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Review

Infections After the Earthquake Disaster

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ABSTRACT

Earthquakes are among the most frequent natural disasters, responsible for approximately 1.87 million deaths in the 20th century. A magnitude-7.8 earthquake hit southeastern Turkey and parts of Syria in the early morning of February 6th, 2023. Earthquakes damage hospitals and healthcare facilities and lead to reduced emergency capacity. Such situations worsen the physical and mental health conditions of injured individuals. The incidence of infections due to injuries/trauma, water and foodborne infections, and acute respiratory infections were reported. Herein, we reviewed the infections among susceptible individuals, which may more easily develop in this area.

Keywords: Disasters, earthquake, infectious diseases

Introduction

Earthquakes are among the most frequent natural disasters, responsible for approximately 1.87 million deaths in the 20th century (1). Earthquakes occur with different frequencies around the world. Turkey is located on the Anatolian plate, where major earthquakes have occurred throughout history. From the 1900s to the present, 20 earthquakes with a magnitude of 7 have occurred, and unfortunately, Turkey is one of the countries most affected by earthquakes. A magnitude-7.8 earthquake hit southeastern Turkey and parts of Syria in the early morning of February 6th, 2023. The earthquake was followed by another 7.5 magnitude earthquake approximately 9 hours later, with more than 200 aftershocks causing at least 50,000 people to lose their lives, with thousands more injured.

Developing countries are more vulnerable to disasters because of their lack of resources, infrastructure, and disaster preparedness systems. Such devastating earthquakes have serious health, social and economic consequences. In the acute period after the earthquake, deaths are seen as a result of the collapse of the buildings where people live, and the traumas experienced. In the post-earthquake period, various infections may develop, and the earthquake survivors may be lost due to these infections. Stress from earthquakes and trauma, lack of hygiene, and unsuitable environmental conditions pave the way for infections. As a result of damage to infrastructure services such as electricity, water, and sewage systems, people's inability to access sufficient and clean drinking water and contamination from sewage systems to drinking water (fecal contamination), especially water and foodborne infections can occur. People who live in affected areas are usually forced to change their lifestyles, and sheltering the people affected by the earthquake in crowded camps also poses the risk of infections developing. Earthquakes damage hospitals and healthcare facilities and lead to reduced emergency capacity. Such situations worsen the physical and mental health conditions of the injured individuals. The post-earthquake period can be divided into three phases in terms of the development of infections (2):

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• **Phase 1 (0-4 days):** Treatment of injuries, skin and soft tissue infections secondary to trauma

• **Phase 2 (4 days-4 weeks):** Infections caused by collective life in the camp areas, contagious diseases

• Respiratory tract infections, droplet-borne infections.

• Foodborne and/or waterborne infections

• **Phase 3 (> four weeks):** Infections with long incubation periods, latent infections,

Post-earthquake infections and/or epidemics usually occur 4-30 days after an earthquake. The incidence of infectious diseases has been reported to increase after destructive earthquakes worldwide. Post-earthquake infections and/or epidemics can develop due to the displacement of large numbers of people, the overcrowding of communal living areas, a decrease in clean water resources and/or inadequate hygiene practices, an excessive proliferation of vectors, malnutrition, and many more adverse conditions which arise depending on the magnitude of the earthquake, particularly in developing and/or undeveloped countries. Respiratory, gastrointestinal and skin infections are the most common infections detected in the post-earthquake period.

Infections due to Injuries/Traumas

Wound infections are common after crush injuries. Traumatic abrasions and lacerations may become infected due to contact with concrete, wood, metal, soil, or contaminated water. The longer the stay under the rubble is, the higher the possibility of developing crush syndrome and the greater the risk of exposure to pathogens become. The deterioration of skin integrity with injury, necrotic tissue, and protein-rich exudate from the wound lead to bacterial colonization and infections. In addition to these facilitating conditions, fasciotomies also increase the development of infections. The most common agents in wound infections are *Staphylococcus* spp. and *Streptococcus* spp. Gram-negative bacteria such as *Aeromonas, E. coli, Klebsiella*, *Pseudomonas*, anaerobic pathogens, and fungi are the most commonly detected pathogens.

Chen et al. (3) reported that 66.7% of the patients with crush syndrome became infected after 48 hours of admission and *Acinetobacter baumanii* and *Pseudomonas aeruginosa* were the most common bacterial isolates in the wound infections after the Wenchuan earthquake. Guner and Oncu (4) reported that 60.9% of those patients with crush syndrome had wound infections, and 15% developed sepsis. Infectious complications were reported in 75.7% of the patients with crush syndrome in another article, of which wound infections were the most common. Wound infections occurred in all patients undergoing fasciotomy (5). *Staphylococcus aureus*, *Escherichia coli, Enterococcus faecalis*, and *Enterobacter cloacae* were the most frequent pathogens isolated from pus or wounds during the initial stage of admission, while *Acinetobacter baumannii, Pseudomonas aeruginosa*, and *Klebsiella pneumonia* were the most frequent pathogens during the middle and advanced stages of admission (5). Sepsis and wound infections were reported to be the most common infectious complications after the 1999 Marmara Earthquake (6). *Acinetobacter* spp., *Pseudomonas* spp. and *Staphylococcus* spp. were the most frequent microorganisms detected in the blood cultures of those patients with sepsis, while *Acinetobacter* spp., *Pseudomonas* spp., *Klebsiella* spp., and *Staphylococcus* spp. were the most common in wound infections. Bulut et al. (7) documented infections in 25.8% of hospitalized patients after the 1999 Marmara earthquake. Deep surgical infection was the most common infection (33%), and bacteremia occurred in 20% of cases. The most frequently isolated microorganisms were *Pseudomonas aeruginosa, Acinetobacter baumannii*, methicillin-resistant *Staphylococcus aureus*, and *Candida* spp.

Water and Foodborne Infections

Diarrhea outbreaks, Hepatitis A and E infections can develop particularly in developing countries. Diarrhea is the most important cause of death in the shelter camps where the survivors stay (8). The cause of diarrhea is usually due to the use of dirty water. Water contamination can be caused by sewage mixing or contamination during its transportation and/or storage. In addition, diarrhea outbreaks have been reported to occur due to the use of common water tanks or the pots and pans used in food preparation. A lack of hygiene products and contaminated food are the other leading factors (9). *Salmonella enterica* serotype Paratyphi A, *Vibrio cholerae,* and norovirus are the most common pathogens (9,10). In a study conducted after the 1999 Marmara earthquake, it was reported that diarrhea cases increased after the earthquake, and the most common cause was *Shigella* spp. (11). Following the 2005 earthquake in Pakistan, an estimated 42% increase in diarrheal infections was reported in an unplanned and poorly equipped refugee camp (12). Due to poor hygiene, over-crowding, a lack of potable water, and ineffective sanitation, an increase in diarrheas was reported in Iran after the 2003 earthquake (13). *V. cholerae* is highly endemic in countries with pre-existing poor water, sanitation, and sewage systems where disasters such as earthquakes,

floods, and tsunamis can exacerbate the risk of infection; however, microbiological laboratories are often absent or limited in these areas.

Leptospirosis can be transmitted through contact with contaminated water, food and soil containing contaminated urine (leptospires) from infected animals (e.g., rodents). Contamination occurs through the contact of damaged skin and mucous membranes with water, damp soil, or mud contaminated with rodent urine. Increased risk factors and outbreaks were reported after Typhoon Nali (14) in China and Taiwan in 2001.

Increases in hepatitis A and hepatitis E have also been reported after earthquakes, in the event of the collapse of the sewer system, or when there is a disturbance in the discharge of wastewater or difficulties in accessing clean drinking water. Clusters of hepatitis A and E cases were also described among a susceptible community in Banda Aceh (Indonesia) following the 2004 tsunami disaster (15). Sencan et al. (16) evaluated the HAV and HEV seroprevalence in children living in post-earthquake camps in Düzce, with hepatitis A and E seroprevalence found to be higher in disaster survivors in those who had more difficulty in reaching hygiene materials. Kaya et al. (17) reported high hepatitis A seroprevalence (64%), persisting for four years after the 1999 Düzce earthquake; however, hepatitis E was rare (0.3%).

Infections Associated with Overcrowding

Acute respiratory infections (ARIs) may be increased due to overcrowding, poor ventilation, and poor nutrition in crowded shelters, specifically in cold weather (18). A study conducted after the 2001 El Salvador earthquake showed that 30% of affected people experienced upper respiratory tract infection (19). In Iran, ARIs were found among 14% of the survivors after Bam earthquake in 2003 (13).

Influenza, SARS-CoV-2, Measles, Neisseria meningitidis infections, and tuberculosis are important infectious diseases which can more easily develop in overcrowded camp areas; therefore, vaccination plays a critical role in preventing these pathogens. Crowded conditions also increase the risk of scabies infestation due to a lack of hygiene, insufficient water consumption, and the shared use of beds.

Ethics

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References

1. Naddaf M. Turkey-Syria earthquake: what scientists know. Nature 2023; 614:398-9.
2. Kouadio IK, Aljunid S, Kamigaki T, Hammad K, Oshitani H. Infectious diseases following natural disasters: prevention and control measures. Expert Rev Anti Infect Ther 2012; 10:95-104.
3. Chen X, Zhong H, Fu P, Hu Z, Qin W, Tao Y. Infections in crush syndrome: a retrospective observational study after the Wenchuan earthquake. Emerg Med J 2011; 28:14-7.
4. Guner SI, Oncu MR. Evaluation of crush syndrome patients with extremity injuries in the 2011 Van Earthquake in Turkey. J Clin Nurs 2014; 23:243-9.
5. Zhang H, Zeng JW, Wang GL, Tu CQ, Huang FG, Pei FX. Infectious complications in patients with crush syndrome following the Wenchuan earthquake. Chin J Traumatol 2013; 16:10-5.
6. Keven K, Ates K, Sever MS, et al. Infectious complications after mass disasters: the Marmara earthquake experience. Scand J Infect Dis 2003; 35:110-3.
7. Bulut M, Fedakar R, Akkose S, Akgoz S, Ozguc H, Tokyay R. Medical experience of a university hospital in Turkey after the 1999 Marmara earthquake. Emerg Med J 2005; 22:494-8.
8. Connolly MA, Gayer M, Ryan MJ, Salama P, Spiegel P, Heymann DL. Communicable diseases in complex emergencies: impact and challenges. Lancet 2004; 364:1974-83.
9. Waring SC, Brown BJ. The threat of communicable diseases following natural disasters: A public health response. Disaster Manag Response 2005; 3:41-7.
10. World Health Organization. Diarrheal diseases (2009): WHO Fact-sheet No. 330 (2009). http://www.who.int/mediacentre/factsheets/fs330/en/
11. Vahaboğlu H. Epidemic Control and Surveillance Study Carried Out After the Marmara Earthquake. ANKEM Derg 2001; 15:657-660.
12. World Health Organization. Acute water diarrhea outbreaks. Wkly Morb Mortal Rep 1, 6 (2005)
13. Akbari ME, Farshad AA, Asadi-Lari M. The devastation of Bam: an overview of health issues 1 month after the earthquake. Public Health 2004; 118:403-8.
14. Yang HY, Hsu PY, Pan MJ, et al. Clinical distinction and evaluation of Leptospirosis in Taiwan -- a case control study. J Nephrol 2005; 118:45-53.
15. World Health Organization. Acute jaundice syndrome. Wkly Morb Mortal Rep 2006; 23:8.
16. Sencan I, Sahin I, Kaya D, Oksuz S, Yildirim M. Assessment of HAV and HEV seroprevalence in children living in post-earthquake camps from Düzce, Turkey. Eur J Epidemiol 2004; 19:461-5.
17. Kaya AD, Ozturk CE, Yavuz T, Ozaydin C, Bahcebasi T. Changing patterns of hepatitis A and E sero-prevalences in children after the 1999 earthquakes in Duzce, Turkey. J Paediatr Child Health 2008; 44:205-7.
18. World Health Organization. Flooding and communicable diseases factsheet. Risk assessment and preventive measures. www.who.int/hac/techguidance/ems/flood_cds/en/.
19. Woersching JC, Snyder AE. Earthquakes in El-Salvador: a descriptive study of health concerns in a rural community and the clinical implication, part I. Disaster Manag Response 2003; 1:105-9.