

POST DISASTER GOVERNANCE AND DISEASE SURVEILLANCE FOLLOWING EARTHQUAKE

Zamzaireen Z.A.^{1,2}, Natalia C.I.^{1,2}, Mohd Safwan I.^{1,2},
Muhammad Hanafiah Juni^{3*}

¹Doctor of Public Health Candidate, Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

²Ministry of Health Malaysia

³Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

**Corresponding author: AP Dr. Muhamad Hanafiah Juni, Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.*

Email: hanafiah_juni@upm.edu.my

ABSTRACT

Background: Earthquake like other disasters may lead to outbreak. Surveillance is essential in post-disaster phase and governance is crucial for an effective and efficient development and implementation of surveillance system. This manuscript aims to analytically analyse epidemiological surveillance following earthquake in view of its governance.

Materials and Methods: Scoping systematic review was conducted using Pubmed and ScienceDirect, with keywords of epidemiology AND surveillance AND earthquake. Total of 1864 articles from public domains and 52 from other sources obtained and duplicates removed. Primary screening of 1319 articles' titles and abstracts was done. English published articles in the past ten years were the inclusion criteria and reviewed articles excluded. Secondary screening of 397 articles resulted in 22 articles, included in this manuscript.

Result: Ten countries following earthquakes were reviewed on its governance with the characteristics of participation and transparency, accountability and rule of law as well as non-discrimination and equality. Post earthquake surveillance of diseases included air borne and respiratory disease, vector borne disease, water borne disease, blood borne disease and gastrointestinal tract disease.

Conclusion: Post disaster phase is a sudden burden for government and society with possibility of communicable diseases outbreak. Effective recovery process includes coordination, timeliness and capabilities to monitor and evaluate a surveillance system. Governance comprises of participation government's transparency, accountability and equality.

Keywords: Epidemiology, governance, surveillance, earthquake

1.0 Introduction

Earthquake is defined as the “shaking of earth caused by waves moving on and below the earth's surface and causing: surface faulting, tremors vibration, liquefaction, landslides, aftershocks and/or tsunamis” (World Health Organisation (WHO), 2017).

Intensity and magnitude are the expression of the severity of an earthquake, but the terms are different. Characteristics of earthquakes are measured using these two terms. Magnitude is the measurement of energy released at the point of the earthquake and it can be measured using seismographs (U.S. Geological Survey (USGS), 2016). On the other hand, the strength of shaking produced by the earthquake is measured as intensity. Intensity is determined from effects on people, natural environment, and the human structures (USGS, 2016).

The vibrations from earthquakes that travel through the Earth are called seismic waves. A zigzag trace that is recorded by seismographs record shows the varying amplitude of ground oscillations indicating the location, time and magnitude of an earthquake (USGS, 2016). On the Richter Scale, magnitude is expressed in discrete and continuous figures (USGS, 2016). Table 1.1 shows the intensities that are typically observed at locations near the epicentre of earthquakes for different magnitudes.

Table 1.1: Intensities of Earthquakes at Different Magnitudes

Source: United States Geological Survey, 2017

Magnitude	Typical Maximum Modified Mercalli Intensity	Abbreviated Modified Mercalli Intensity Scale
1.0 - 3.0	I	Not felt except by a very few under especially favourable conditions.
3.0 - 3.9	II - III	Felt only by a few persons at rest, especially on upper floors of buildings.
4.0 - 4.9	IV - V	Felt by nearly everyone.
5.0 - 5.9	VI - VII	Felt by all. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structure
6.0 - 6.9	VII - IX	Damage considerable in specially designed structures
7.0 and higher	VIII or higher	Some well-built wooden structures destroyed or if higher can cause total damage.

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1.1 Outbreak following Earthquake

Following an earthquake, outbreaks may occur within days, weeks or month. The clinical phases of public health concerns can be divided into three namely; the impact phase, the post-impact phase and the recovery phase (Kouadio, Aljunid, Kamigaki, Hammad & Oshitani., 2012). Up to four days in the impact phase is the needs for treatment of injuries. Occurrence of infectious diseases may emerge during the post impact phase that last from four days up to four weeks following a disaster. Symptoms of either infections with incubation period that is long or latent-type may present itself at week four following the disaster, in the recovery phase. At this phase, endemic of diseases may pronounce into an epidemic.

Earthquake itself does not directly cause disease outbreak. The most important risk factors for increment of disease transmission following disaster are overcrowding, inadequate shelter, insufficient coverage of immunization, poor water sanitation and hygiene conditions, high exposure to or proliferation of vectors, insufficient nutrient intake and treatment delay (Kouadio et al., 2012). In addition to this, abrupt environment changes synergistically exacerbate these risk factors as consequences of disaster after effect. Adequate health promotion and education as well as facilities to cater for the victims are important for prevention of diseases following disaster (Kouadio et al., 2012).

1.2 Disaster preparedness and Surveillance

Disaster management requires well- coordinated public policy for disaster prevention, mitigation, preparedness, emergency response and reconstruction. Preparedness is the measures that ensure the organized mobilization of personnel, funds, equipment, and supplies within a safe environment for effective relief. Disaster preparedness is building up of capacities before a disaster situation prevails in order to reduce impacts (United State Agency for International Development (USAIDS), 2016). During a disaster, it is important to conduct surveillance to determine the extent and scope of the health effects on the affected populations. Surveillance is the systematic collection, analysis, and interpretation of deaths, injuries, and illnesses, which enables public health to track and identify any adverse health effects in the community. It allows us to assess the human health impacts of a disaster and evaluate potential problems related to planning and prevention (Centers for Disease Control and Prevention (CDC), 2017). Public health surveillance during a disaster allows for the detection of potential disease outbreaks and track disease and injury trends. Conducting health surveillance allows for the ability to make informed decisions about action items such as allocating resources, targeting interventions to meet specific needs, and planning future disaster response.

1.3 Governance of Disaster

Governance in the context of disaster is termed as succeeding the collaborative ventures between various organizations for the purpose of solving issues that is beyond the scope of any one single organization (Mamula-Seadon, 2014). Prior to disaster, governance is an essential factor and more dominantly in the process of recovery following a disaster. The capability of catering for the population in a continuous manner and also the maintenance during post disaster is of utmost importance. The mechanism of efficient governance is competently able to address the needs of the affected population in a timely manner. Besides

legislations, operationally, the basic necessities that need to be met include personnel that are dedicatedly competent and also facilities that are suitable for assigned services (Tierney & Oliver-Smith, 2012).

Core values and principles of good governance for the monitoring and evaluation of epidemiological surveillance for communicable diseases based on the United Nation Development Program (UNDP) includes participation and transparency, accountability and rule of law as well as non-discrimination and equality (United Nation Development Program (UNDP), 2011).

This manuscript aims to analytically analyse epidemiological surveillance following earthquake in view of its governance and surveillance system.

2.0 Materials and Methods

A scoping systematic review was conducted. Articles were searched based on Pubmed and ScienceDirect public domains. The keywords of (epidemiology AND surveillance) AND earthquake was applied to obtain the literatures. Figure 1.1 PRISMA 2009 flow diagram illustrates the flow of literature search. 1864 articles were initially searched from the search engines and additional 52 articles were found from other sources. Duplication articles were removed and 1319 articles underwent primary screening for relevance articles based on titles and abstract. Three authors reviewed these articles concurrently and decision made based on the consensus of all the authors to reduce biases. After screening, 397 articles underwent secondary review for eligibility. Inclusion criteria included English articles published from 2007 to 2017, and also accessible as free full texts. Reviewed articles were excluded as per the exclusion criteria. Those articles that explained regarding surveillance and its governance were included. Finally, 22 articles were included as the final literature search.

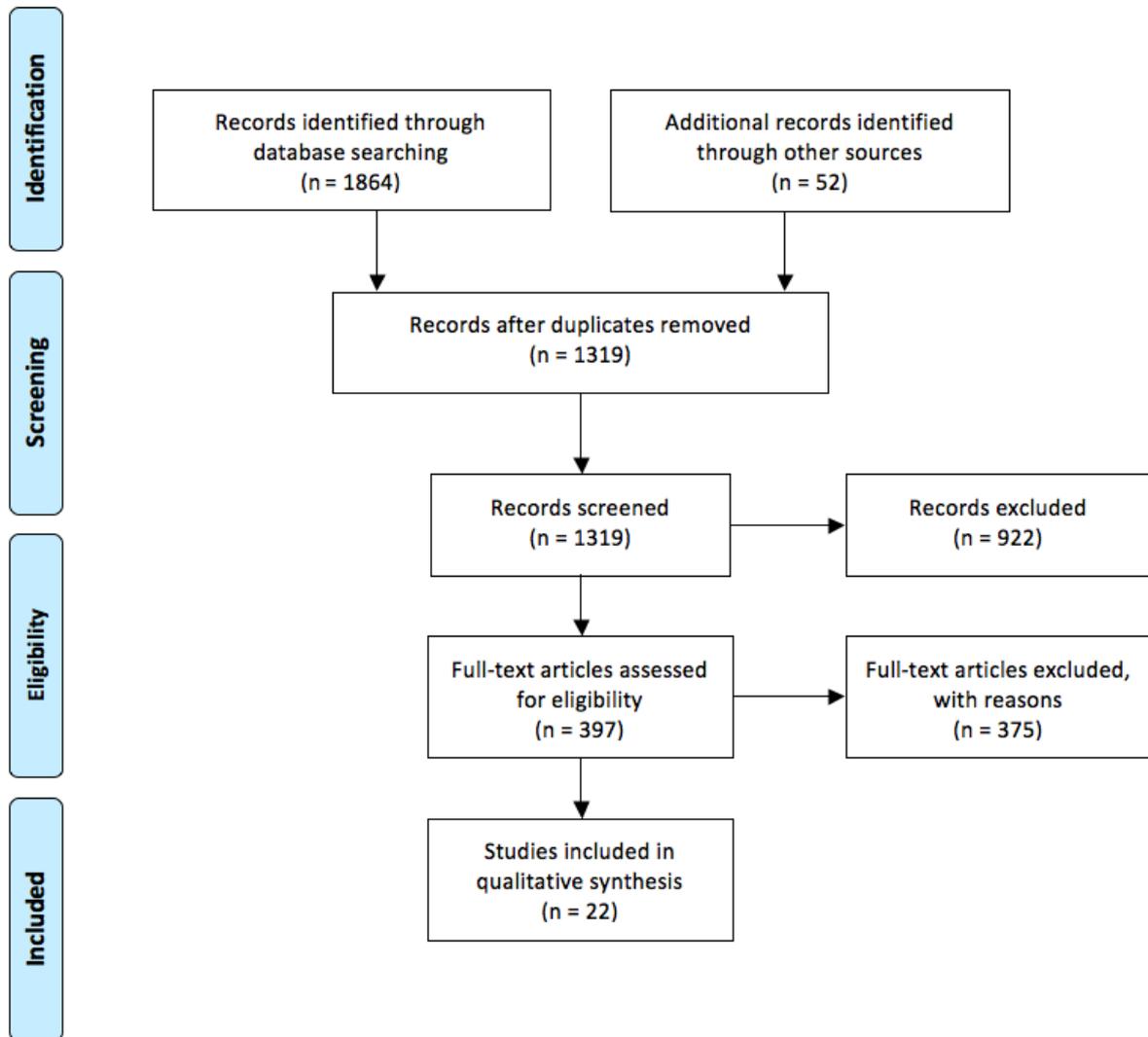


Figure 1.1: PRISMA 2009 Flow Diagram for Post Disaster Governance and Disease Surveillance following Earthquake

3.0 Results and Discussions

Post disaster governance following earthquakes can be summarised within characteristics of participation and transparency, accountability and rule of law as well as non-discrimination and equality as in Table 3.1 below, reviewing articles from 10 countries.

Table 3.1: Post Disaster Governance following Earthquake

No.	Title	Author, Year, Country	N, Population setting /Data Source /Study description	Participation and Transparency	Accountability and Rule of Law	Non-Discrimination and Equality
1	Impact of the 2016 Ecuador Earthquake on Zika Virus Cases	Vasquez, D., Palacio, A., Nuñez, J., Briones, W., Beier, J.C., ... & Tamariz, L (2017). Ecuador	2234 patients suspected of having Zika virus infection (affected and control areas)	MOH's health centres collect information on reportable transmissible conditions including ZIKV, included into national database/registry. All suspected cases seen at MOH health care were included	MOH provide guidelines on testing and management protocol for cases	Control, non-affected adjacent area was included as data collection area
2	Hepatitis E virus seroepidemiology: a post-earthquake study among blood donors in Nepal	Shrestha, A.C, Flower, R.L., Seed, C.R., Rajkarnikar, M., Shrestha, S.K., Thapa, U., ... & Faddy, H.M. (2016). Nepal	1845 blood donors from earthquake-affected-regions, tested for Hepatitis E virus IgM, IgG and antigen	Nepal Red Cross Society, Central and district Blood Transfusion Service (sample collection & testing), blood donors, Brisbane Researcher and Development team at the Australian Red Cross Blood Service,	N/A	Donors were inclusive of repeat and first-time donors
3	Plasmodium falciparum Drug-Resistant Haplotypes and Population Structure in Postearthquake Haiti, 2010.	Morton, L.C., Huber, C., Okoth, S.A., Griffing, S., Lucchi, N., ... & Barnwell, J.W (2016). Haiti	349 blood spots from suspected cases of malaria in temporary health facilities in Port-au-Prince	Staffs at the temporary health facilities and at the international airport including the non-governmental organizations supporting the facilities, and the suspected cases	Haiti Ministry of Public Health and Population	Both suspected and confirmed cases were included for collection of dried blood spots samples from both temporary and existing health facilities in both metropolitan and suburban's area
4	Pediatric Epidemic of Salmonella enterica Serovar Typhimurium in the Area of L'Aquila, Italy, Four Years after a Catastrophic Earthquake.	Nigro, G., Bottone, G., Maiorani, D., Trombatore, F., Falasca, S & Bruno G (2016). Italy	Clinical data and laboratory data collected from children that were hospitalized and ambulatory	National Health Institute, Experimental Zoonophylactic Institute, Department of Hygiene, Epidemiology & Public Health, & Department of Food & Nutrition Security (multidisciplinary working group)	Epidemiological Unit of San Salvatore hospital	Eggs, sausages and water sources from various food and water industries including homemade.
5	Increasing Incidence of Tuberculosis Infection in the Coastal Region of	Sakurai, M., Takahashi, T., Ohuchi, M., Terui, Y., Kiryu, K & Shikano, K (2016).	Annual tuberculosis patients' data between 1 April 2009 and 31 March 2013 obtained	Public health centres register tuberculosis cases and placed under control of states.	Miyagi Prefectural Government databases of public health centres	Classification for infections from tubercle bacillus was based from all forms of TB -

	Northern Miyagi after the Great East Japan Earthquake	Japan	from Miyagi Prefectural Government database			pulmonary, extra-pulmonary or LTBI. Age classification includes a wide range from 0-99 years old.
6	Characteristics of pneumonia deaths after an earthquake and tsunami: an ecological study of 5.7 million participants in 131 municipalities, Japan	Shibata, Y., Ojima, T., Tomata, Y., Okada, E., Nakamura, M., ... & Hashimoto, S (2016). Japan	Japan's Basic Resident Register 2010 and 2012, Vital Statistics 2010 and 2012, National Census 2010 - data on population and pneumonia deaths	Vital statistics on deaths - public health centres in prefectures collect and data sent to the Ministry of Health, Labour and Welfare, population data - Basic Resident Register (maintained by municipalities with monthly reports) and National Census (five yearly)	Ministry of Health, Labour and Welfare' registry	Both earthquake risk and tsunami risk were used for analysis of pneumonia risk ⇒ tsunami was found to increase pneumonia death
7	Risk Assessment of Malaria Prevalence in Ludian, Yongshan, and Jinggu Counties, Yunnan Province, after 2014 Earthquake Disaster	Feng, J., Xia, Z., Zhang, L., Cheng, S & Wang, R (2016). China	Cases from the Web-Based Reporting System from January 2005 to July 2015	Web-Based Reporting System (early daily detection of malaria cases) and Annual Reporting System ⇒ total number of cases - local and imported malaria cases). National Malaria Elimination Action Program (2010–2020)	The Health and Family Planning Commission of Yunnan Province organized health and epidemic prevention teams, with Ludian, Yongshan, and Jinggu Health Disease Control departments - Initiated post-earthquake epidemic prevention measures (full sanitation coverage and vector disease control).	Both types of cases were included - symptoms but no parasites detected (from blood sample) and laboratory-confirmed cases (laboratory test, microscopy, rapid diagnostic or polymerase chain reaction tests)
8	The influence of the Great East Japan Earthquake on tuberculosis control in Japan	Shimouch, A., Kobayashi, N., Nagata, Y., Urakawa, M & Ishkawa, N (2015). Japan	Casualties data - Ministry of Internal Affairs and Communications and also National Police Agency	Public health centres notify tuberculosis cases	Ministry of health - conduct tuberculosis control activities with treatment support by the public health nurses (via health centres)	TB patient data analysis included not just the result of investigation and treatment regimen, but also including information on patient support obtained from staff meetings
9	Eczema and Asthma Symptoms among Schoolchildren in Coastal and Inland Areas after the 2011 Great East Japan Earthquake: The ToMMo Child Health Study	Miyashita, M., Kikuya, M., Yamanaka, C., Ishikuro, M., Obara, T., ... & Kuriyama, S (2015). Japan	Questionnaire administered to parents of 25,198 children from 233 public schools in 13 municipalities of Miyagi Prefecture of Japan (northeast)	Tohoku Medical Megabank Organization (ToMMo) Child Health Study - observation of schoolchildren in 28 Miyagi Prefecture's municipalities after the earthquake in Great East Japan 2011 using International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire	Tohoku Medical Megabank Organization	Children in all grades were included (1st to 8th)
10	Tuberculosis in the aftermath of the 2010 earthquake in Haiti	Koenig, SP., Rouzier, V., Vilbrun, S.C., Morose, W., Collins, S.E., ... & Pape, J.W (2015). Haiti	Case finding for active tuberculosis in an internally displaced camp and also nearby slum. Screening for tuberculosis performed by community health workers. Symptoms of persistent	Reporting system - National Tuberculosis Program with Haitian Group for the Study of Kaposi's Sarcoma and Opportunistic Infections for active case finding and also Haitian National Laboratory	Ministry of Health	Slumps and camps were included in active case detection for TB cases ⇒ increment of cases was noted to be from actual disease burden as compared to improvement of case detection

			cough were referred to physician			
11	Molecular epidemiology of <i>Staphylococcus aureus</i> in post-earthquake northern Haiti	Rosenthal, M.E., Mediavilla, J., Chen, L., Sonnenfeld, J., Pierce, L., ... & Rojzman, A (2014). Haiti	<i>Staphylococcus aureus</i> nasal screening analysis in three settings; acute care, subacute rehabilitation, and community. Polymerase chain reaction-positive <i>Staphylococcus aureus</i> screening nasal cultures subjected to molecular analysis and also evaluation for antibiotic susceptibility	Survey and nasal screening were collected from the participant at 3 study sites	Swabs were transported on ice to the Public Health Research Institute at Rutgers University in Newark, New Jersey, USA for PCR test	All patient, healthcare workers and visitors were invited to enrolled in this study
12	A prospective cohort study of cutaneous leishmaniasis risk and opium addiction in south eastern Iran.	Aflatoonian, M.R., Sharifi, I., Hakimi Parizi M., Fekri, A.R., Aflatoonian, B., ... & Sharifi, H (2014). Iran	904 participants selected (226 opium addicts and 678 non-addicts) for interview and examination for possible disease and also history of opium consumption with active cutaneous leishmaniasis lesion or scars, followed up for seven years	Bam health personnel help in conducting this study by clinically examining, confirming and	N/A	N/A
13	Environmental factors influencing epidemic cholera	Jutla, A., Whitcombe, E., Hasan, N., Haley, B., Akanda, A., ... & Colwell, R (2013) Northern India and Pakistan	Analysis of cholera epidemic surveillance data and cholera mortality	N/A	Annual reports from Meteorological Reporter to the India Government (1875-1900) – surveillance data for epidemic cholera, Annual Reports of the Sanitary Commissioner to the Punjab Government (1875-1900) – cholera mortality	N/A
14	Cholera surveillance during the Haiti epidemic--the first 2 years	Barzilay, E.J., Schaad, N., Magloire, R., Mung, K.S., Boney, J., ... & Tappero, J.W (2013). Haiti	National Cholera Surveillance System	The NCSS was composed of both governmental and nongovernmental health facilities. Data were collected and reported to the health ministry by health authorities in the departments and communes. Technical staff from the Centers for Disease Control and Prevention (CDC) and the PAHO contributed to the design and continuous improvement of the system.	The health ministry was further responsible for the management, analysis, and dissemination of all data.	The NCSS modified the WHO case definition for cholera of “acute watery diarrhoea, with or without vomiting, in a patient aged 5 years or more” to include persons of any age in a cholera-affected department

				<p>In May 2011, the health ministry made commune-level data publicly available in surveillance reports through its official website</p> <p>Data from surveillance also being release through press conference, standardized report and weekly report</p> <p>The availability of commune-level data helped focus and direct support for specific cholera treatment centre</p> <p>The dissemination of commune-level data also allowed for targeted, intensified water and sanitation interventions and for the prioritization of sites for potential new interventions, such as the use of an oral cholera vaccine.</p>		
15	High-resolution spatial analysis of cholera patients reported in Artibonite department, Haiti in 2010–2011	Allan, M., Grandesso, F., Pierre, R., Magloire, R., Coldiron, M.,... & Porten, K. (2016). Haiti	Cross-sectional spatial analysis of population data and all patients seen and notified on the health facility registers in Artibonite from October 2010 (epidemiological week 42), to the end of 2011 (epidemiological week 52)	<p>Immediately after the first reported cases, Haiti's Ministry of Health (MOH) set up a dedicated cholera surveillance system to record cholera patients and deaths.</p> <p>These data, regularly updated, have been available online since the beginning of the epidemic.</p> <p>An overview of cases reported in this surveillance system during the first two years of the epidemic was published in February 2013</p>	<p>The local health department were responsible the aggregate to reported to the MOH</p> <p>During out-break phases, the MOH, various non-governmental organizations and local health workers would perform ad hoc analyses of the geographic origin of patients at these lower levels in order to better target interventions</p>	N/A
16	The prevalence of helicobacter pylori among dyspeptic patients in an earthquake-stricken area	Suvak, B., Dulger, A. C., Suvak, O., Aytemiz, E., & Kemik, O., (2015). Turkey	Between December 2011 and February 2012 (one month following an earthquake), 209 dyspeptic patients who underwent gastroscopy were included in the study. Furthermore, the current H. pylori prevalence was evaluated among 139 dyspeptic patients between January 2014 and May 2014.	Medical data were obtained from 97 dyspeptic patients (57 women and 40 men, aged 18-75 years) who underwent GI endoscopy before the earthquake. Between January 2014 and May 2014, 139 dyspeptic patients (60 female, mean age 48;4 years) were also selected in the same region to evaluate the current status of H. pylori infection.	Ministry of Health	There is equality and no discrimination in selecting the data from the same locality.
17	Post-treatment Clinical Outcomes of Cutaneous	Ayubi, E., Ashrafi-Asgarabad, A., Safiri, S.,	Cross sectional study using pre-existing data from	Data from epidemiologic surveillance systems provided by Kerman Health Center	N/A	Al. 9,077 individuals infected by CL caused by L. tropica

	Leishmaniosis (CL) in the Bam Area, South Eastern Iran: Analysis of over 9,000 Cases	Kousha, A., Baniasadi, M., & Augner, C. (2015). Iran	epidemiologic surveillance systems was conducted from March 2003 to March 2011 in the Kerman province including Bam and Normashir. 9,077 individuals infected by CL were included in the study			were included in the study
18	Effectiveness of reactive oral cholera vaccination in rural Haiti: a case-control study and bias-indicator analysis	Ivers, L.C., Hilaire, I.J., Teng, J.E., Almazor, C.P., Jerome, J.G., ... & Franke, M.F., (2015). Haiti	Two matched case-control studies examine the effectiveness of oral cholera vaccination involving 47 cases and 42 controls. The studies were done in the Artibonite Department of Haiti, in three health centres that provide primary health services	Community health workers in the region were train to undertake surveillance and refer acute watery diarrhoea cases to the health centre,	Oral cholera vaccination campaign with bivalent whole-cell vaccine and this study was conducted with partnership with the Haitian Ministry of Health.	All who were eligible for the vaccination campaign (i.e., age ≥ 12 months, not pregnant, and living in the region at the time of the vaccine campaign) were included.
19	Investigation of an Influenza A (H3N2) outbreak in evacuation centres following the Great East Japan earthquake	Kamigaki, T., Seino, J., Tohma, K., Soma, N. N., Otani, K., & Oshitani, H., (2011). Japan	105 confirmed cases investigated, conducted in five evacuation centres, reported minimum of one influenza case (23 March - 11 April 2011). Cases confirmed by point-of-care tests. Residues were obtained and subjected to PCR for sub-typing of influenza	Data was obtained from five evacuation centres with at least one reported influenza case. Epidemiological data, including demographic characteristics, residence, date of onset, clinical symptoms, familial links to previous cases, and history of wearing masks, were obtained by interviewing patients.	Ministry of Health Japan prioritized all residents aged ≥ 65 years for influenza vaccination	There is no discrimination in selecting the evacuation centres, it involved all school and community centres
20	Deterioration in regional health status after the acute phase of a great disaster: Respiratory physicians' experiences of the Great East Japan Earthquake	Ohkouchia, S., Shibuyaa, R., Yanaia, M., Kikuchia, Y., Ichinoseb, M., & Nukiwaa, T., (2012). Japan	Fourteen regional core hospitals In Miyagi responded to the questionnaire	Health-Promoting Association of Respiratory Medicine of Tohoku. Data was collected according to the number of operating beds available from fourteen regional core hospitals.	The Ministry of Health, Labour and Welfare (MHLW) of Japan - medical assistance teams (DMATS)	N/A

21	Impact of the Tohoku earthquake and tsunami on pneumonia hospitalisations and mortality among adults in northern Miyagi, Japan: a multicentre observational study	Daito, H., Suzuki, M., Shiihara, J., Kilgore, P. E., Ohtomo, H., Morimoto, K., ... & Okinaga, S., (2013). Japan	A multicentre survey was conducted at three hospitals in Kesennuma City, northern Miyagi Prefecture. All adults aged ≥ 18 years hospitalised between March 2010 and June 2011 with community-acquired pneumonia were identified using hospital databases and medical records. Total of 550 pneumonia hospitalisations were identified (325 during pre-disaster and 225 cases during post-disaster period)	Kesennuma City Hospital (KCH), the Kesennuma City Medical Association and Nagasaki University. Demographic, clinical, radiographic, microbiological and evacuation site information was collected from the medical charts. The patients' addresses before the disaster were extracted from the hospital database and converted to geographical coordinates. Patients with pneumonia who died in any of the three study hospitals were categorised as fatal cases. The severity of pneumonia was assessed using the CURB65 scoring system	Ministry of Health	N/A
22	Mobile device-based Reporting System for Sichuan Earthquake-affected Areas Infectious Disease Reporting in China	Yan, G., & Mei, S. X., (2012). China	Software engineering and business modelling are used to design and develop a cellphone-based reporting system. The PDA-based system used by the Field Adapted	County hospital level report a national notifiable disease via the web-based reporting system to the China CDC (CCDC) and county CDC, for review and verification. The data are aggregated and analysed on a daily, weekly, monthly, and	It was difficult to assess the region's health needs or monitor potential disease outbreaks. There was only partial recovery of telecommunications systems	N/A

Epidemiological surveillance following earthquake as shown in Table 3.2 covers disease from air borne and respiratory disease, vector borne disease, water borne disease, blood borne disease and gastrointestinal tract disease

Table 3.2: Diseases Surveillance following Earthquake

No.	Title	Author, Year, Country	N, Population setting /Data Source /Study description	Type of Disease	Findings
1	Impact of the 2016 Ecuador Earthquake on Zika Virus Cases	Vasquez, D., Palacio, A., Nuñez, J., Briones, W., Beier, J.C., ... & Tamariz, L (2017). Ecuador	2234 patients suspected of having Zika virus infection (affected and control areas)	Vector borne	1110 patients had a reverse transcription-polymerase chain reaction assay, 159 were positive for ZIKV. The cumulative incidence of ZIKV in the affected area was 11.1 per 100 000 after the earthquake. The odds ratio of having ZIKV infection in those living in the affected area was 8.0 (95% CI = 4.4, 14.6; $P < .01$) compared with the control area.
2	Hepatitis E virus seroepidemiology: a post-earthquake study among	Shrestha, A.C, Flower, R.L., Seed, C.R., Rajkarnikar, M., Shrestha, S.K., Thapa, U..., &	1845 blood donors from earthquake-affected-regions, tested for Hepatitis E virus IgM, IgG and	Blood borne	3.2% had Hepatitis E virus IgM positive and two donors had Hepatitis E virus antigen positive. 41.9% had Hepatitis E virus IgG positive. Higher Hepatitis E virus IgG and IgM prevalence in donors who ate pork (likely to

	blood donors in Nepal	Faddy, H.M. (2016). Nepal	antigen		be zoonotic transmission)
3	Plasmodium falciparum Drug-Resistant Haplotypes and Population Structure in Postearthquake Haiti, 2010.	Morton, L.C., Huber, C., Okoth, S.A., Griffing, S., Lucchi, N., ... & Barnwell, J.W (2016). Haiti	349 blood spots from suspected cases of malaria in temporary health facilities in Port-au-Prince	Vector borne	121 samples were positive for Plasmodium falciparum positive via polymerase chain reaction. These samples were genotyped for drug-resistant pfcrt, pfdfhr, pfdfps, and pfmdr1 alleles. 108 samples that were sequenced for chloroquine resistant markers in pfcrt - 107 were wild type (CVMNK) and one sample was a chloroquine-resistant allele (CVIET).
4	Pediatric Epidemic of Salmonella enterica Serovar Typhimurium in the Area of L'Aquila, Italy, Four Years after a Catastrophic Earthquake.	Nigro, G., Bottone, G., Maiorani, D., Trombatore, F., Falasca, S & Bruno G (2016). Italy	Clinical data and laboratory data collected from children that were hospitalized and ambulatory	Gastrointestinal tract disease	Salmonella infection occurred in 155 children (53% girls one to 15 years old). Out of these children, 44 children were hospitalized. Aterno river that borders the district of L'Aquila, was the source of local crops' contamination. Subsequently, the vegetables derived from the polluted crops.
5	Increasing Incidence of Tuberculosis Infection in the Coastal Region of Northern Miyagi after the Great East Japan Earthquake	Sakurai, M., Takahashi, T., Ohuchi, M., Terui, Y., Kiryu, K & Shikano, K (2016). Japan	Annual tuberculosis patients' data between 1 April 2009 and 31 March 2013 obtained from Miyagi Prefectural Government database	Air borne	Northern Miyagi's coastal region - number of tuberculosis patients increased in post-disaster (p < 0.001, 9.6 vs.19.1 per 100,000 people). Northern Miyagi's inland and coastal regions - number of patients with latent tuberculosis infection increased in post-disaster (p < 0.001)
6	Characteristics of pneumonia deaths after an earthquake and tsunami: an ecological study of 5.7 million participants in 131 municipalities, Japan	Shibata, Y., Ojima, T., Tomata, Y., Okada, E., Nakamura, M., ... & Hashimoto, S (2016). Japan	Japan's Basic Resident Register 2010 and 2012, Vital Statistics 2010 and 2012, National Census 2010 - data on population and pneumonia deaths	Air borne	6603 patients died because of pneumonia post one year of earthquake. Standardised Mortality Ratio increased significantly at first to 12th weeks. Second week's Standardised Mortality Ratio in inland and coastal regions were 1.48 (95% CI 1.24 to 2.61) and 2.49 (95% CI 2.02 to 7.64) respectively. Standardised Mortality Ratio of coastal region was higher than the inland region
7	Risk Assessment of Malaria Prevalence in Ludian, Yongshan, and Jinggu Counties, Yunnan Province, after 2014 Earthquake Disaster	Feng, J., Xia, Z., Zhang, L., Cheng, S & Wang, R (2016). China	Cases from the Web-Based Reporting System from January 2005 to July 2015	Vector borne	In the three counties, 87 malaria cases were reported 81.6% occurred between 2005 and 2009. Five cases in Jinggu County occurred between January 2014 and July 2015. In 2010 there was no local transmission in the three counties. Returning from Myanmar were the source of 95.5% of imported malaria cases. Main endemic areas in the three counties were Lehong, Qingsheng, and Weiyuan townships.
8	The influence of the Great East Japan Earthquake on tuberculosis control in Japan	Shimouch, A., Kobayashi, N., Nagata, Y., Urakawa, M & Ishkawa, N (2015). Japan	Casualties data - Ministry of Internal Affairs & Communications & also National Police Agency	Air borne	96 tuberculosis patients (on treatment) in the eight studied public health centres during earthquake did not default treatment
9	Eczema and Asthma Symptoms among Schoolchildren in Coastal and Inland Areas after the	Miyashita, M., Kikuya, M., Yamanaka, C., Ishikuro, M., Obara, T., ... & Kuriyama, S (2015). Japan	Questionnaire administered to parents of 25,198 children from 233 public schools in 13 municipalities of Miyagi Prefecture of Japan	Respiratory disease	Based on the International Study of Asthma and Allergies in Childhood questionnaire, prevalence of allergic symptoms in 2nd, 4th, 6th, and 8th graders were 12.4%, 9.9%, 9.3%, and 5.6% for wheeze, and 20.1%, 18.0%, 14.0%, and 12.4% for eczema, respectively. Multivariate logistic analysis -

	2011 Great East Japan Earthquake: The ToMMo Child Health Study		(northeast)		younger age, hospitalization history, difficulties in children's daily lives were statistically significantly associated with both allergic symptoms (both $P < 0.05$). Coastal municipality settlement associated with symptoms of eczema ($P = 0.0278$).
10	Tuberculosis in the aftermath of the 2010 earthquake in Haiti	Koenig, SP., Rouzier, V., Vilbrun, S.C., Morose, W., Collins, S.E., ... & Pape, J.W (2015). Haiti	Case finding for active tuberculosis in an internally displaced camp and also nearby slum. Screening for tuberculosis performed by community health workers. Symptoms of persistent cough were referred to physician	Air borne	After the earthquake, number of tuberculosis cases has increased - 693 per 100,000 (undiagnosed tuberculosis was higher for persons in the internally displaced camp, 1165 per 100,000 (urban slum), as compared to national estimates (230 per 100,000 population)
11	Molecular epidemiology of Staphylococcus aureus in post-earthquake northern Haiti	Rosenthal, M.E., Mediavilla, J., Chen, L., Sonnenfeld, J., Pierce, L., ... & Rojzman, A (2014). Haiti	Staphylococcus aureus nasal screening analysis in acute care, subacute rehabilitation, and community. PCR-positive Staphylococcus aureus screening nasal cultures subjected to molecular analysis and evaluation for antibiotic susceptibility	Respiratory disease	Carriage rates of methicillin-susceptible Staphylococcus aureus - 8.4%, methicillin-resistant S. aureus - 2.8%. There was also high rate of tetracycline resistance. MRSA had no virulence markers. Unique MSSA phenotypes were identified
12	A prospective cohort study of cutaneous leishmaniasis risk and opium addiction in south eastern Iran.	Aflatoonian, M.R., Sharifi, I., Hakimi Parizi M., Fekri, A.R., Aflatoonian, B., ... & Sharifi, H (2014). Iran	904 participants selected (226 opium addicts and 678 non-addicts) for interview and examination for possible disease and also history of opium consumption with active cutaneous leishmaniasis lesion or scars, followed up for seven years	Vector borne	Cutaneous leishmaniasis severity in opium addicts was significantly higher than non-opium addicts ($P < 0.001$), based on lesion numbers, duration and size
13	Environmental factors influencing epidemic cholera	Jutla, A., Whitcombe, E., Hasan, N., Haley, B., Akanda, A., ... & Colwell, R (2013) Northern India and Pakistan	Analysis of cholera epidemic surveillance data and cholera mortality	Water borne	Epidemic's location is near rivers with sporadic outbreaks (low river flows, so favourable cholera growth). Human activities interact with contaminated water causes epidemic (sanitary infrastructure compromised)
14	Cholera surveillance during the Haiti epidemic--the first 2 years	Barzilay, E.J., Schaad, N., Magloire, R., Mung, K.S., Boncy, J., ... & Tappero, J.W (2013). Haiti	National Cholera Surveillance System	Water borne	Until 20 October 2012, the reports were; 604,634 cases of infection, 329,697 hospitalizations, and 7436 deaths from cholera. 1675 of 2703 stool specimens (62.0%) isolated Vibrio cholera. In 2010, 57% of global cholera epidemic was from Haiti with 53% of global cholera deaths and 375% in 2011
15	High-resolution spatial analysis of cholera patients reported in Artibonite department, Haiti in 2010–2011	Allan, M., Grandesso, F., Pierre, R., Magloire, R., Coldiron, M., ... & Porten, K. (2016). Haiti	Cross-sectional spatial analysis of population data and all patients seen and notified on the health facility registers in Artibonite from October 2010 (epidemiological week 42), to the end of 2011	Water borne	The study result in high-resolution mapping for pinpointing locations most affected by cholera, and in the future could help prioritize the places in need of interventions such as improvement of sanitation and vaccination. The findings also describe spatio-temporal transmission patterns of the epidemic in a cholera-naïve country such as Haiti.

			(epidemiological week 52)		
16	The prevalence of helicobacter pylori among dyspeptic patients in an earthquake-stricken area	Suvak, B., Dulger, A. C., Suvak, O., Aytemiz, E., & Kemik, O., (2015). Turkey	Between December 2011 and February 2012 (one month following an earthquake), 209 dyspeptic patients who underwent gastroscopy were included in the study. Furthermore, the current H. pylori prevalence was evaluated among 139 dyspeptic patients between January 2014 and May 2014.	Gastrointestinal tract	H. pylori infection was observed in 118 of 209 (56.5%) disaster survivors with dyspepsia. In the pre-disaster group, H. pylori infection was found in 40 of 97 (41.2%) patients. Group of subjects who experienced the disaster, there were 112 (80.6%) patients with H. pylori infection.
17	Post-treatment Clinical Outcomes of Cutaneous Leishmaniosis (CL) in the Bam Area, South Eastern Iran: Analysis of over 9,000 Cases	Ayubi, E., Ashrafi-Asgarabad, A., Safiri, S., Kousha, A., Baniyasi, M., & Augner, C. (2015). Iran	Cross sectional study using pre-existing data from epidemiologic surveillance systems was conducted from March 2003 to March 2011 in the Kerman province including Bam and Normashir. 9,077 individuals infected by CL were included in the study	Vector borne	After the disastrous earthquake in the Bam area in 2003 the number of adverse post-treatment outcomes increased. Therefore, the occurrence of lesions on the head (face, ear and neck) had the strongest effects on the outcome. Completing treatment duration could be an important protective factor to preclude adverse outcomes
18	Effectiveness of reactive oral cholera vaccination in rural Haiti: a case-control study and bias-indicator analysis	Ivers, L.C., Hilaire, I.J., Teng, J.E., Almazor, C.P., Jerome, J.G., ... & Franke, M.F., (2015). Haiti	Two matched case-control studies examine the effectiveness of oral cholera vaccination involving 47 cases and 42 controls. The studies were done in the Artibonite Department of Haiti, in three health centres that provide primary health services	Water borne	Bivalent whole-cell oral cholera vaccine was found effectively protected against cholera in Haiti from 4 months to 24 months after vaccination.
19	Investigation of an Influenza A (H3N2) outbreak in evacuation centres following the Great East Japan earthquake	Kamigaki, T., Seino, J., Tohma, K., Soma, N. N., Otani, K., & Oshitani, H., (2011). Japan	105 confirmed cases were investigated, and the investigation was conducted in five ECs that had reported at least one influenza case from 23 March to 11 April 2011. Cases were confirmed by point-of-care tests and those residues were obtained and subjected to reverse transcription PCR and/or real time	Air borne	105 confirmed cases detected with a mean attack rate of 5.3% (range, 0.8%–11.1%). An epidemiological tree for two ECs demonstrated same-room and familial links that accounted for 88.5% of cases. Majority of cases occurred in those aged 15-64 years. No deaths were reported. Familial link accounted for on average 40.5% of influenza cases in two ECs and rooms where two or more cases were reported accounted for on average 85% in those ECs.

			RT-PCR for sub-typing of influenza		
20	Deterioration in regional health status after the acute phase of a great disaster: Respiratory physicians' experiences of the Great East Japan Earthquake	Ohkouchia, S., Shibuyaa, R., Yanaia, M., Kikuchia, Y., Ichinoseb, M., & Nukiwaa, T., (2012). Japan	Fourteen regional core hospitals In Miyagi responded to the questionnaire	Respiratory disease	Comparison of disease prevalence from March 11 to April 10 in 2011 and 2010 - number of inpatients in the hospitals listed was 2.7 times greater. CAP increases in poor health condition especially in shelters - 2.2 times higher in 2011 than in 2010. The number of patients with influenza increased from 1 in 2010 to 20 in 2011. The numbers of COPD and asthma exacerbation patients were about three times higher in 2011 than in 2010.
21	Impact of the Tohoku earthquake and tsunami on pneumonia hospitalisations and mortality among adults in northern Miyagi, Japan: a multicentre observational study	Daito, H., Suzuki, M., Shiihara, J., Kilgore, P. E., Ohtomo, H., Morimoto, K., ... & Okinaga, S., (2013). Japan	A multicentre survey was conducted at three hospitals in Kesenuma City (population 74 000), northern Miyagi Prefecture. All adults aged ≥ 18 years hospitalised between March 2010 and June 2011 with community-acquired pneumonia were identified using hospital databases and medical records. A total of 550 pneumonia hospitalisations were identified (325 during the pre-disaster period and 225 cases during the post-disaster period)	Respiratory disease	Majority (90%) of the post-disaster pneumonia patients were aged ≥ 65 years, and only eight cases (3.6%) were associated with near drowning in the tsunami waters. The clinical pattern and causative pathogens were almost identical among the pre-disaster and post-disaster pneumonia patients. A marked increase in the incidence of pneumonia was observed during the 3-month period following the disaster; the weekly incidence rates of pneumonia hospitalisations and pneumonia-associated deaths increased by 5.7 times (95% CI 3.9 to 8.4) and 8.9 times (95% CI 4.4 to 17.8), respectively. The increases were largest among residents in nursing homes followed by those in evacuation shelters.
22	Mobile device-based Reporting System for Sichuan Earthquake-affected Areas Infectious Disease Reporting in China	Yan, G., & Mei, S. X., (2012). China	Software engineering and business modelling are used to design and develop a cellphone-based reporting system. The PDA-based system used by the Field Adapted Survey Toolkit (FAST) was deployed. 1339 records were collected using PDAs developed and deployed by FAST.	All types of diseases	Approximately one week after deployment of the mobile phone-based reporting system, the cumulative reporting rate reached the same level (81%) as the same period in 2007.

Following a disaster, the pre-existing relationships of people and environment and inter-person's social relationships are disrupted. Therefore, mitigation actions towards the reduction of adverse health effects are vital to be implemented by public health persons. Subsequently, to contain as much damage as possible and most importantly to restore public service delivery to level of pre-disaster, everyone that is involved in the effort of relief needs information that is timely and precise. This would include victims, field-workers, coordinators, managers and also policymakers. Hence, surveillance is crucial for identification of health problems, establishment of priorities by decision-makers and finally to evaluate effectiveness of implemented activities of relief (Noji, 1997).

3.1 Post Disaster Governance following Earthquake

Governance is often defined as a system that enables collaborative activities that bring together multiple organizations (government and non-government) to solve problems that extend beyond the purview of any single organization (Tierney & Oliver-Smith, 2012). Governance structures include public sector organizations, community-based organizations, private sector organizations, international relief organizations and nations, and emergent groups and individuals (Smith & Birkland, 2012).

The different forms of governance are authority, power, influence, degree of decentralization, and accountability affect disaster recovery. It is important to understand, for instance, how policy initiatives with local communities can be influenced by the way local and national governments work together and how larger trends in national policies affect the capacities of communities to engage with their governmental agencies. Defining the forms of governance that take the energy and commitment individuals and communities show during an emergency and sustain it through appropriately aligned government efforts, especially in response and recovery situations, is one of the key challenges of successful recovery (MNRPG, 2013). Furthermore, if successful recovery requires informed, coordinated, and sustained leadership throughout all levels of government and community and phases of the recovery process (Federal Emergency Management Agency (FEMA), 2011), it is paramount to design governance structures that foster meaningful engagement between the state and civil society (MNRPG, 2013).

World Bank (2011), identified good recovery governance as pre-planning for recovery, introduction of specific agencies to deal with recovery, commitment to community engagement, government agencies working with local government in recovery planning, pre-existing aid and recovery arrangements, incorporation of risk mitigation strategies into recovery planning, provision of advice to individuals and learning and improving pre-existing arrangements. Among the consequences of disaster such as earthquake were facilities and equipment were destroyed or lack of other resources which lead to unconfirmed diagnosis and affect disease surveillance (Barzilay et al., 2013; Kamigaki et al., 2011; Rosenthal et al., 2014; Suvak et al., 2015). This should be in mind and be part of the recovery planning so that alternative strategies can be provided should these problems arise.

Leadership at all levels, including spontaneous, emergent leadership typical of disasters, requires governments to be able to anticipate and adapt. In nearly every national experience, policy leaders have encountered situations in which community members have spontaneously

organized and begun to respond and recover to a disaster well before government agencies and programs have mobilized. It is important to understand how various forms of governance align with these mobilizations that occur largely outside the control and direction of particular agencies. Governments need to learn to identify and work with community leader and even help create effective leaders because they are the potential allies and partners for government authorities (MNRPG, 2013).

International policymakers identified that, to a large extent, the challenge of building disaster resilience is a matter of democratic governance. It involves partnering with communities, building mutual support within communities and across jurisdictional boundaries, and sustaining involvement. In general, the work of building resilience, both pre- and post-disaster, demands cooperation among citizens, between subnational and national levels of government, and integration of both the public and private sectors and thus closely resembles the collaborative nature of community recovery. Furthermore, research and policymaking have been advanced by views of resilience as a construct formed through the interdependencies that evolve from established societal patterns and not as a replica of institutional, group, or program arrangements (MNRPG, 2013). Governance for recovery requires leadership capable of transforming historical hierarchical government models into adaptable, integrated, networked, multi-stakeholder environments with deliberative and collaborative models of state-civil society. In other words, effective governance for recovery is synonymous with effective governance for resilience (MNRPG, 2013).

Governance understands social capital and the power of social groups to organize, generate, and deploy individuals within a community to take decisive action when facing hardships (Multi-national Resilience Policy Group (MNRPG), 2013). Therefore, public health and emergency management professionals must be prepared to respond to and meet the needs of the affected public with proper comprehensive governance mechanism.

An effective epidemiological surveillance should fulfil the characteristics of good governance which are; participation and transparency, accountability and rule of law as well as non-discrimination and equality (UNDP, 2011). Participation and transparency include empowerment through having representative in the government and also via other mechanisms that facilitates free, active and meaningful involvement in decision-making processes. During times of crises this may contribute to the overall adaptability and stability of institutions and promotes innovative policy dialogues (UNDP, 2011). Involvement of County hospital in mobile device-based reporting system for Sichuan earthquake-affected areas infectious disease reporting in China was an example of participation and transparency of good governance characteristic. There were 68 000 users accessing the system daily at all levels and it was beneficial as phone-based reporting system for infectious disease surveillance (Yan & Mei, 2012). Transparency of the data can help other party to utilize it for other purpose. For examples, the dissemination of cholera surveillance data during the first year of outbreak enabled targeted, intensified water and sanitation interventions and for the prioritization of potential new interventions, such as the use of an oral cholera vaccine (Barzilay, 2013). However, there are instant whereby the ad hoc data analysis by government and various stakeholders were used solely for operational purposes and have not been published and were unknown to others (Allan et al., 2016). Therefore, others cannot use it for different purposes.

Participation adds on to effective accountability and rule of law. With regards to crisis, it has been recognised that, as governments assume a broader, more significant role in response to crisis, it becomes even more important that they are effective and accountable; otherwise, they would compound the severity of the problems (UNDP, 2011). Where the rule of law exists, it is easier to manage potential conflicts during crisis. In Japan for instance, Ministry of Health Japan, prioritised all residents aged ≥ 65 years for influenza vaccination (Kamigaki et al., 2011). Moreover, another article portrayed the lack of accountability. Hepatitis E virus outbreak occurred frequently in the past four decades in Nepal but lacked baseline IgM positive blood donors (Shrestha et al., 2016). Hence, respective organisation ought to be made accountable to respond to these recurrent outbreaks.

Equality addresses power inequalities and requires the extension of development gains to the most excluded groups and individuals (United Nations Office of the High Commissioner for Human Rights (UNOHCHR), 2008). In the context of effective surveillance system, there should be equality and non-discrimination of the data. In the study by Allan et al. (2016), the National Cholera Surveillance System recorded 590 community deaths, which had not visited Health facilities prior to their death. Because this data was not recorded in health facilities, it was not included in the study while other cases who visited the health facilities were included (Allan et al., 2016).

3.2 Diseases Surveillance following Earthquake

Surveillance system is important as it promotes integration and comprehensiveness, through all-hazards' approaches, supported by frameworks and structures and based upon a shared system of governance and policy making (Mamula-Seadon, 2014). An effective surveillance system should consider the diseases under surveillance, objectives and procedures of conducting the surveillance and methods of informing policymakers for practical purposes. An efficient coordination and integration is required in a surveillance system with multiple diseases. Furthermore, to strengthen a country's national surveillance system, there are multiple strategies that can be implemented. The strategies include; prioritisation of diseases for surveillance, assessments of systems that are already in place, action plans' projections, actual implementations of plans and finally, monitoring and evaluations (WHO, 2006). Surveillance system needs to be updated regularly. A study by Vasquez et al. (2017) on Zika cases post-earthquake faced difficulty because the surveillance data was not linked to medical record of the patient to evaluate their clinical symptoms of suspected or confirmed case. Therefore, including the clinical symptoms in the surveillance data can make improvement.

There are multiple levels of surveillance namely central, intermediate, and peripheral and community. Providers are included in each level and may or may not be included in the system of surveillance. Implementers and stakeholders include institutional training centres and laboratories pertaining to public health and also programmes that are disease specific. Description of roles and responsibilities of stakeholders and implementers should be clearly outlined. This would also include their inter-relationships. Besides that, data flow, dissemination and information usage also need to be comprehensive across the surveillance levels (WHO, 2006).

Multiple stakeholders and partners collaboration is the effort needed for intra and inter-countries' effective implementation of a comprehensive system of surveillance. At national level, laboratory network is an example of intra-collaboration whereas for inter-countries' collaboration, the focus is on activities of surveillance and response (WHO, 2006). Based on the articles reviewed, one of the difficulties faced by post-earthquake studies was that the migration of the people or evacuee from or to the affected area (Sakurai et al., 2016; Shibata et al. 2016; Yan & Mei, 2012). This might lead to underestimating or overestimating the magnitude of the disease whether the infected people leaving the area or moving into the area being studied. Strong partnership between the local authorities is needed to track down the movement of the infected people. It is important in cases such as tuberculosis in which the patient need to be complete the course of treatment.

4.0 Conclusion and Recommendations

Transformation in governance post disaster are designed to build and sustain institutional capacity for recovery by engaging across a broad sector of government and nongovernment organizations, to allow for formation and growth of partnerships through enabling processes, and to facilitate fuelling of the recovery process with money and information through coordination between different levels and stakeholders. Supportive governance embracing of stakeholder engagement is necessary to ensure coping capacities in societies. For engagement and coordination to lead to effective recovery, governance has to ensure broad participation, transparency, accountability, efficiency, and responsiveness. Integrating social capital, ensuring meaningful deliberation and engagement with affected communities, achieving effective vertical coordination with multiple levels of government and other stakeholders, and capacity building at the local and regional level are among key factors for effective recovery governance and leadership. An adaptable, integrated, networked, multi-stakeholder environment with deliberative and collaborative models of state-civil society – governance for recovery is synonymous with effective governance for resilience.

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Declaration

Authors declare that this manuscript has never been published in any other journal.

Authors contribution

Author 1: information gathering, preparation and editing of manuscript

Author 2: information gathering, preparation and editing of manuscript

Author 3: information gathering, preparation and editing of manuscript

Author 4: final review of manuscript and final editing

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