major question strike to our minds is why zoonotic diseases are of great concern? The answer lies in the fact that these are able to cause negative impact on economy, commerce, travel and trade of a country. Further, elderly people, pregnant women, children and immunocompromised patients are more prone to acquire zoonotic diseases. The spread of such zoonotic disease is the after effect of a disaster. The communities should adopt various preventive measures to manage the outbreak of various zoonotic diseases that can be new, emerging or re-emerging. In this general review, an attempt is made to discuss the relation between disasters and occurrence of zoonotic diseases as well as strategies to control them.

Causes and effects of post-disaster outbreaks of zoonotic diseases

The main predisposing factor and primary cause of concern for the spread of disease is the population displacement. The people who have been displaced from their natural habitat after a natural disaster or environmental change are called as environmental migrants or climate refugees. The size and characteristics of population indicates the extent of spread of disease in a disaster affected population. These include availability of safe drinking water, immunization status and nutritional status of the population. The environment after disasters give ideal conditions for the endemic disease already present in the area to grow into an epidemic proportions [3]. The consequences of flooding faced by public health responders are outbreaks of disease that takes place because of overcrowding in disaster relief shelter camps. It is mainly because of contamination of surface water by toxic chemical and faecal material resulting into outbreak of gastrointestinal diseases in affected population. There are prolonged health impacts after the disaster on a population that includes collapse of health care facilities, destruction of farming activities, interruption with primary health care as first aid, disturbing surveillance system and self-medication [4]. Some natural disasters like volcanoes, tsunamis, landslides, earthquakes, forest fire can alter the landscape of a particular geographical area and destroys some local species. The population faces mental health problem like grief, anxiety, shock and depression. The communicable disease spread rapidly after disaster and the risk of epidemic gets higher. Flood water washes off different mosquito breeding sites. The residual standing water creates new breeding sites and it leads to proliferation of vector population for spread of vector borne diseases like Japanese encephalitis and dengue fever [5]. The contaminated floodwater increases the chances of skin infection, diarrheal diseases, stomach infections, spread of bacterial (leptospirosis, cholera, *Escherichia coli* infection) and viral (Hepatitis A and E) diseases and other toxigenic disease which can be transmitted by faeco-oral route [6]. Disaster like hurricanes and floods provide humid environment and ample growth for moulds to grow. The moulds would not cause any structural damage, but have a negative impact on health of the people affected by causing allergic reactions and other health hazards like dizziness, conjunctivitis, sinus infections, eyes rashes and other. The maintenance of proper hygiene, sanitation facilities and good hygienic environment should be the biggest priority to minimize the risk of spread of communicable disease. There are some parasitic diseases which also prevail after a disaster such as lymphatic filariasis, leishmaniasis and onchocerciasis.

Phases of disease outbreak after disaster

The outbreak of infectious diseases has been categorized under three broad clinical phases of disasters.

Phase 1: (The Impact Phase)-This phase usually lasts for 4 days and includes extricating the victims from the affected area and providing them with the initial treatment related with the injuries.

Phase 2: (The Post Impact Phase)-This phase comprises of the first wave of infectious disease when the disease can emerge and usually subsides from 4 days to 4 weeks.

Phase 3: (Recovery Phase)-This phase begins after 4 weeks and it shows the symptoms in people which have been affected with disease with long incubation period or latent type infections which make the disease clinically apparent. The transmission of infectious disease and outbreaks has usually been recorded after population displacement, a major risk factor and public health breakdown in not being able to cope up with controlling the disease after disasters.

Diseases related to disasters

Water borne diseases

Floods account for 40% of the natural disasters worldwide due to weather and climatic changes. The surface water gets contaminated with the pathogenic bacteria and harms the population being affected including humans and animals. The risk of occurrence of diarrheal disease is more in the developing than the developed countries. Floods and hurricanes tend to follow severe outbreaks of diarrheal disease which have proven to be fatal sometimes. In Bangladesh in the year 2004 a massive outbreak of bacterial gastroenteritis occurred involving more than 17,000 cases, the most common bacteria isolated were Enterotoxigenic *Escherchia coli* and *Vibrio cholerae* (O1 Inaba and O1 Ogawa) [7]. Cholera was one of the most common diarrheal diseases in the flood associated endemics during monsoon followed by rotavirus in 1988, 1998 and 2004. Diarrhea related with other causes like *Shigella*, ETEC and *Salmonella* were also detected [8, 9]. In 2005, the Gulf coast of USA was struck by Hurricane Katrina. Thereafter, 18 cases of vibriosis were noted among individuals having wound infections. The infection progressed rapidly and 5 out of 18 affected patients died [10]. An outbreak of diarrhoea in 2013 caused by *Cryptosporidium* that occurred six weeks after flooding has been reported from Germany. The subsequent investigation concluded the damaged sewage system as important causative factor [11]. During the disastrous Tsunami of South Asia in 2004, major causalities were with wound infections resulting due to exposure to sewage contaminated water. Foreign bodies and soil was removed from wounds of affected people [12,13]. Hepatitis A and E is a common reported zoonosis post floods. It spreads by faeco-oral route and because of lack of proper hygiene and sanitation. Hepatits A is endemic in most of the developing countries and children acquire immunity once exposed at an early age. Hepatits E outbreaks have also been

seen in endemic areas after heavy rainfall and post flooding. It is usually a self-limiting disease but the fatality rate in pregnant women is high. The increased transmissions of Hepatits A and E have been reported in Sudan and India [14].

Leptospirosis is also one of the most commonly occurring diseases after floods. The natural disasters cause scattering of debris, garbage and food that amplifies rodent population. Another major cause for contamination of water is free ranging animals. Various cases of *Leptospira* infection have been documented [15, 16, 17]. It has seen to be highly endemic in Philippines mainly during July-October [18]. In 1999, Philippines showed a threefold increase in cases of *Leptospira* infection during monsoon season in Manila, Philippines [19]. The Department of Health reported 178 deaths amongst 2,299 patients from 15 hospitals until mid-October in Metro Manila after serious flooding caused by occurrence of typhoon on September 26, 2009 [18]. The campus of University of Hawaii got flooded on October 31, 2004. The first case of *Leptospira* infection was recorded on November 19, 2004 [20]. Another 9 cases of leptospirosis were observed in Central Queensland, Australia which experienced widespread flooding during December 2010 and January 2011 [21]. The city of Santa Fe, Argentina in March-April 1998 conducted different studies to detect *Leptospirae* infected individuals post flooding. The results of study involving 32 persons and 8 dogs, showed occurrence of leptospirosis among 12 persons and 6 dogs [22]. Cases of Leptospirosis have been regularly recorded in Maharashtra since 1998. More than 2000 infected cases with 167 death toll was recorded in 2005 Mumbai floods [23]. The number of cases has drastically increased and expansion of leptospirosis has been extensive since the year 1998 to 2005 in ten districts [24, 25, 26].

Giardiasis was commonly reported in children aged between 3 to 13 years [27]. Plague is one of a deadly disease and a serious outbreak of bubonic plague was reported in central India, Gujarat. On September 23, 1994, reports of many deaths due to pneumonic plague in Gujarat state, Surat city were also reported [28].

Disease associated with crowding

The most commonly reported disease with crowding are acute respiratory infections (ARI) and are commonly reported in children and causes 20% of death leading to pneumonia [29]. The risk of transmission of the respiratory viral pathogens increases due to disruption of housing due to disasters and overcrowding of people in shelters organised for disaster struck population [30]. Other than ARIs, measles and meningitis tend to occur in population living in overcrowded shelters [31].

El Savador in January and Feburary 2001 experienced 2 major earthquakes leading to 30% respiratory infections in rural inhabitants [32]. The Villanueva area, Nicaragua was affected due to Hurricane Mitch in 1998 and reported upto fourfold increase in the respiratory infections within 30 days [33]. Bellos *et al*. (2010) [34] studied published data between 1980 and 2010 to know the burden of acute respiratory infection in a population affected by various crises such as natural disasters, armed conflict, forced displacement, and nutritional emergencies. The findings of this study indicated a very high excess morbidity and mortality (20-35% proportional mortality) and case-fatality (up to 30-35%) due to ARI.

Vector-borne diseases

The vectors mainly mosquitoes breed in standing water and multiply. The breeding sites are washed away by hurricanes and heavy rains, then remaining residual water form new breeding sites for these vectors and favour the spread of vector-borne diseases. The rescued population is brought together under shelters organised which leads to mixing of both normal healthy and carrier individuals. This overcrowding of suspected and susceptible hosts increases the likelihood of vector-borne disease outbreaks [35, 36].

Various parasitic diseases are also spread due to the increase in vector population such as leishmaniasis, onchocerciasis and lymphatic filariasis. Zarindasht, a rural town in Southern Iran was struck by two mild earthquakes on July 10, 2003. Prior to this disaster the disease leishmaniasis was prevalent in the region at a rate of 58.6 per 1,00,000 population. However, after earthquake the leishmaniasis took epidemic form with incidence rate of 864 cases per 1,00,000 people in the following 12 months [37]. An earthquake in 1991 in Atlantic region of Costa Rica showed extreme increase in the cases of malaria and was found to be associated with habitat changes that proved to be breeding sites for mosquitoes [38]. Aceh province showed a drastic increase in malarial cases and 987 confirmed cases were reported [39]. Climatic changes like El-nino effect linked to flooding was associated with epidemics of malaria in northern Peru dry coastal region [40]. In early 2017, northern Peru experienced major flooding with large outbreaks of both chikungunya and dengue fever and >19,000 cases were suspected for dengue fever [41].

Other diseases associated with disaster

The diseases which are related to disasters but cannot be considered under above categories are the stress induced infectious diseases. Being it human or animal, both undergo a tremendous amount of stress as they are evacuated and relocated to a new place especially in overcrowded shelter homes. Tsunami in December 2004 severely affected Aceh Province in Indonesia. Within a span of a month, 106 cases of tetanus were clinically diagnosed in affected population [42]. In January 1994 earthquake in Northridge, Calif, California USA found to be related to 203 outbreaks of coccidioidomycosis caused by *Coccidioides immitis* [43]. In 1985 the town of Califronia, Armero was swept by the fourth largest volcanic eruption in mankind resulting in wounding 45,000 and death of over 23,000 and followed by outbreak of mucormycosis, a zygomycetic infection [44] (Patiño *et al*., 1991). In 2005, a major Hurricane Katrina struck USA and witnessed high fatalities amongst affected population due to pulmonary type of infection caused by *Cladosporium* spp. [45]. In 1978, Haiti was struck by an earthquake that led to an outbreak of African Swine fever [46]. The Dominica, a Caribbean island nation witnessed outbreak of cowdriosis, a tickborne rickketsial disease in the cattle population. The outbreak was supposedly caused due to introduction of Amblyomma tick after Hurricane David which struck the island [47].

Clostridium tetani causes tetanus by release of toxins. On May 27, 2006 Yogyakarta, Indonesia was struck by an earthquake and 26 patients suffering from tetanus were admitted to eight different hospitals following earthquake. Amongst them, 8 (30.8%) people died. After the tsunami in Aceh province of Indonesia in the year 2004, 106 cases of tetanus were reported including 20 deaths. The outbreak

reached to its peak 2½ weeks post tsunami [48]. Barzallo *et al.* (2018) [49] reported increase in the Zika virus infection by 0.509% per epidemiological week after an earthquake of magnitude 7.8 struck the Eucador along its coast on April 16, 2016. Outbreaks of extremely drug resistant (XDR) *Acinetobacter baumannii*, occurred post flooding at a tertiary care center in Thailand. *A. baumannii* was reported in patients admitted in the four surgery and six medicine units since October 24, 2010 at Thammasat University Hospital, Pratumthani, Thailand. The bacterium was highly resistant to carbapenems, fluoroquinolones, cephalosporins, aztreonam, aminoglycosides and sulbactam [50].

An earthquake caused Tsunami at Tohoku, Japan with a 9.0 magnitude caused 19,000 casualties. There was emergence of Tsunami lung in patients who were swept away by waves of tsunami inhaling salt water that was contaminated with mud and bacteria. *Burkholderia pseudomallei* and *Nocardia* spp. were cultured from the patients affected with Tsunami lung [51]. On March 11, 2011 the Great East Japan Earthquake led to a tsunami that struck Pacific Coastline of Northern island of Japan engulfed a 74-year old man developed chest pain, cough, fever and dyspnea. The old man showed an unusual case of pleural empyema [52]. Volcanoes and storms have a tendency to increase the suspended particles like CO2, SO2, Ash, dust and toxic air even after a long time after the event. In 1992, sand of Saudi Arabia and drooping of pigeons triggered a hyperergic lung condition, Al-Eskan disease or Desert Storm pneumonitis [53]. After South Asia tsunami in December 2004, most patients suffered from wound injuries, fractures and complications after drowning.

Containment of Zoonoses

Disaster Risk Reduction is a concept of minimising the risk after disaster by systematic efforts to identify and manage the factor causing risk. It is carried out by administrative policies, directions and operations to implement policies [1]. Occurrence of zoonotic diseases after disasters can be prevented by taking following containment measures.

a) Prevention

It is the key to contain zoonoses. Prevention, early diagnosis, early treatment would lessen the impact of common outbreaks on public health [54].

Safe uninterrupted drinking water should be made available to the affected population in the overcrowded shelters. Chlorine can be effectively used as it is inexpensive and widely available and is effective against most of the water borne pathogens [55]. The site to be planned for shelter of people should provide adequate access to safe drinking water and proper sanitation. Personal hygiene should be properly maintained and people should be provided with soap and water [56].

b) Providing primary health care

Health service needs are to be prioritized. The baseline health services consist of two phases. Phase1-acute response, phase 2-long-time recovery [57]. During the phase of acute response, it is necessary to ensure availability of proper medication and facility to carry out cleaning of wounds for people. Subsequently, during phase 2, efforts are required to disseminate proper health care messages like, promotion of safe preparation of food, boiling or chlorination of water, motivating for good hygienic practices and encouraging use of mosquito treated nets etc.

c) Surveillance and monitoring system

These systems should be quickly established to rapidly evaluate and validate various diseases and monitor. The techniques involved in surveillance are primarily sampling and conducting systemic surveys and developing reporting systems [58]. The major aim of surveillance is to minimise the effect of consequences of disaster on the health. Each field survey addresses some basic questions which can prevent any loss to life. Each of the survey offers some answers to general questions like availability of medical care, epidemic control and it needs careful investigation [59].

d) Immunization

Campaigns should be organised post disaster. One of the most cost effective was the measles immunization programme in public health so far [60]. After Hurricane Katrina in September 2005, Houston-Harris county Immunization Registry found that >18,900 immunizations were recorded after a year and saved $1.6 million only for vaccine [61]. The people of Haiti offered children with vaccination against pertussis, measles, dipthera, polio, tuberculosis and tetanus since 1977 in a routine immunization programme [62]. 17% population in Haiti had access to proper hygienic and sanitation facilities before 2010 [63].

References

1. Mendoza Mainegra E, PercedoAbreu MI. Disaster management: The role and preparedness of Veterinary services in OIE 2012.
2. Watson JT, Gayer M, Connolly MA. Epidemics after natural disaster in Emerg Infect Dis. 2007; 13(1):1.
3. Bidaisee S, Pichainarongk S. Communicable disease transmission and prevention of following disasters in J Infectious Disease Med Microbiol. 2018; 2(1):14-17.
4. Kouadio IK, Aljunid S, Kamigaki T, Hammad K, Oshitani H. Infectious diseases following natural disasters: prevention and control measures in Expert Rev Anti Infect Ther. 2012; 10(1):95-104.
5. Zhang F, Liu Z, Zhang C, Jiang B. Short-term effects of floods on Japanese encephalitis In Nanchong, China, 2007-2012: A time-stratified case-crossover study in Sci Total Environ. 2016; 563-564:1105-10.
6. Mack L, 2017. available at https://info.debgroup.com/blog/hygiene-the-invisible-threat-after-natural-disasters.
7. Qadri F, Khan A, Faruque AS, Begum YA, Chowdhury F, Nair GB. Enterotoxigenic Escherichia coli and Vibrio cholerae diarrhea, Bangladesh, 2004 in Emerg Infect Dis. 2005; 11(7)**:**1104-1107.
8. Kunii O, Nakamura S, Abdur R, Wakai S. The impact on health and risk factors of the diarrhoea epidemics in the 1998 Bangladesh floods in Public Health. 2002; 116(2):68-74.
9. Schwarz B, Harris J, Ashraful I. Diarrheal epidemics in Dhaka, Bangladesh during three consecutive floods: 1988, 1998 and 2004 in Am J Trop Med Hyg. 2006; 74:1067-1073.
10. Ivers LC, Ryan ET. Infectious diseases of severe weather-related and flood-related natural disasters in Curr Opin Infect Dis. 2006; 19(5):408-414.
11. McCarthy MC, He J, Hyams KC, El-Tigani A, Khalid IO, Carl M *et al.* Acute hepatitis E infection during the 1988 floods in Kartoum, Sudan in Trans R Soc Trop Med Hyg. 1994; 88(2):177.

12. Garzoni C, Emonet S, Legout L, Benedict R, Hoffmeyer P, Bernard L *et al*. Atypical infections in tsunami survivors in Emerg Infect Dis. 2005; 11(10)**:**1591-1593.
13. Maegele M, Gregor S, Yuecel N. One year ago not business as usual: wound management, infection and psychoemotional control during tertiary medical care following the 2004 Tsunami disaster in Southeast Asia in Crit Care. 2006; 10(2):50.
14. Gertler M, Durr M, Renner P, Poppert S, Askar M, Breidenbach J *et al*. Outbreak of *Cryptosporidium hominis* following river flooding in the city of Halle (Saale), Germany, August 2013 in BMC Infect dis**.** 2015; 15**:**88.
15. Barcellos C, Sabroza P. The place behind the case: leptospirosis risks and associated environmental conditions in a flood-related outbreak in Rio de Janeiro in Cadernos de Saude Publica. 2001; 17:59-67.
16. Sehgal SC, Sugunan AP, Vijayachari P. Outbreak of leptospirosis after the cyclone in Orissa in Natl Med J India. 2002; 15:22-23.
17. Centers for Disease Control and Prevention. Brief report: leptospirosis after flooding of a university campus, MMWR Morb Mortal Wkly Rep. 2006; 55:125-127.
18. Amilasan AS, Ujiie M, Suzuki M, Salva E, Belo MC, Koizumi N *et al*. Outbreak of leptospirosis after flood, the Philippines, 2009 in Emerg infect dis. 2012; 18(1):91-4.
19. Easton A. Leptospirosis in Philippine floods in BMJ. 1999; 319(7204):212.
20. Gaynor K, Katz AR, Park SY, Nakata M, Clark TA, Effler PV. Leptospirosis on Oahu: an outbreak associated with flooding of a university campus in Am J Trop Med Hyg. 2007; 76(5):882-885.
21. Smith JK, Young MM, Wilson KL, Craig SB. Leptospirosis following a major flood in Central Queensland, Australia in Epidemiol Infect. 2013; 141(3):585-590.
22. Vanasco NB, Sequeira G, Dalla Fontana ML, Fusco S, Sequeira MD, Enria D. Report on a leptospirosis outbreak in the city of Santa Fe, Argentina, March-April 1998 in Pan Am J Public Health. 2000; 7(1):35-40.
23. Routray A, Panigrahi S, Swain K, Das M, Ganguly S. Leptospirosis: A Review on Zoonosis in Indian Scenario in Int J Livest. 2018; 8(11):29-37.
24. Karande S, Bhatt M, Kelkar A, Kulkarni M, De A, Varaiya A *et al*. An observational study to detect leptospirosis in Mumbai, India in Arch dis child. 2003; 88(12):1070-1075.
25. Karande S, Kulkarni H, Kulkarni M. Leptospirosis in children in Mumbai slums in Indian J Pediatr. 2002; 69:855-858.
26. Shivakumar S. Leptospirosis-Current scenario in India. Medicine Update, 2008. doi: 10.13140/2.1.4905.6968
27. Lora-Suarez F, Marin-Vasquez C, Loango N, Gallego M, Torres E, Gonzalez MM *et al*. Giardiasis in children living in post-earthquake camps from Armenia (Colombia) in BMC Public Health. 2002; 2:5.
28. Deodhar NS, Yemul VL, Banerjee K. Plague that never was: A review of the Alleged Plague Outbreaks in India in 1994 in J Public Health policy. 1994; 19(2):184-199.
29. World Health Organization. Acute Respiratory Infections: Update September 2009. www.who.int/vaccine_research/diseases/ari/en/index.html.
30. Paterson DL, Wright H, Harris PNA. Health Risks of Flood Disasters, 2018. from https://academic.oup.com/cid/advance-article-abstract/doi/10.1093/cid/ciy227/4945455 by Nottingham University user on 23 March 2018.
31. Marin M, Nguyen HQ, Langidrik JR, Edwards R, Briand K, Papania MJ. Measles transmission and vaccine effectiveness during a large outbreak on a densely populated island: implications for vaccination policy in Clin Infect Dis. 2006; 42(3):315-319.
32. Woersching JC, Snyder AE. Earthquakes in El Salvador: a descriptive study of health concerns in a rural community and the clinical implications, part I in Disaster Manag Response. 2003; 1(4):105-109.
33. Campanella N. Infectious diseases and natural disasters: the effects of Hurricane Mitch over Villanueva municipal area, Nicaragua in Public Health Rev. 1999; 27:311-319.
34. Bellos A, Mulholland K, O'Brien KL, Qazi SA, Gayer M, Checchi F *et al*. The burden of acute respiratory infections in crisis-affected populations: a systematic review in Confl Health. 2010; 4:3.
35. Lifson AR. Mosquitoes, models, and dengue in Lancet. 1996; 347:1201-1012.
36. Solomon T, Dung NM, Kneen R, Gainsborough M, Vaughn DW, Khanh VT *et al*. Japenese Encephalitis in J Neurol. Neurosur. Psychiatry. 2000; 68(5):405-415.
37. Fakoorziba MR, Baseri A, Eghbal F, Rezaee S, Azizi K, Moemenbellah-fard MD *et al*. Post-earthquake outbreak of cutaneous leishmaniasis in a rural region of southern Iran in Ann Trop Med Parasi. 2001; 105(3):217-224.
38. Saenz R, Bissell RA, Paniagua F. Post-disaster malaria in Costa Rica in Prehosp Disaster Medicine. 1995; 10:154-160.
39. Guha-Sapir D, Van Panhuis WG. Health Impact of 2004 Andaman Nicobar Earthquake and Tsunami in Indonesia in Prehosp Disaster Med. 2009; 24(06):493-499.
40. Gagnon AS, Smoyer-Tomic KE, Bush AB. The El Nino southern oscillation and malaria epidemics in South America in Int J Biometeorol. 2002; 46:81-89.
41. Schneider MC, Velasco-Hernandez J, Min KD. The Use of Chemoprophylaxis after Floods to Reduce the Occurrence and Impact of Leptospirosis Outbreaks in Int. J Environ. Res. Public Health. 2017; 14:594
42. Barboza P, Coulombier D, Defilippi L, Gayer M. Outbreak of tetanus cases following the tsunami in Aceh province, Indonesia in Glob public Health. 2006; 1(2):173-177.
43. Schneider E, Hajjeh RA, Spiegel RA, Jibson RW, Harp EL, Marshall GA *et al*. A coccidioidomycosis outbreak following the Northridge, Calif, earthquake in JAMA. 1997; 277:904-8.
44. Patiño JF, Castro D, Valencia A, Morales P. Necrotizing soft tissue lesions after a volcanic cataclysm in World J Surg. 1991; 15:240-247.
45. Rao CY, Reed D, Kemmerly S, Morgan J, Fridkin SK. Assessing invasive mold infections, mold exposures and personal protective equipment use among immunocompromised New Orleans residents after Hurricane Katrina. Society for Healthcare Epidemiology of America 17th Annual Scientific Meeting, 2007, 14-17, Baltimore. [cited 2013 Aug 12]; http://www.shea-online.org/Assets/files/The_Environment.doc.pdf.
46. Heath SE, Kenyon SJ, Zepeda Sein CA. Emergency management of disasters involving livestock in

developing countries in Rev. sci. tech. Off. int. Epiz. 1999; 18(1)**:**256-271.
47. Hugh-Jones M. The probability of the spread of *Amblyomma variegatura* in the Caribbean. Letter to the editor in Prev vet Med. 1990; 8:77-78.
48. Pascapurnama DN, Murakami A, Chagan-Yasutan H, Hattori T, Sasaki H, Egawa S. Prevention of tetanus outbreak following natural disaster in Indonesia: Lessons learned from previous disaster in Tohoku J Exp Med. 2016; 283(3):219-227.
49. Barzallo DP, Barzallo AP, Narvaez E. The 2016 Earthquake in Ecuador: Zika Outbreak after a Natural Disaster in Health Secur. 2018; 16(2):127-134. https://doi.org/10.1089/hs.2017.0099.
50. Apisarnthanarak A, Yang HL, Warren DK. Termination of an Extreme-Drug Resistant-*Acinetobacter baumannii* outbreak in a hospital after flooding: Lessons learned in Clin Infect Dis. 2012; 55(11):1589-1590.
51. Nukiwa T. An overview of respiratory medicine during the Tsunami Disaster at Tohoku, Japan, on March 11, 2011 in Respiratory Investigation. 2012; 50(4):124-128.
52. Ota H, Kawai H. An unusual case of pleural empyema in a tsunami survivor in Asian Cardiovasc Thorac Ann. 2012; 20(3):344-346.
53. Bandyopadhyay R, Paul R. Lung problems in environmental disasters in Medicine Update, 2012, 22.
54. Salazar MA, Pesigan A, Law R. Post-disaster health impact of natural hazards in the Philippines in 2013 in Glob Health Action. 2016; 9:31320.
55. Wisner B, Adams J, World Health Organisation. Environmental health in emergencies and disasters: a practical guide. World Health Organization, 2002. https://apps.who.int/iris/handle/10665/42561.
56. Young H, Harvey P. The sphere project: the humanitarian charter and minimum standards in disaster response: introduction in Disasters. 2004; 28(2):99.
57. Runkle JD, Brock-Martin A, Karmaus W, Svendsen ER. Secondary Surge Capacity: A Framework for Understanding Long-Term Access to Primary Care for Medically Vulnerable Populations in Disaster Recovery in Am J Public Health. 2012; 102(12):e24-32
58. Noji EK. Disaster Epidemiology and Disease Monitoring in J Med Syst. 1995; 19(2):171-174.
59. Spencer HC, Campbell CC, Romero A. Disease surveillance and decision making after the 1976 Guatemala earthquake in Lancet. 1977 2:181-184.
60. Connolly MA, Gayer M, Ryan MJ, Salama P, Spiegel P, Heymann DL *et al*. Communicable diseases in complex emergencies: impact and challenges in Lancet. 2004; 364(9449):1974-83.
61. Boom JA, Dragsbaek AC, Nelson CS. The success of an immunization information system in the wake of Hurricane Katrina in J Pediatr. 2007; 119(6):1213-1217. Doi: 10.1542/peds.2006-3251
62. Rainey JJ, François L, Danovaro-Holliday MC, Mung K, Magloire R, Kanada G *et al*. Vaccination coverage in Haiti: results from the 2009 National Survey in Vaccine. 2012; 30(9):1746-1751.
63. Vertefeuille JF, Dowell SF, Domercant JW, Tappero JW. Cautious optimism on Public Health in Post-earthquake Haiti in The Lancet. 2010; 381(9866):517-519.