American Journal of Medical Case Reports, 2024, Vol. 12, No. 5, 68-72
Available online at http://pubs.sciepub.com/ajmcr/12/5/1
Published by Science and Education Publishing
DOI:10.12691/ajmcr-12-5-1

Issues in the Acute Phase of the Noto Peninsula Earthquake in Reiwa 6 (2024)

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Received March 16, 2024; Revised April 18, 2024; Accepted April 25, 2024

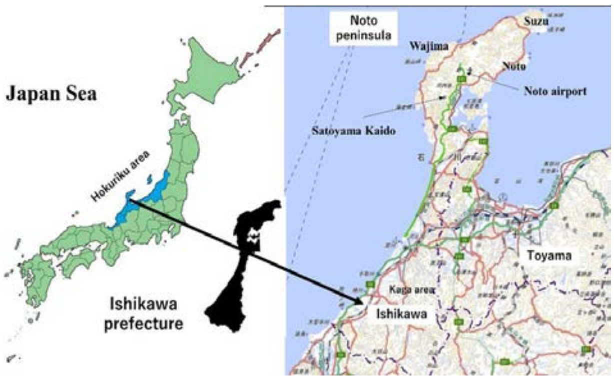
Abstract The earthquake and ensuing tsunamis caused 241 fatalities, 1,299 injuries, and damaged 110,287 residences in the Noto Peninsula amid harsh winter conditions. Demographic vulnerabilities, including an aging population and depopulation trends, heightened the region's susceptibility. Lifeline destruction, compounded by challenges in providing relief via land, sea, and air, was evident. Prolonged recovery operations led to secondary evacuations and difficulties in restoring daily life. Medical aspects revealed casualties, infrastructure damage, and decreased functionality in Wajima and Suzu City. Evacuation centers witnessed issues like hypothermia and infection concerns among the elderly. Approximately 650 Disaster Medical Assistance Teams were mobilized. The Noto Peninsula earthquake highlights unique challenges in aging and depopulating regions, emphasizing the need for disaster preparedness and response in similar vulnerable areas.

Keywords: *Noto Peninsula, earthquake, disaster*

Cite This Article: Youichi Yanagawa, Hiroki Nagasawa, Hiroaki Taniguchi, Tatsuro Sakai, Kazuhiko Omori, and Hiromichi Ohsaka, "Issues in the Acute Phase of the Noto Peninsula Earthquake in Reiwa 6 (2024)." *American Journal of Medical Case Reports*, vol. 12, no. 5 (2024): 68-72. doi: 10.12691/ajmcr-12-5-1.

1. Introduction

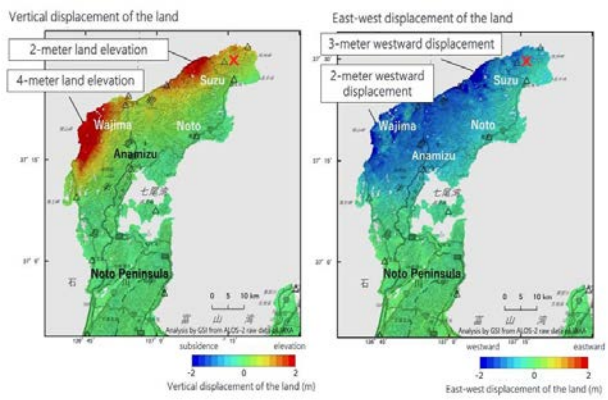
On January 1, Reiwa 6, at 16:10, the Noto Peninsula Earthquake with an estimated magnitude of 7.6 occurred (Figure 1). This seismic event resulted in an expansion of approximately 4.4 square kilometers of land towards the sea within a range of about 90 kilometers on the northern side of the Noto Peninsula. [1]



Noto Peninsula protrudes northward from the central region of the Hokuriku area into the Sea of Japan, making it the peninsula with the largest projection area along the Japan Sea coastline. It suffered significant damage, particularly in areas along the Satoyama Kaido and main arterial roads along the coastline.

Figure 1. Map of main roads in Ishikawa prefecture

The maximum coseismic displacement was observed in Wajima City, Ishikawa Prefecture, measuring approximately 240 meters (Figure 2). Furthermore, the ground uplift in Wajima City reached a maximum of 3.9 meters, marking the most significant uplift in the past 6,000 years. [2]



In the western part of Wajima City, an uplift of approximately 4 meters and a westward movement of up to approximately 2 meters are observed. In the northern part of Suzu City, an uplift of approximately 2 meters and a westward movement of up to approximately 3 meters are observed. Analysis by GSI from ALOS-2 raw data of JAXA Geospatial Information Authority of Japan

Figure 2. Analysis of Earth Observation Data from DAICHI-2 for Crustal Deformation Associated with the 2024 Noto Peninsula Earthquake in the Reiwa 6th Year

The earthquake was characterized by a seismic intensity of 7 in Shika Town, Ishikawa Prefecture, and coastal areas experienced tsunamis, causing widespread damage. As of March 19, 2024, it has been confirmed that there were more than 241 fatalities, over 1,299 injuries, and damage to 110,287 residences due to this seismic event. [3,4]

We conducted a study with the aim of understanding the extent of the damage and revealing its characteristics based on information announced by the administration and the media during the local earthquake disaster.

2. Material and Methods

The protocol of this retrospective study was approved by our institutional review board, and the examinations were conducted according to the standards of good clinical practice and the Declaration of Helsinki. The approval number was 431.

We organized information obtained through the internet using the keyword "Noto Peninsula Earthquake." The inclusion criteria for selecting information included choices from government sources, newspapers, and television reports. Information from the general public was excluded as part of the criteria. The above information has been narratively organized.

3. Disaster Report

The Characteristics of the Noto Peninsula Earthquake in Reiwa 6

(1). Noto Peninsula Characteristics

Noto Peninsula protrudes northward from the central region of the Hokuriku area into the Sea of Japan, making it the peninsula with the largest projection area along the Japan Sea coastline (Figure 1). It suffered significant damage, particularly in areas along the Satoyama Kaido and main arterial roads along the coastline, connecting with Kaga region in Ishikawa Prefecture and the Noto Expressway in Toyama Prefecture. Noto Airport, also affected, is located in the region. The Noto Northern Medical Zone has an area of 1,130 square kilometers, a population decline rate of -10.4% (2015-2020), an aging rate of 48.7% (65 years and older in 2020), and a population density of 54.1 people/square kilometer in 2020, indicating depopulation and aging trends in the region. [5] Notably, the cities and towns of Wajima, Suzu, Anamizu, and Noto, which suffered substantial damage, account for over 90% of the overall mortality rate. All four have been recognized as "completely depopulated" under the "Special Measures Law for the Sustainable Development of Depopulated Areas," meeting certain criteria related to population decline rate, elderly population ratio, and fiscal strength index. [6]

(2). Date of Occurrence

The earthquake occurred on New Year's Day, and due to the holiday season, securing personnel for support was challenging, leading to a gradual deployment. [7]

(3). January Meteorological Characteristics

Ishikawa Prefecture has a climate on the Japan Sea side with low sunshine rates, and during the winter characterized by northwest seasonal winds, temperatures are low with frequent snowfall. [8] Over the past 30 years, average meteorological data from the Japan Meteorological Agency indicates an average temperature of 2.8°C (range: -0.4 to 6°C), average wind speed of 2.7 m/s, monthly sunshine duration of 62 hours, and a total snow depth of 89 cm per month. [9] This harsh winter period, marked by low temperatures, strong winds, and short sunshine hours, hindered smooth aerial reconnaissance and relief efforts.

(4). Catastrophic Destruction of Lifelines

Due to extreme changes in terrain, roads, water supply, communication facilities, and electrical facilities suffered catastrophic damage (Figure 3). Twenty-four routes and 54 locations became impassable, resulting in temporary power outages for around 27,000 households in the Noto region and water supply disruptions for 66,000 households.4 Numerous isolated settlements emerged. Restoration efforts faced challenges such as ongoing aftershocks, the need to be cautious of landslides, and the recurrence of damages due to aftershocks, as well as delays in recovery operations prioritizing winter snow removal. [10]

The roads on the way to the Noto Peninsula have suffered severe damages due to extreme changes in terrain.

Figure 3. Roads on the way to the Noto Peninsula

(5). Support from Land, Sea, and Air

On land, areas with significant damage experienced catastrophic destruction of roads, making the transportation of relief supplies challenging. [4] Sea routes faced issues related to tsunamis in the acute phase, destruction of ports due to changes in terrain, coastal land uplift, and changes in the seafloor. [11,12] Aerial support faced difficulties due to issues like runway cracks at airports and the need for clear visibility for helicopters during the winter. [4]

(6). Secondary Evacuation

The catastrophic destruction of lifelines, delays in recovery operations, challenges posed by the region's topography and climate, made it difficult to restore daily life. Consequently, it became necessary to initiate mass evacuations from primary shelters to areas unaffected by the earthquake. [13]

(7). Medical Aspects

(a). Casualties and Infrastructure Damage and Decline in Medical Functionality

The earthquake caused the collapse of homes in Wajima and Suzu City, resulting in numerous fatalities. This included a significant number of young individuals, amplifying the severity of the impact. [14,15] The earthquake led to water and power outages, equipment failures, and the displacement of medical personnel, severely compromising the functionality of the hospital. Consequently, a large portion of inpatients had to be transferred to other medical facilities (Figure 4). While the emergency department continues to operate with the support of Disaster Medical Assistance Teams (DMAT) and other medical professionals, the staff who would typically work in their own institution are facing heightened fatigue due to the continuous demand. [14,15] Providing appropriate medical care to the affected population has become challenging, necessitating secondary evacuation of victims to areas unaffected by the disaster.

The earthquake led to water and power outages, equipment failures, and the displacement of medical personnel, severely compromising the functionality of the hospital. Consequently, a large portion of inpatients had to be transferred to other medical facilities.

Figure 4. Transporting a patient from a hospital in Wajima city to another hospital, escorted by a Disaster Medical Assistance Team

(b). Disease Patterns

Cases of hypothermia have been reported. [16] The elderly population, already facing age-related immune system decline, experienced an increased susceptibility to infections due to the collective living conditions in places like gymnasiums during evacuation. [17] Concerns arose about the outbreak of infectious diseases in this context. [18] While, there were no notable cases of carbon monoxide poisoning related to heating, as the region was accustomed to snowfall and, therefore, well-prepared for heating measures.

(c). DMAT Deployment

DMAT, established after the Great Hanshin-Awaji Earthquake, have been mobilized extensively. As of January 17, approximately 650 teams, the largest deployment in Japan's disaster response history, have been dispatched to provide medical assistance in hospitals, evacuation centers, and administrative support in the affected areas, with ongoing efforts at present. [19]

4. Discussion

In the aftermath of this earthquake, addressing the impact in sparsely populated areas during inclement weather has presented a significant challenge. The disruption of roads has isolated affected communities, making it difficult for efficient disaster relief and medical assistance. In cases where access is hindered not only by road closures but also by the challenges of air and sea routes, finding effective solutions for disaster relief and healthcare delivery becomes an extremely complex issue.

The first solution, as evidenced in the aftermath of this earthquake, involves utilizing military forces with the capability of entering isolated areas via repaired roads, air routes, or sea routes. [20,21] The United States military in Japan also participated in the transportation of supplies using helicopters in response to the Noto Peninsula earthquake this time. [22] It has been proven effective to restore and utilize at least one road among the damaged infrastructure to establish self-sufficiency for entry into isolated communities. [23]

While waiting for weather conditions to improve, the use of military aircraft capable of entering affected areas, even during nighttime, becomes crucial. Military aircraft that can access the disaster site, especially helicopters capable of landing, play a significant role. Ensuring spaces like school playgrounds are suitable for military helicopter landings and securing areas for military aircraft to take off and land, such as creating heliports in parks or sports fields, is essential, particularly in regions where road disruptions and the emergence of isolated communities are anticipated due to earthquake damage. Planning and preparing such spaces in advance is necessary for effective disaster response.

Drones can indeed be valuable for information gathering and transporting supplies; however, their operation in acute disaster areas alongside manned aircraft like helicopters poses a risk of collisions and should be avoided. [24] In the acute phase of a disaster, the integrated operation of manned aircraft and drones is essential. In the case of this earthquake, the use of drones for civilian purposes was prohibited by national laws. [25] Efforts should be made to establish guidelines and protocols for the coordinated use of both manned aircraft and drones in disaster-stricken areas, ensuring safety and efficiency in information collection and material transport. Additionally, legal frameworks should be adapted to accommodate the responsible and controlled use of drones during emergency situations. In expressing future aspirations, one can imagine the development of ambulance-like vehicles capable of vertical takeoff and landing, with medical personnel on board. [26] Such vehicles could prove beneficial not only in large-scale disasters but also in routine emergency response situations.

The second solution involves the organization of civilian entities in a manner similar to self-sufficient military units. The integration of civilian organizations under the unified disaster preparedness office of local authorities allows for the establishment of an organizational structure akin to the Self-Defense Forces. Pre-training initiatives to enable these organizations to function as self-sufficient entities during a disaster are crucial. This approach could potentially increase the number of organizations capable of entering affected areas, contributing to infrastructure restoration, particularly in road recovery, alongside the Self-Defense Forces. In the realm of healthcare, many DMATs attempted to enter the disaster site from the acute phase onward. However, severe road disruptions hindered their swift entry into the affected areas. [27] To address this issue, early collaboration with the Self-Defense Forces and other initiatives to facilitate entry into disaster areas could be crucial.

Finally, as a preparatory measure during non-disaster periods, it may be crucial to strongly recognize the risk in regions where large-scale disasters have frequently occurred in the past and work towards automation. However, obtaining the understanding of the residents who have their livelihoods in those areas poses a significant challenge. In the event of a Nankai Trough earthquake, large-scale disasters are anticipated not only in depopulated areas but also in densely populated regions, making the idea of complete automation less realistic. [28] As an alternative approach, it might be essential to create frameworks for temporary evacuation to non-affected areas with pre-established sister city agreements in case of a disaster. [29] This could involve temporarily abandoning the disaster-affected region and seeking refuge in areas that have signed such agreements during non-disaster times. It is worth noting that in Japan, where the population is decreasing and depopulation is progressing, there is a trend towards the consolidation of medical institutions to streamline healthcare services. [30] This trend could have a negative impact during large-scale disasters with the frequent occurrence of isolated communities, as seen in the current earthquake scenario.

The present study proposes improvements in disaster response based on the damage caused by the Noto Peninsula earthquake. However, it suggests that a more detailed approach, based on previous guidelines concerning earthquake damage, may be necessary for responding to such disasters. [31]

5. Conclusion

The Noto Peninsula earthquake occurred in an aging and depopulating region, resulting in the most extensive topographical changes at the worst possible timing. Numerous isolated settlements emerged, making the deployment and expansion of support, including medical assistance, challenging. Japan, surrounded by the sea and facing issues of population decline, aging, and the expansion of depopulated areas, has many peninsulas similar to Noto, with the looming possibility of a Nankai Trough earthquake in the near future. Learning from this disaster, addressing how to prepare for such events has become a significant challenge.

ACKNOWLEDGEMENTS

Grant: This work was supported in part by a Grant-in-Aid for Special Research in Subsidies for ordinary expenses of private schools from The Promotion and Mutual Aid Corporation for Private Schools of Japan. (No grant number).

Conflicts of Interest

The authors declare no conflicts of interest in association with this study.

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