



Roles of Dental Care in Disaster Medicine in Japan

Junichi Yamazoe^{1,2,3} · Hisaki Naito⁴

Accepted: 26 May 2022 / Published online: 25 June 2022
© The Author(s), under exclusive licence to Springer Nature Switzerland AG 2022

Abstract

Purpose of Review Natural disasters occur frequently in Japan. A disaster medical system was rapidly developed in Japan following the Great Hanshin-Awaji Earthquake in 1995. Dentistry has become increasingly important in disaster medicine. This review summarizes the roles of dental professionals in disaster medicine, highlights relevant issues, and identifies new directions for research to improve disaster relief activities based on our previous experiences as dental professionals supporting the victims of major disasters.

Recent Findings Many preventable deaths after a disaster are caused by aspiration pneumonia, which occurs against a background of factors that are compounded by a harsh living environment. An important aim of dental care in disaster medicine is to prevent these disaster-related deaths in vulnerable persons such as the elderly. This can be achieved through interventions to maintain oral hygiene, preserve and enhance oral function (i.e., chewing and swallowing), and improve the diet, since these interventions help to prevent the development of malnutrition and frailty in vulnerable people. Dental identification of disaster victims could be improved through the use of intraoral three-dimensional scanners and artificial intelligence to automate the acquisition of dental findings and through the construction of a national database of digitized dental records. Advances in personal identification methods will be needed given the prediction that a catastrophic earthquake will occur on the Nankai Trough during the next 30 years and claim more victims than the 2011 Great East Japan Earthquake.

Summary Disaster-related deaths due to aspiration pneumonia can be prevented by providing appropriate dental care to those in need. The process of identifying victims could be made more efficient through the use of intraoral three-dimensional scanning, artificial intelligence, and a digital database of dental records. Establishing and strengthening relationships between professionals in different regions will help to optimize the multidisciplinary response to future large-scale disasters.

Keywords Natural disaster · Dentistry · Aspiration pneumonia · Dental identification · Multidisciplinary team · Dietary support

This article is part of the Topical Collection on *Oral Disease and Nutrition*

✉ Junichi Yamazoe
yamazoe@dent.kyushu-u.ac.jp

- ¹ Section of Geriatric Dentistry and Perioperative Medicine in Dentistry, Kyushu University Hospital, Fukuoka 812-8582, Japan
- ² Section of Oral Healthcare and Dentistry Cooperation, Division of Maxillofacial Diagnostic and Surgical Science, Faculty of Dental Science, Kyushu University, Fukuoka 812-8582, Japan
- ³ Center for Advanced Medical Innovation, Kyushu University, Fukuoka 812-8582, Japan
- ⁴ Disaster Medical Education and Research Center, Kumamoto University Hospital, Kumamoto 860-8556, Japan

Introduction

Japan is particularly vulnerable to natural disasters. Large-scale natural disasters have occurred frequently in Japan since the Great Hanshin-Awaji Earthquake of 1995, and many people have died or gone missing as a result of these catastrophic events [1]. In addition to claiming many lives, a large-scale disaster destroys much of the healthcare system in the affected area. Based on the lessons learned from the Great Hanshin-Awaji Earthquake, Japan rapidly developed a disaster medical system and implemented new national policies [2].

Dentistry has become increasingly important in disaster management, and its main roles include the provision of dental treatments and oral care to those affected by a

disaster as well as the identification of victims. Forensic dentistry has grown in importance since 1985, when dentists cooperated to identify the 520 victims of the crash of Japan Airlines Flight 123 [3]. Following the Hokkaido Southwestern Offshore Earthquake in 1993, local dentists provided rapid dental care to the evacuees including the replacement of dentures that had been washed away by the tsunami [4]. During the evacuation of people following the Kumamoto earthquake in 2016, those with special considerations (including the elderly) were given dental care (e.g., adjustment of ill-fitting dentures) as part of the program to provide emergency food assistance [5, 6]. The Great Hanshin-Awaji Earthquake brought attention to deaths that could have been prevented (disaster-related deaths). Among the 6434 lives claimed by the Great Hanshin-Awaji Earthquake, more than 900 fatalities were disaster-related deaths caused mainly by pneumonia [7]. Subsequently, Yoneyama et al. reported that maintenance of oral hygiene reduces the incidence of pneumonia in the elderly [8••], and this led to the conclusion that aspiration pneumonia is an important cause of disaster-related death. Aspiration pneumonia occurs in persons requiring special care against a background of factors

that are compounded by the harsh living environment resulting from the disaster (Fig. 1). Ohta has described the multidisciplinary medical support needed to reduce the incidence of pneumonia following a disaster [9•] (summarized in Fig. 1). Measures that help to maintain good oral health/function and reduce the risk of aspiration pneumonia include examination of the oral cavity and the provision of guidance, education, and dental care by a multidisciplinary team [10].

The Great East Japan Earthquake that occurred in March 2011 revealed numerous deficiencies in the emergency dental care that was delivered as part of the relief operation. These deficiencies arose because the disaster was unexpectedly severe, affected a large number of people, and caused extensive structural damage. The Bureau of Social Welfare and Public Health [11] has defined six phases of a disaster (immediate, hyperacute, acute, subacute, chronic, and mid-term) that vary in terms of the type of support needed (summarized in Table 1). It became clear during the aftermath of the Great East Japan Earthquake that preventing the development of pneumonia in people requiring special care requires the delivery of dental hygiene services after the subacute disaster phase. Multidisciplinary cooperation

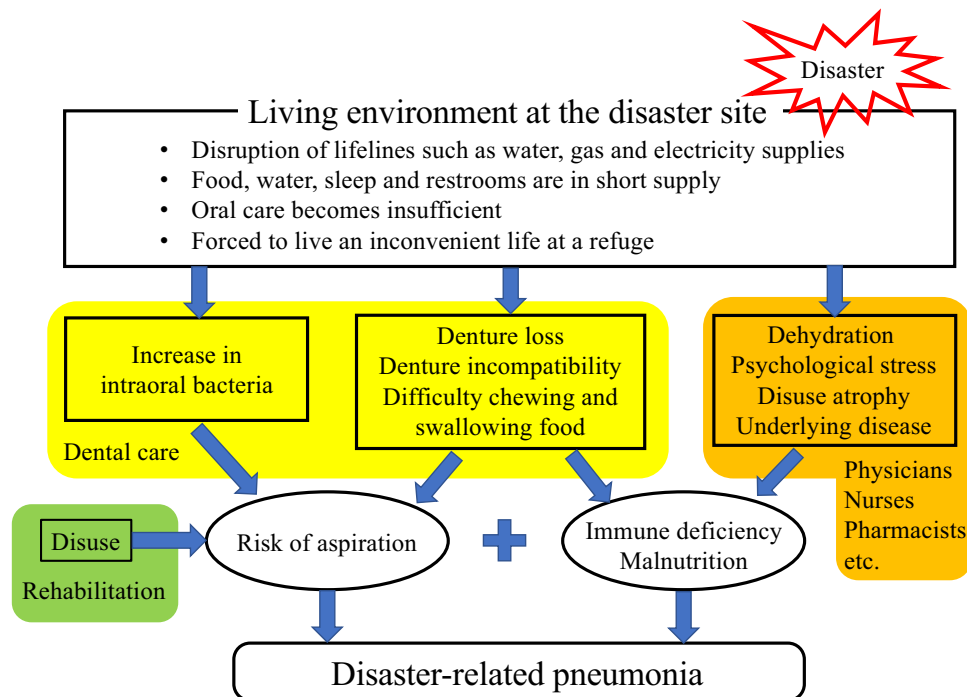


Fig. 1 The causes of disaster pneumonia and the potential for intervention through dental care. Aspiration pneumonia in persons requiring special care is caused by a complex combination of factors related to the oral environment and worsening of underlying disease. In addition to these factors, disuse syndrome and feeding problems can lead to malnutrition and weakened immunity that also contribute to the onset of pneumonia. Therefore, the incidence of disaster-related

pneumonia can be reduced through appropriate interventions made by a multidisciplinary team of dental, medical, and social/welfare professionals. These interventions include improving the environment of the evacuation centers, treating deficiencies in oral function (chewing and swallowing), and providing dietary support as well as guidance on medication use and oral care

Table 1 Classification of disaster phases used for medical rescue activities

Time	Phase	Possible situation
Up to 6 h after a disaster	Immediately after a disaster	Rescue and relief operations are initiated due to the injury of a large number of people caused by a collapsed building or fire, etc
6 to 72 h after a disaster	Hyperacute	A large number of rescued people are transported to medical institutions. However, lifelines (water, gas, electricity, etc.) and transportation are disrupted, and little human and material resources have been received from outside the disaster area
72 h to 1 week after a disaster	Acute	The extent of the damage is gradually being assessed. Lifelines are beginning to be restored, and readiness to accept human and material resources is being established
1 week to 1 month after a disaster	Subacute	Local medical care, lifelines, and transportation are gradually recovering
1 month to 3 months after a disaster	Chronic	Despite the prolonged evacuation, the area is almost back to normal, and local medical facilities and pharmacies are gradually reopening
More than 3 months after a disaster	Mid-term	Most medical aid stations are closed, and normal medical care is almost fully restored

is also important to ensure that evacuees preserve their oral functions and receive adequate nutritional and dietary support [12].

A large number of medical records were lost as a consequence of the destruction caused by the Great East Japan Earthquake and ensuing tsunami [13]. The loss of medical data made it extremely difficult to identify many of the victims. We believe that the creation of a government-managed system that includes a national database of digitized dental records would facilitate the identification of victims of future disasters [14]. The Great East Japan Earthquake claimed a large number of lives and created a challenging environment in which to perform oral cavity examinations. These factors slowed the collection of dental information, reduced the accuracy of the findings, and placed a heavy burden on the dentist in charge. In our view, the development of an automated system that produces dental charts from digitized images of the teeth would greatly speed up the process of victim identification after a large-scale disaster [15].

The Kumamoto earthquake of 2016 occurred while emergency dental response systems were still being put in place based on the lessons learned from previous disasters. Therefore, we formed an “oral health support team” to help people in regions affected by the Kumamoto earthquake, and we provided dental care during the chronic phase of the disaster [5, 6, 9•, 16, 17]. In July 2018, we were dispatched to a region of northern Kyushu that had been affected by torrential rain. We arrived when the disaster was in its chronic phase. After conducting an assessment of the evacuation center, we provided dental services to people requiring special care in order to promote their oral hygiene (as a countermeasure against infectious diseases) and maintain their oral function (to prevent disuse) [6, 9•, 16, 17]. We have also responded to other recent natural disasters in the Kyushu area of Japan.

A super-disaster such as a Nankai Trough earthquake could occur in Japan in the near future. Therefore, we are

collaborating with nearby medical universities, hospitals, and medical organizations to train personnel to deliver disaster medical care as part of a multidisciplinary team. We are also conducting research to improve the effectiveness of the response to a large-scale disaster [18]. The purpose of this review is to summarize how dental professionals approach disaster medicine and highlight new directions for research aimed at improving the role of dental care in disaster medicine. This article is based on a backward-looking review of our experiences as dental professionals providing support to people affected by previous natural disasters.

Dental Care Improves the Health and Quality of Life of People Living in Disaster Areas and Prevents Disaster-Related Deaths

Dental Care Prevents Pneumonia, the Leading Cause of Disaster-Related Deaths

The incidence of pneumonia in the area affected by the Great Hanshin-Awaji Earthquake was higher than that recorded during normal times in Japan [7]. The incidence of pneumonia also increased after the Great East Japan Earthquake and remained elevated for a period of 3 months after the disaster struck [19]. Thus, pneumonia becomes more prevalent following a large-scale disaster, particularly among the elderly and other persons requiring special care. This “disaster-related pneumonia” is considered to be aspiration pneumonia, which is caused by a combination of factors that arise as a consequence of the harsh environment created by a disaster (Fig. 1). Dental care focusing on both oral hygiene and oral function (mastication and swallowing) is known to reduce the risk of pneumonia [8••]. Disaster-related deaths due to pneumonia can be prevented by the provision of dental services from 1 to 2 weeks after the disaster, which is the

period when outbreaks of disaster-related pneumonia are said to be more likely to occur [19]. The dental care team can reduce the incidence of disaster-related deaths from aspiration pneumonia through interventions to maintain oral health and prevent subclinical aspiration, immune system weakening, and malnutrition. The successful delivery of these services requires the dental care team to operate as part of a comprehensive medical system that includes professionals from multiple disciplines. Therefore, we worked to establish a highly effective collaboration with doctors, nurses, speech pathologists, and caregivers during our response to the Kumamoto earthquake, and we utilized the Japanese version of the Oral Health Assessment Tool (OHAT-J) [20] to share dental records among multiple professionals.

Dental Care Helps to Maintain the Nutritional Status of People Affected by a Disaster

The dental care needs of the evacuees vary widely from one disaster phase to another, and the challenges imposed by each phase must be met. During our time as a dental care team responding to the Kumamoto earthquake in April 2016, we observed that the number of people reporting difficulties with eating increased from the subacute phase to the chronic phase of the disaster [17]. Therefore, a primary focus of our activities was to ensure that oral feeding was adequate in the survivors of the disaster in order to prevent disaster-related pneumonia and malnutrition. We performed dental examinations and helped people to maintain or improve their oral hygiene. We also evaluated chewing/swallowing function and performed nutritional assessments in the elderly and persons with disabilities who had difficulty chewing and swallowing (i.e., people who required special attention). We helped nursing homes that were in crisis due to water shortages, power outages, and staff exhaustion to rebuild their oral care systems. In addition, we delivered dental care to nursing home residents who were receiving enteral feeding or at high risk of aspiration pneumonia, and this support was given until the on-site dental care system was restored by facility staff and local dental care providers. We also helped elderly patients fed via gastrostomy or nasogastric tubes to maintain their oral hygiene and oral function; we also monitored their diet and offered feeding/swallowing evaluations and guidance in collaboration with doctors and speech-language pathologists in the Japan Rehabilitation Assistance Team (JRAT). Furthermore, we worked in consultation with the Japan Dietetic Association-Disaster Assistance Team (JDA-DAT) to secure thick liquid diets as well as specialized diets for patients with diabetes or kidney disease. We also carried out feeding and swallowing assessments

in people with severe physical and mental disabilities and provided them with guidance.

The correction of denture malfunction formed an important part of our work during our participation in the food assistance program delivered in the aftermath of the Kumamoto earthquake. This has also been reported for other disaster relief programs [21]. Emergency denture treatment procedures are carried out by a multidisciplinary team, and dental care professionals play a significant role. Prosthodontics is an established discipline with a long history, but it seems to have evolved under the assumption that standardized denture fabrication processes are available in a well-equipped environment such as a dental office. The development of dental visiting services in Japan has led to an increasing number of dentists providing denture treatment procedures for the elderly outside of the dental practice. However, the success or failure of the treatment is greatly influenced by the knowledge, experience, and skill of the visiting dentist. In addition, it can be extremely difficult to work in the oral cavity when dealing with people who have special needs, and this can increase the complexity of denture-related dental procedures. Research is needed to develop a denture treatment method that can be applied in the setting of a natural disaster to improve the oral function of people who have difficulty eating food.

Dental Care Can Prevent the Development or Worsening of Frailty, Which Can Progress Rapidly During a Disaster

Aging is associated with gradual physical and mental decline and can lead to the development of frailty in some individuals. Frailty can reduce a person's level of independence to the extent that nursing care becomes needed. In Japan's super-aging society, people at risk of becoming frail are supported by a community-based comprehensive care system with the aim of preventing a prominent decline in their physical and mental health. Dental care is provided to the elderly and other persons in need within this community-based comprehensive care system because the deterioration of oral function associated with aging (oral frailty) predisposes to inadequate nutrition and impairments in physical and mental functions (frailty) [22, 23]. When a disaster strikes, these social systems collapse. As a result, people with needs and disabilities are denied access to a variety of medical services, which leads to a rapid increase in frailty. Therefore, dental care teams need to intervene early after a disaster to help those in need of medical services such as oral care and dietary adjustments. By doing so, dental care teams can play an important role in preventing the rapid progression of frailty until community healthcare services are restored.

The importance of actively offering dental care to susceptible individuals in order to avert the development of frailty is illustrated by our experience of a case that presented to us following the Kumamoto earthquake. We were asked to provide support to an elderly woman who had choked on a rice ball during lunch and nearly died as a result. On examination, the woman was found to have poor masticatory function because of a lack of functional teeth for chewing food. She had not worn dentures for a long time due to incompatibility, and she had been on a puréed diet before the disaster had struck. She had become bedridden in her living room after the disaster and had not left her house for about 3 weeks because the medical support she normally received had been suspended. When we examined the patient, she was in a poor state of arousal, her activities of daily living were reduced due to muscle disuse, and she had difficulty maintaining a seated position on the end of the bed. The suspension of healthcare services that had been available before the earthquake (including help obtaining a diet of the appropriate consistency) had led to a reduction in her food intake and a decline in her nutritional status. The above factors had caused her to become bedridden and develop disuse atrophy. This case of a patient who did not receive support until she almost choked to death emphasizes the need to identify persons at risk of developing frailty after a major disaster and provide them with appropriate care to ensure that they maintain an adequate nutritional status.

A National Digitized Database and Use of Artificial Intelligence Would Improve the Dental Identification of Victims of Large-Scale Disasters

Teeth are covered by enamel, which is the hardest material found in the human body. Since teeth are resistant to post-mortem alterations in composition or structure, forensic dentistry is frequently used to facilitate the identification of human remains through comparisons of post-mortem findings with pre-mortem records. It is vital that the identification of disaster victims is performed both accurately and quickly [24], and personal identification based on dental findings is an effective method when the death toll is high [25]. The prevalence of dental diseases and the dental clinic consultation rate are both high in Japan [26]. As a result, pre-mortem dental records are available for many people in Japan, and the dental findings show variations between individuals that can be used for identification purposes. However, a large number of medical records were lost following the damage and destruction caused by the Great East Japan Earthquake and accompanying tsunami [13], and this made

it very difficult to identify many of the victims of this large-scale disaster. We believe that the development of a government-managed system that incorporated a national database of dental care information would facilitate the identification of victims of future natural disasters.

The probability of a major earthquake occurring on the Nankai Trough (which lies just south of Japan) within the next three decades is predicted to be 70–80%. Moreover, it has been suggested that a large-scale earthquake in this region would result in a death toll up to 20 times higher than that of the Great East Japan Earthquake [27]. The high likelihood of an imminent major earthquake in Japan highlights the requirement for a digitized identification system that could be used to collect and analyze dental findings in the event of a future natural disaster. In order for such a system to have practical utility in the setting of a large-scale disaster, it would need to employ straightforward methods for collecting and interpreting post-mortem dental information and be capable of rapidly generating accurate results. One possible approach would be to automate the generation of dental charts for disaster victims using intraoral three-dimensional (3D) scanning and artificial intelligence (AI)-based analysis.

Intraoral 3D scanning is now widely utilized in dental clinics as an accurate method of optical impression [28, 29]. Importantly, dental information obtained with an intraoral 3D scanner has been used successfully for personal identification [30•]. Images acquired with an intraoral 3D scanner can be stored as digital data and hence are well suited for use in a digitized identification system. Therefore, we consider intraoral 3D scanning to have great potential as a technique for collecting and digitizing pre- and post-mortem dental records in a highly efficient manner.

AI has been applied as a diagnostic tool in a variety of medical settings. It is anticipated that further development of AI-based techniques will enhance the speed and accuracy of diagnoses based on medical imaging [31]. For example, AI has been used to discriminate benign from malignant skin lesions in photographs [32] and detect gastric cancer lesions in endoscopic images [33]. AI has various potential applications in dentistry [34]. Furthermore, AI has already been shown to be capable of identifying teeth and detecting carious lesions in radiographs [35, 36].

We believe that the application of a deep learning algorithm to dental imaging data would allow the condition of each tooth to be determined rapidly and accurately. Therefore, we have been conducting research aimed at developing an AI system that can extract the features of dental treatment scars from images acquired by an intraoral 3D scanner [15, 30•]. We anticipate that the development of this deep learning algorithm will be a first step toward the creation of an automated system for the generation of dental charts from intraoral 3D scans.

Training Programs and Enhanced Cooperation Between Support Teams Would Improve the Response to a Future Large-Scale Disaster

Various new healthcare policies were implemented in Japan following the Great Hanshin-Awaji Earthquake in 1995. These policies included the establishment of an air medical service (Doctor-Heli), training of a Japanese Disaster Medical Assistance Team (DMAT), development of an Emergency Medical Information System (EMIS), and improvement of emergency transport services [37, 38]. Doctors associated with the air medical service are responsible for the establishment of disaster base hospitals that can accept critically ill patients promptly in the event of a disaster. These systems and services were utilized during the disaster relief operation for the Great East Japan Earthquake. Subsequently, disaster medical coordinators were appointed by the Medical Affairs Bureau of the Ministry of Health, Labor and Welfare in 2012 to support the activities of the disaster response headquarters [39]. Various medical teams supporting the DMAT were also formed including the Japan Medical Association Team (JMAT), Disaster Psychiatric Assistance Team (DPAT), and Japan Disaster Rehabilitation Assistance Team (JRAT). The DMAT coordinated the response to the 2016 Kumamoto earthquake and was assisted by various medical teams not only during the acute phase but also during the later phases when cooperation between numerous healthcare providers was required [40].

We consider the main roles of the dental support team to be as follows. Important tasks during the acute phase of a disaster include the treatment of traumatic injuries to the oral cavity and the manufacture of replacement dentures for victims who have lost theirs. Dental services that should be provided after the subacute stage include oral care to prevent aspiration pneumonia and interventions to maintain oral function and adequate feeding. In addition, dental findings will need to be collected from victims for identification purposes. Of course, additional factors can affect the specific services that the dental care team can offer. For example, a major flood occurred in Japan in 2020 during the COVID-19 pandemic, and the infection control measures put in place made it difficult for the dental care team to perform clinical examinations and provide oral care to individuals affected by the disaster. Therefore, one of the important tasks performed by the dental care team was to gather information regarding the dental needs of each evacuation center and supply high-quality oral care products to the evacuation centers when they were in short supply.

In addition, public health nurses and members of other medical teams need to share clinical data (such as age and medical history) for the evacuees at each evacuation center and report the onset of any respiratory diseases that might be related to poor oral care. The clinical information collected from people

at the evacuation centers should be stored centrally and be accessible to other medical teams including the dental care team. In Japan, various information gathering systems are available to facilitate the provision of medical support in the event of a disaster. The EMIS provides information on damage to medical institutions. The J-SPEED is based on the Surveillance in Post-Extreme Emergencies and Disasters (SPEED) of the Republic of the Philippines, and it allows disaster support teams in Japan to collect health-related data and determine the number of patients requiring assistance [41, 42, 43]. The use of a “rapid assessment sheet” during the acute phase can help to quickly establish an understanding of the conditions at each evacuation site [44]. Notably, digital transformation is advancing the collection of information for disaster medicine.

Many victims of recent disasters in Japan have been elderly people, who need special consideration when it comes to the provision of support [45, 46, 47]. Thus, it is vital that the dental care team shares information in the event of a disaster to ensure that the necessary support is delivered to those who need it most. Egawa et al. reported that disaster risks are related to the coping capacities of healthcare systems [48, 49]. Therefore, it is critical that a system be created that is capable of delivering dental support to people affected by a large-scale disaster. Improving the knowledge and skills of healthcare professionals (including those involved in dentistry) through the provision of training in disaster medicine will optimize the delivery of relief. Furthermore, strengthening the cooperation between the dental care team and other disaster support teams will help to identify those persons most in need of assistance. The Japanese Ministry of Education, Culture, Sports, Science and Technology educates and assists the human resources responsible for cooperation and support in the event of a disaster [50]. Kumamoto University, in collaboration with Kyushu University, provides an educational program on cooperative multidisciplinary support in the event of a disaster. Niigata University, Tohoku University, and Fukushima Medical University also have educational programs. We are confident that training programs in disaster medicine such as these will further improve disaster resilience.

Conclusion

The main role of the dental care team in disaster medicine is to minimize disaster-related deaths, disaster-related health hazards, and disaster-related frailty through multidisciplinary collaboration with various healthcare and non-healthcare professionals including those at administrative agencies. Furthermore, the provision of appropriate dental care requires detailed knowledge of the characteristics of each phase of a disaster. Another important responsibility of the dental care team is to rapidly and accurately identify disaster victims so that their bodies can be returned to their families as quickly as

possible. The provision of dental care can preserve the dignity of those affected by large-scale disasters and provide peace of mind to the families of the victims. Smooth and effective delivery of dental support services to persons affected by a disaster requires the establishment of good relationships between the dental care team and other providers of support. To make this possible, education programs in disaster medicine should aim to provide knowledge and skills training as well as facilitate the establishment and strengthening of relationships between professionals in different fields and different regions. Finally, efforts should be made to improve the disaster mitigation capabilities of each region.

Acknowledgements We would like to thank Dr. Ito, Dr. Ushijima, and Dr. Uji of the Kumamoto Dental Association for providing valuable materials. We thank OXMEDCOMMS (www.oxmedcomms.com) for editing the manuscript.

Declarations

Conflict of Interest The authors declare no competing interests.

Human and Animal Rights and Informed Consent Permission to use the activity records and support activity reports of each disaster for research purposes was obtained from the prefectural dental associations responsible for information management and the Kyushu Federation of Dental Associations from which the responders were dispatched.

References

Papers of particular interest, published recently, have been highlighted as:

- Of importance
- Of major importance

1. Cabinet Office, Japan. 2021 white paper: disaster management in Japan. https://www.bousai.go.jp/en/documentation/white_paper/pdf/2021/R3_hakusho_english.pdf
2. Koido Y, Kondo H, Ichihara K, Kohayakawa Y, Henmi H. Research on the DMAT response to the 2011 East Japan Earthquake. *J Natl Inst Public Health*. 2011;60:495–501.
3. Sakuma A, Saitoh H, Katsumura S, Kumagai A, Oka H, Motomura A, et al. Study on the factors hindering improvement in the success rate of dental identification in disasters in Japan. *Jpn J Disaster Med*. 2021;26:1–10.
4. Hirai T, Ishijima T, Koshino H, Ikeda Y, Konishi Y, Kon K, et al. Prosthodontic approach to the sufferers from the disaster — considerations from prosthodontic treatments and questionnaires obtained after the strong earthquake in the southwest area of Hokkaido. *J Jpn Prosthodont Soc*. 1995;39:114–22. <https://doi.org/10.2186/jjps.39.114>.
5. Kato T, Morita H, Tsuzuki T, Yamaguchi M, Ohata H, Tanoue D, et al. Emerging role of dental professionals in collaboration with medical personnel in disaster relief following the 2016 Kumamoto earthquakes: implications for the expanding scope of dental practice. *Int Dent J*. 2019;69:79–83. <https://doi.org/10.1111/idj.12412>.
6. Yamazoe J, Shimizu Y, Naito H, Yugawa A, Eto N, Wada N. An analysis of the disaster dental support missions of oral general practitioner belonging to university hospital in Kyushu area. *J Jpn Soc Gen Dent*. 2019;11:1–11.
7. Osaki Y, Minowa M. Factors associated with earthquake deaths in the Great Hanshin-Awaji Earthquake, 1995. *Am J Epidemiol*. 2001;153:153–6. <https://doi.org/10.1093/aje/153.2.153>.
- 8.●● Yoneyama T, Yoshida M, Matsui T, Sasaki H. Oral care and pneumonia. *Lancet*. 1999;354:515. [https://doi.org/10.1016/S0140-6736\(05\)75550-1](https://doi.org/10.1016/S0140-6736(05)75550-1). **This study shows that dental care may be effective in preventing pneumonia after a disaster.**
- 9.● Ohta H. The verification of three times disaster dental support experience – the mission of general dentist and disaster dental coordinator. *J Jpn Soc Gen Dent*. 2019;11:31–7. **This study illustrates how the delivery of emergency medical and dental care after a disaster requires cooperation between members of a multidisciplinary team.**
10. Kishimoto H, Kadoi K. Oral management in times of large-scale disaster. *J Jpn Soc Parenter Enteral Nutr* 2012;27:1041–1045.
11. Bureau of Social Welfare and Public Health. Guidelines for disaster medical relief activities. 2018. (In Japanese). https://www.fukushihoken.metro.tokyo.lg.jp/iryoku/kyuukyuu/saigai/guideline.files/1shou1-3_guideline2.pdf
12. Kawanishi K, Toyoshita S, Koshino H, Kawano M, Matsura K, Kaida Y, et al. The relation between dental medical support and nutrition condition in the disaster area of Great East Japan Earthquake. *J Jpn Soc Masticatory Sci Health Promot*. 2012;22:52–61.
13. Ido K, Nakamura N, Nakayama M. Miyagi Medical and Welfare Information Network: a backup system for patient clinical information after the Great East Japan Earthquake and tsunami. *Tohoku J Exp Med*. 2019;248:19–25. <https://doi.org/10.1620/tjem.248.19>.
14. Suzuki T. Dental identification in mass fatality incidents. *Ann Jpn Prosthodont Soc*. 2015;7:129–34. <https://doi.org/10.2186/AJPS.7.129>.
15. Eto N, Yamazoe J, Tsuji A, Wada N, Ikeda N. Development of an artificial intelligence-based algorithm to classify images acquired with an intraoral scanner of individual molar teeth into three categories. *PLoS ONE*. 2022;7: e0261870. <https://doi.org/10.1371/journal.pone.0261870>.
16. Morita H, Kato T, Ohta H, Kubota J, Yamazoe J, Shigetomi T, et al. Trial of training for disaster dental health care support activities. *Jpn J Gerodontology*. 2019;33:482–90.
17. Ohta H, Nakakuki K, Tanoue D, Katayama K, Nibu I, Kumai T, et al. Multidisciplinary “eating” support by maintaining oral function for vulnerable people in Minamiaso area after the 2016 Kumamoto earthquake. *J Jpn Disaster Food Soc*. 2019;6:69–76.
18. Ministry of Education, Culture, Sports, Science and Technology, Japan. Problem-solving advanced medical personnel training program, “training advanced medical personnel for disaster medicine in multi-professional collaboration”. 2018; https://www.mext.go.jp/component/a_menu/education/detail/_icsFiles/fieldfile/2018/10/25/1410103_07.pdf
19. Daito H, Suzuki M, Shihara J, Paul EK, Ohtomo H, Morimoto K, et al. Impact of the Tohoku earthquake and tsunami on pneumonia hospitalisations and mortality among adults in northern Miyagi, Japan: a multicentre observational study. *Thorax*. 2013;68:544–50. <https://doi.org/10.1136/thoraxjnl-2012-202658>.
20. Matsuo K, Nakagawa K. Reliability and validity of the Japanese version of the Oral Health Assessment Tool (OHAT-J). *JJSDH*. 2016;37:173–7.
21. Tsuboyama-Kasaoka N, Kondo A, Harada M, Ueda S, Sudo N, Kantani Y, et al. Analysis of an oral health report from dietitians dispatched to the areas affected by the Great East Japan Earthquake. *Jpn J Dysphagia Rehab* 2017;21:191–199. https://doi.org/10.32136/jdsr.21.3_191

22. • Iijima K. Upstream preventive strategy for age-related sarcopenia in the elderly: why do the elderly fall into inadequate nutrition? *Ann Jpn Prosthodont Soc.* 2015;7:92–101. <https://doi.org/10.2186/ajps.7.92>. **This study demonstrates that dental care may help to prevent the rapid progression of frailty in the aftermath of a disaster.**
23. Nishimoto M, Tanaka T, Takahashi K, Unyaporn S, Fujisaki-Sueda-Sakai M, Yoshizawa Y, et al. Oral frailty is associated with food satisfaction in community-dwelling older adults. *Jpn J Geriatr.* 2020;57:278–81. <https://doi.org/10.3143/geriatrics.57.273>.
24. Aoki T, Ito K, Aoyama S. Disaster victim identification and ICT. *IEICE Fundam.* 2015;9:119–30. https://doi.org/10.1587/essfr.9.2_119.
25. Utsuno H. Victim identification in large-scale disasters using dental findings. *IATSS.* 2019;43:90–6. <https://doi.org/10.1016/j.iatssr.2019.06.005>.
26. Zaito T, Saito T, Kawaguchi Y. The oral healthcare system in Japan. *Healthcare.* 2018;6:79. <https://doi.org/10.3390/healthcare6030079>.
27. Takano H, Momota Y, Ozaki T, Terada K. Personal identification from dental findings using AI and image analysis against great disaster in Japan. *J Forensic Leg Investig Sci* 2019;5:041. <https://doi.org/10.24966/FLIS-733X/100041>
28. Fukazawa S, Odaira C, Kondo H. Investigation of accuracy and reproducibility of abutment position by intraoral scanners. *J Prosthodont Res.* 2017;61:450–9. <https://doi.org/10.1016/j.jpor.2017.01.005>.
29. Uhm SH, Kim JH, Jiang HB, Woo CW, Chang M, Kim KN, et al. Evaluation of the accuracy and precision of four intraoral scanners with 70% reduced inlay and four-unit bridge models of international standard. *Dent Mater J.* 2017;36:27–34. <https://doi.org/10.4012/dmj.2016-064>.
30. • Eto N, Yamazoe J, Okumura M, Samejima N, Tsuji A, Wada N, et al. A case of personal identification based on the oral information obtained using an intraoral 3D scanner. *Res Pract Forens Med.* 2020;63:17–22. **This study demonstrates the feasibility of using a digitized system based on intraoral 3D scanning for the personal identification of disaster victims.**
31. Ahuja AS. The impact of artificial intelligence in medicine on the future role of the physician. *PeerJ.* 2019;7: e7702. <https://doi.org/10.7717/peerj.7702>.
32. Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM, et al. Dermatologist-level classification of skin cancer with deep neural networks. *Nature.* 2017;542:115–8. <https://doi.org/10.1038/nature21056>.
33. Hirasawa T, Aoyama K, Tanimoto T, Ishihara S, Shichijo S, Ozawa T, et al. Application of artificial intelligence using a convolutional neural network for detecting gastric cancer in endoscopic images. *Gastric Cancer.* 2018;21:653–60. <https://doi.org/10.1007/s10120-018-0793-2>.
34. Nguyen TT, Larrivée N, Lee A, Bilaniuk O, Durand R. Use of artificial intelligence in dentistry: current clinical trends and research advances. *J Can Dent Assoc.* 2021;87:17.
35. Tuzoff DV, Tuzova LN, Bornstein MM, Krasnov AS, Kharchenko MA, Nikolenko SI, et al. Tooth detection and numbering in panoramic radiographs using convolutional neural networks. *Dentomaxillofac Radiol.* 2019;48:20180051. <https://doi.org/10.1259/dmfr.20180051>.
36. Lee JH, Kim DH, Jeong SN, Choi SH. Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. *J Dent.* 2018;77:106–11. <https://doi.org/10.1016/j.jdent.2018.07.015>.
37. Kondo H, Koido Y, Morino K, Homma M, Otomo Y, Yamamoto Y, et al. Establishing disaster medical assistance teams in Japan. *Prehosp Disaster Med.* 2009;24:556–64. <https://doi.org/10.1017/s1049023x00007512>.
38. Fuse A, Yokota H. An analysis of Japan Disaster Medical Assistance Team (J-DMAT) deployments in comparison with those of J-DMAT's counterpart in the United States (US-DMAT). *J Nippon Med Sch.* 2010;77:318–24. <https://doi.org/10.1272/jnms.77.318>.
39. Egawa S, Suda T, Jones-Konneh TEC, Murakami A, Sasaki H. Nation-wide implementation of disaster medical coordinators in Japan. *Tohoku J Exp Med.* 2017;243:1–9. <https://doi.org/10.1620/tjem.243.1>.
40. Kondo H, Koido Y, Kawashima Y, Kohayagawa Y, Misaki M, Takahashi A, et al. Consideration of medical and public health coordination – experience from the 2016 Kumamoto. *Japan Earthquake Prehosp Disaster Med.* 2019;34:149–54. <https://doi.org/10.1017/S1049023X19000177>.
41. Salazar MA, Pesigan A, Law R, Winkler V. Post-disaster health impact of natural hazards in the Philippines in 2013. *Glob Health Action.* 2016;9:31320. <https://doi.org/10.3402/gha.v9.31320>.
42. Kubo T, Yanasan A, Herbosa T, Buddh N, Fernando F, Kayano R. Health data collection before, during, and after emergencies and disasters – the result of the Kobe Expert Meeting. *Int J Environ Res Public Health.* 2019;16:893. <https://doi.org/10.3390/ijerph16050893>.
43. Chimed-Ochir O, Yumiya Y, Taji A, Kishita E, Kondo H, Wakai A, et al. Emergency medical teams' responses during the West Japan heavy rain 2018: J-SPEED data analysis. *Prehosp Disaster Med.* 2022;37:205–21. <https://doi.org/10.1017/S1049023X22000231>.
44. Regarding the compilation of discussions in the working group on cooperation between medical care, health, welfare and disaster prevention in the first year of Reiwa. (In Japanese). <https://www.mhlw.go.jp/content/000627849.pdf?msckid=0e82051bb99911ec85e0c49db92ecb8e>
45. Naito H, Sueta D, Nakayama H, Araki E, Tanihara H, Kasaoka S, et al. Clinical features of disaster-associated direct deaths during recent inland earthquakes in Japan. *Tohoku J Exp Med.* 2020;251:169–73. <https://doi.org/10.1620/tjem.251.169>.
46. Naito H, Sueta D, Hanatani S, Ikeda H, Hirose A, Senokuchi T, et al. Factors affecting human damage in heavy rains and typhoon disasters. *Tohoku J Exp Med.* 2022;256:175–85. <https://doi.org/10.1620/tjem.256.175>.
47. Sueta D, Sakamoto K, Usuku H, Fujisue K, Yamanaga K, Arima Y, et al. Clinical features of disaster-related deaths after the Kumamoto Earthquake 2016: comparison with the Great East Japan Earthquake 2011. *Circ Rep.* 2019;11:531–3. <https://doi.org/10.1253/circrep.CR-19-0097>.
48. Egawa S. Progress of disaster medicine during ten years after the 2011 Great East Japan Earthquake. *Tohoku J Exp Med.* 2021;253:159–70. <https://doi.org/10.1620/tjem.253.159>.
49. Egawa S, Murakami A, Sasaki H: Healthy community resilient against disaster. In: Santiago-Fandino V, Sato S, Maki N, Iuchi K, editors. *The 2011 Japan earthquake and tsunami: reconstruction and restoration. Insights and assessment after 5 years.* Cham: Springer; 2017.
50. Ministry of Education. (In Japanese) https://www.mext.go.jp/a_menu/koutou/iryou/1403528.htm

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.