

Review

# Seminar Lessons: Infectious Diseases Associated with and Causing Disaster

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**Abstract:** Disasters such as the magnitude-9 Great East Japan Earthquake occur periodically. We considered this experience while developing measures against a predicted earthquake in the Nankai Trough. This report includes a summary of 10 disastrous infectious diseases for which a counter-measures seminar was held. Thirty-five speakers from twenty-one organizations performed the lectures. Besides infectious diseases, conference topics also included disaster prevention and mitigation methods. In addition, the development of point-of-care tests, biomarkers for diagnosis, and severity assessments for infectious diseases were introduced, along with epidemics of infectious diseases affected by climate. Of the 28 pathogens that became a hot topic, 17 are viruses, and 14 out of these 17 (82%) are RNA viruses. Of the 10 seminars, the last 2 targeted only COVID-19. It was emphasized that COVID-19 is not just a disaster-related infection but a disaster itself. The first seminar on COVID-19 provided immunological and epidemiological knowledge and commentary on clinical practices. During the second COVID-19 seminar, vaccine development, virological characteristics, treatment of respiratory failure, biomarkers, and human genetic susceptibility for infectious diseases were discussed. Conducting continuous seminars is important for general infectious controls.

**Keywords:** disaster; infectious diseases; leptospirosis; tuberculosis; dengue; POCT; COVID-19



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## 1. Introduction

In 2019, 396 natural disasters were recorded in the Emergency Events Database (EM-DAT), with 11,755 deaths, 95 million people affected, and USD 103 billion in economic losses worldwide. This burden was not shared equally since Asia suffered the highest impact, accounting for 40% of disaster events, 45% of deaths and 74% of the total affected [1]. Japan has historically suffered from large-scale natural disasters. Hojoki, one of the oldest essays in Japan, describes a great fire (A.D. 1177), a tornado followed by the relocation of the capital (A.D. 1180), a famine (A.D. 1181–2), and an earthquake (A.D. 1185). Recently, Japan endured the Great East Japan Earthquake and Tsunami (GEJET) of 11 March 2011—a magnitude-9 earthquake that attacked Sendai and neighboring cities, leaving 20,000 people missing. This area was attacked by a tsunami (Jogan) on 13 July 869, indicating that large-scale tsunamis occur within a 1000-year interval [2]. The Nankai Trough mega-earthquake (NTME) is anticipated as the next major earthquake in Japan, involving the Shizuoka prefecture. It is anticipated to cause approximately 323,000 deaths and approximately USD 1.5 trillion in direct impact, with a production and service decline amounting to approximately USD 0.4 trillion [3]. Sharing our knowledge of the disaster is one way to initiate effective measures against these disasters. For this purpose, we decided to share our knowledge with annual seminars about infectious diseases that may

occur due to disasters. The participants were from the International Research Institute of Disaster Science (IRIDeS) at Tohoku University in Sendai who suffered from GEJET, and those involved in disaster countermeasures and medical treatment in the Shizuoka prefecture since 2014. It is important to enhance the resilience of national health systems for disaster risk reduction. Some approaches include integrating disaster risk management into primary, secondary, and tertiary healthcare (especially at the local level), developing health workers' understanding of disaster risks, applying and implementing disaster risk reduction approaches to healthcare, promoting and enhancing training in the field of disaster medicine, and training community health groups in disaster risk reduction through health programs in collaboration with other sectors [4]. During disasters, a lack of safe water access and inadequate sanitation facilities allow the transmission of water-borne and food-borne pathogens. Diarrheal diseases such as cholera, typhoid fever, and shigellosis cause epidemics with high mortality rates. Malaria and other vector-borne diseases in risk areas include arboviruses, such as dengue, yellow fever, Japanese encephalitis, Rift Valley fever, and tick-borne illnesses, including Crimean–Congo hemorrhagic fever and typhus. Diseases associated with overcrowding, such as measles in unvaccinated areas and tuberculosis, can occur after natural disasters. During the seminars, we discussed infectious diseases associated with disasters, such as leptospirosis [5], dengue virus infection [6], and tuberculosis [7,8]. We also discussed biomarkers for these diseases that reflect disease severity [9], and a point-of-care test (POCT) to detect pathogens, including loop-mediated thermal amplification (LAMP) in tuberculosis [10], single-tag hybridization chromatographic-printed array (STH-PAS) [11], and a nanopore technology-based sequencer called MinION [12]. We proposed that acquired immune deficiency syndrome (AIDS) co-infected with tuberculosis (TB) (AIDS/TB) constitutes a natural disaster because the deaths caused by AIDS/TB account for 47% of all deaths in South Africa [13]. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [14] caused a pandemic in 2019 (COVID-19) with more than 286 million cases and 5,429,617 deaths by the end of 2021 (<https://coronavirus.jhu.edu/>) (accessed on 30 December 2021). The expansion of the pandemic severely damaged society. Therefore, the last two seminars were held exclusively on SARS-CoV-2 infections. In this manuscript, we introduce 10 seminars on measures against disaster-related infectious diseases and propose the role seminars play in combating infectious diseases associated with disasters.

## 2. Content of Seminars

Table 1 shows the speakers, their lecture titles, and the dates of the seminars in chronological order. The first seminar was held at Shizuoka General Hospital (SGH), followed by a second seminar hosted by the Division of Disaster-related Infectious Diseases (DRI) at IRIDeS. The third seminar was held as part of the third world conference on disaster risk reduction (DRR) in Sendai (2015) (<https://www.un.org/press/en/highlights/wcdrr>) (accessed on 30 December 2021). The following seminars were conducted based on the Sendai framework for disaster risk reduction [4]. The content of the seminars were classified into categories (Figure 1). Recalling the 10 seminars, 35 speakers from 21 organizations performed lectures about infectious diseases, as well as disaster prevention and mitigation methods. Five of these lectures discussed disaster risk reduction (DRR) from many aspects, including human security [2,15], the United Nations world conference [4], disaster prevention, and measures of the Shizuoka prefecture.

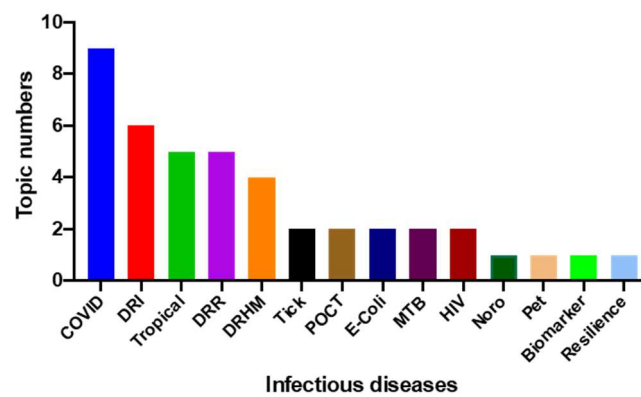
**Table 1.** Conference speakers and their titles in chronological order.

No.	Date	Speaker	Affiliation	Title	Classification
1	24 February 2014	Sato T	JBCL	Examination of digestive system required for disaster infectious diseases	<i>E. coli</i>
		Koga S	U. Shizuoka	Disaster infectious diseases, after earthquakes and tsunamis	DRI
		Hattori T	IRIDeS	Human security program against disasters and infectious diseases	DRR
2	19 July 2014	Sato T	JBCL	Examination of digestive system required for disaster infectious diseases	<i>E. coli</i>
		C.-Y. H	IRIDeS	Disaster-related infectious diseases in the Philippines	Tropical
		Ashino Y	Tohoku U.	Actual condition of HIV infections in the Tohoku region of Japan	HIV
		Egawa S	IRIDeS	Medical response in the Great East Japan Earthquake	DRHM
3	13 March 2015	C.-Y. H	IRIDeS	Collaborative research on disaster-related infectious diseases with Philippines	Tropical
		Sumi A	SMU	Seasonal tuberculosis epidemic	MTB
		Ndhlovu LC	U. Hawaii	Consideration of the HIV epidemic during disaster related events	HIV
		Hakamata Y	SGH	Preparation for disaster-related infectious diseases in Shizuoka Prefecture	DRI
		Suzuki Y	Hokkaido U.	Tuberculosis as a disaster-related disorders	MTB
4	4 July 2015	Fukuoka T	SSH	Experience of outbreak of pathogenic <i>Escherichia coli</i> O157	<i>E. coli</i>
		Kutsuna K	NCGM	Dengue fever	Tropical
		Kaji M	SCHC	About infectious disease measures in Shizuoka city	DRI
		Yanagihara Y	U. Shizuoka	Floods and leptospirosis in the Philippines	Tropical
		Egawa S	IRIDeS	Reports of the United Nations world conference on disaster risk reduction	DRR
		5	19 November 2016	Nakayama Y	SKH
C.-Y. H	IRIDeS			Actual conditions of mosquito-borne infectious diseases and its spreading	Tropical
Sato T	JBCL			Countermeasures against norovirus infection in the event of disaster	Norovirus
Kawase M	TBA			Development of new diagnostic method STH-PAS for infectious diseases	POCT
Koga S	U. Shizuoka			Current status and countermeasures for important tick-borne infectious diseases	Tick
6	12 December 2017			Suzuki Y	Hokkaido U.
		Kawamori F	U. Shizuoka	Tick-born infectious diseases in Shizuoka prefecture	Tick
		Hakamata Y	SGH	Summary of pet infectious diseases of concern at evacuation center	Pet infection
		Matsui T	NIID	Risk assessment method for infectious disease at evacuation center—to facilitate ‘common language’ between infection control specialists and public health sectors	DRHM
		Iwata K	Shizuoka U.	From disaster mitigation to disaster prevention society	DRR

Table 1. Cont.

No.	Date	Speaker	Affiliation	Title	Classification
7	1 December 2018	Nakagawa S	Tokai U.	How to utilize the portable DNA/RNA sequencer MiniON for disaster medical care	POCT
		Mori K	SGH	Kidney disease biomarkers in disaster infectious diseases	Biomarker
		Kaji M	SCHC	Measures against infectious diseases in the event of a disaster	DRI
		Hattori T	KIUI	Disaster measures learned from South East Asia	Resilience
		Ueda T	CMDS	Earthquake and tsunami countermeasures in Shizuoka prefecture	DRR
8	16 November 2019	Goka K	NIES	Fire ants, ticks, mosquitoes—biological risks caused by environmental disturbances and globalization	DRI
		Kawaguchi T	KHSU	Infection prevention and control during natural disaster: lessons learned from the Kumamoto Earthquake	DRI
		Tosaka N	SGH	Reponses of medical institutions in infectious disease crisis management	DRHM
		Ueda T	CMDS	Shizuoka prefecture disaster prevention drill	DRR
9	20 March 2021	Miyasaka M	Osaka U.	What did we learn from a novel coronavirus infection?	COVID-19
		Takahashi A	KIUI	Japanese immune strategy and measures against medical collapse	COVID-19
		Yano K	HMC	About new coronavirus information from CDC	COVID-19
		Iwai K	ShCH	COVID-19 from the medical side	COVID-19
10	27 November 2021	Ishii K	IMS	Disruptive innovation in vaccine development research advancing COVID-19 disaster	COVID-19
		Iwatani Y	NMC	Characteristics and mutations in SARS-CoV-2	COVID-19
		Fujimi S	OGMC	Response of the critical care center in Osaka during the COVID-19 pandemic	COVID-19
		Ashino Y	SDCH	COVID-19 treatment recommendations from Sendai city hospital	COVID-19
		Terao C	SGH	Cloned cell proliferation and infection	COVID-19

We must strengthen the sustainable use and management of ecosystems and implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction. Through their experience and traditional knowledge, indigenous peoples provide an important contribution to the development and implementation of plans and mechanisms, including early warning and water safety [4,16]. Therefore, to increase resilience from disaster-related damage, learning to live in harmony with nature was advocated by Thai indigenous Karen peoples. The hill people can only live with intact forest. An intact forest must have seven layers, which include four aboveground layers. A tree in an intact forest must always follow this pattern: the large tree is at the center, while saplings and bushes—the living quarters of birds and insects—surround this tree. Just below the center and above the bushes and saplings are trees whose branches orchids attach to, drawing nutrients from the trees. At the lower levels are grasses and mushrooms. As for the sub-surface layers, there are roots, tubers, worms, snakes, sweet potatoes, and taros. However, if one element is missing, the system is degraded and cannot survive [17]. Living with nature appears to help recovery from disaster (Figure 2).



**Figure 1.** The topic classification of seminar contents. Abbreviation: COVID, COVID-19; DRI, Disaster-related infectious disease; Tropical, Tropical infectious diseases; DRR, Disaster-risk reduction; DRHM, Disaster-risk health management; Tick, Tick-borne diseases; POCT, Point of care test; *E. coli*, *Escherichia coli*; MTB, *Mycobacterium tuberculosis*; HIV, Human immunodeficiency virus; Noro, Norovirus; Pet, Pet-derived infectious diseases.



**Figure 2.** Lives of indigenous people at Ban Huai Hin Lat Nai in Chaing rai. (A) Houses are protected by tropical rainforest. (B) Houses being built by villagers. (C) Self-sufficiency and cultivation while protecting the forest. (D) Stilt food storage. (Photos are courtesy of Mr. Kunio Miyairi and Prof. Tatsuhiko Kawashima, GONGOVA, 2018).

Four lectures on disaster risk health management were also performed to understand the medical system's approach to disasters. In the Kumamoto area of Kyushu, Japan, an Mj 7.3 mainshock occurred on 16 April 2016, close to the epicenter of an Mj 6.5 foreshock that occurred about 28 h earlier [18]. How the disaster base hospitals worked against these disasters was also presented. Six lectures on disaster-related infectious diseases (DRI) shared knowledge on these diseases, including bacillary dysentery after floods [5] and norovirus outbreaks after Hurricane Katrina despite intensive public health measures [19]. Oysters in the Tohoku area carry norovirus, which causes food poisoning. Oyster contamination correlates with food poisoning and diarrhea outbreaks caused by *Escherichia coli* in Shizuoka [20].

Tetanus occurrence after the Aceh earthquake and tsunami in 2004 [21] and tuberculosis outbreaks after the Haiti earthquake were mentioned in another lecture [7,8]. Understanding the seasonality of tuberculosis (TB) epidemics may help identify potentially modifiable risk factors. Sumi et al. confirmed differences in the seasonality of the prevalence data for sputum smear-positive (SSP) and sputum smear-negative (SSN) pulmonary TB cases in Wuhan [22]. To control SSP pulmonary TB cases, they suggested investigating the periodic structures of SSP and SSN pulmonary TB cases' temporal patterns individually. Attendants often talked about each of these diseases. Twenty pathogens (Table 2) were described in this seminar. For early diagnosis of DRI, biomarkers' roles were presented, including galectin-9 (Gal-9) in dengue fever (DF) [9], malaria [23], and osteopontin (OPN) in leptospirosis [24]. Neutrophil gelatinase-associated lipocalin (Ngal) and other tubular dysfunction markers were also introduced to diagnose acute kidney injury (AKI) [25,26].

**Table 2.** Pathogens discussed at the seminars.

Classification (No.) and Pathogens		
Virus infection (17)	RNA (14)	Human Immunodeficiency Virus (HIV); Coronavirus type 1, type 2; Middle east respiratory virus syndrome; Ebola virus; Dengue virus; Zika virus; Severe fever with thrombocytopenia syndrome virus; Rabies; Lyssavirus; Influenza virus; Norovirus; Hepatitis C virus; Measles virus; Rubella virus.
	DNA (3)	Human papilloma virus; Hepatitis B virus; Varicella zoster virus; Chickenpox virus.
Bacteria (8)		Mycobacterium tuberculosis; Escherichia coli; Clostridium tetani; Legionella; Leptospira spp.; Bartonella henselae; Coxiella burnetii; Chlamydia psittaci.
Fungi (1)		Chytrid fungi
Parasite (2)		Plasmodium falciparum Malaria; Trypanosoma cruzi;

Table 2 lists the pathogens discussed at the conference. Interestingly, 17 out of 28 (about 60%) are viruses, and 14 out of 17 (82%) are RNA viruses. It is worth mentioning that representative zoonotic pathogens, such as Coronavirus, Influenza virus, Ebola virus, Rabies lyssavirus, and Leptospira, were discussed. Therefore, it is necessary to set human and animal life as countermeasure targets for preventing disaster-related infectious diseases. At the same time, it is necessary to further in vivo research on pathogens such as RNA viruses, as described here.

### 3. Disaster-Related Infectious Diseases

#### 3.1. Leptospirosis

Leptospirosis is zoonotic, often occurs after floods, and is mainly endemic to subtropical or tropical countries. It has not been reported since 2009 in the Tohoku region (northern Japan). However, four patients with leptospirosis were found in the region between 2012

and 2014. These cases imply that leptospirosis has reemerged in the region, probably due to global warming [27]. In the Philippines, leptospirosis occurs after floods caused by typhoons or heavy rainfall. The main pathogens consist of numerous serovars (>250). The case fatality rate is 10–20%, and the majority of patients, about 85%, are young males. In addition to rats, its main reservoirs are animals such as wild rodents, herbivores, livestock, and pets, which transmit leptospires through *Leptospira*-colonized water with urinary excretion in the environment [28,29]. Dominant *Leptospira* serovars with high virulence include *L. interrogans* serovar Manilae, *L. interrogans* serovar Losbanos, *L. interrogans* serovar Ratnapura, and *L. borgpetersenii*. After a storm surge during the super typhoon Haiyan (Yolanda), pathogenic *Leptospira* survived in coastal soil in Leyte. Metrological factors showed that leptospirosis occurrence is associated with floods following monsoons in Manila. Besides rainfall, leptospirosis is also associated with relative humidity and temperature in the Philippines. The peak occurrence of leptospirosis preceded DF by only one month, despite occurring 2–3 months later than the peak occurrence of dengue in Thailand [6].

We conducted a biomarker analysis of leptospirosis using two representative matricellular proteins, OPN and Gal-9, in plasma. Both the full-length Gal-9 (FL-Gal9) and OPN (FL-OPN) had increased levels of leptospirosis. Compared to other infectious diseases, pFL-Gal-9 levels showed an inverse correlation with pFL-OPN levels ( $r = -0.24$ ,  $p < 0.05$ ), but no correlation with other markers. By contrast, pFL-OPN levels correlated significantly with other markers of kidney injury, indicating that FL-OPN levels reflect kidney injury in leptospirosis. N-gal was associated with tubular dysfunction in AKI [25].

### 3.2. Tick-Borne Disorders

Scrub typhus or “Tsutsugamushi disease” was recognized in Japan as a Japanese flood fever with high mortality [30]. A recent study in Laos suggested that *O. tsutsugamushi* infection is an important cause of central nervous system infections in Laos [31]. Global warming causes changes to all living things on earth. Tick-borne Lyme disease is increasing annually in the United States and Canada [32], and tick-borne encephalitis (TBE), Lyme borreliosis (LB), and emerging borrelial relapsing fever are widespread in Russia [33,34]. The increased number and distribution of ticks, vulnerability to rain, and increased wild animals, which are sources of blood-sucking for ticks, are involved. Tick and tick-borne pathogen surveillance efforts improve our understanding of geographic variation in risk factors for tick-borne diseases, and efforts to build such programs have increased in recent years [35].

### 3.3. Mosquito-Borne Disorders

Disasters change the behaviors of vectors and increase the incidence of vector-borne diseases, including malaria and DF [36]. Unlike the immediate impacts of flooding, malaria epidemics emerge after the acute phase of the crisis has passed. Heavy precipitation is thought to flush established larval habitats; however, malaria vectors rapidly reestablish, and a surge in disease may occur months after the disaster. Chemo-prevention is useful for reducing the excess disease burden associated with a severe flood [37]. It has also been suggested that DF cases in Manila are influenced by monsoon occurrence, contemporaneous with high temperature, high relative humidity, and heavy rainfall. Heavy rainfall precedes the occurrence of DF cases by two months. This timing can be attributed to the life-cycle of mosquitoes and an adequate number of cases for transmission, which is affected by population density [6]. An epidemic from imported DF occurred in Japan in 2014 and 200 cases were diagnosed. According to the analysis of virus strains, it was found that a single strain may have caused Dengue virus (DENV) cases in Tokyo. It should be noted that the plasma levels of Gal-9 are elevated in both DF and malaria. In malaria, Gal-9 levels were higher at day 0 compared with day 7 and day 28 ( $p < 0.0001$ ). Gal-9 levels were significantly higher in severe malaria (SM) cases than uncomplicated (UM) cases on days 0 and 7. Therefore, Gal-9 is released during acute malaria and reflects its

severity in malaria infections [23]. In DENV infection, Gal-9 levels in the critical phase were significantly higher in DENV-infected patients compared with healthy patients or those with non-dengue febrile illness. The highest Gal-9 levels were observed in dengue hemorrhagic fever (DHF) patients. Gal-9 levels significantly declined from peak levels in DF and DHF patients in the recovery phase. Gal-9 levels tracked viral load and reflected the severity of DENV infection [9]. Finally, a dipstick DNA chromatography assay, a single-tag hybridization-printed array strip (STH-PAS), was evaluated for its efficacy in detecting DENV. PCR amplified reverse-transcribed DNA, and the amplified DNA was detected using the STH-PAS system. In clinical studies, the STH-PAS system showed 100% sensitivity with 88.9 and 86.6% specificities compared to Taqman RT-PCR and the SD Dengue Duo NS1 test, respectively. The STH-PAS system was found to have a superior sensitivity to the Taqman system [11].

#### 4. COVID-19 Caused a Disaster

The COVID-19 outbreak is primarily a human tragedy, affecting countless people. Thus, many countries have undergone lockdowns, restricting their economic agents from mobilizing from one country to another, even nationally, due to the communicable COVID-19. The virus has had a growing impact on the global economy; unfortunately, the global health crisis has become a global economic crisis due to the cancellation of flights, restriction of labor mobility, volatility in stock markets, and so on. For vulnerable families, loss of income due to the outbreak translates to spikes in poverty, missed meals for children, and reduced access to healthcare beyond COVID-19 [38]. It also affects the education of surgeons in the medical community. Residents and young surgeons have shown a substantial decrease in clinical experience, affecting resident education and practice, and variable access to personal protective equipment (PPE). These wasteful efforts have resulted in emotional problems and burnout [39]. Internationally, governments have been enforcing travel bans, quarantine, isolation, and social distancing. Extended periods spent at home have resulted in reduced physical activity, changes in dietary intake with the potential to accelerate sarcopenia, deterioration of muscle mass and function (especially in older populations), as well as increases in body fat [40]. It was also revealed that SARS-CoV-2 has a lower mutation rate than other RNA viruses because it encodes proofreading enzyme genes. Nevertheless, ongoing rapid transmission between humans increases the genetic diversity of SARS-CoV-2 genomes, especially the Spike gene (or the receptor-binding domain, RBD); the latter is advantageous in virus infectivity, immune escape, and tolerance [41]. Interestingly, these globally occurring viral genetic changes display a convergent evolution of the SARS-CoV-2 genome worldwide [42]. Therefore, worldwide surveillance of the SARS-CoV-2 genome is important to understanding future epidemics and may help us control COVID-19. The historical background of mRNA-based vaccine development was also introduced during the seminar [43]. Furthermore, immunogenicity and BNT162b2, a lipid nanoparticle-formulated, nucleoside-modified RNA (modRNA) encoding the SARS-CoV-2 full-length spike, modified by two proline mutations that lock it in the prefusion conformation, were proven to be safe and effective [44]. Identifying risk factors for COVID-19 infection is critical to public health importance. Mosaic chromosomal alteration (mCA), a clonal expansion of leukocytes with somatic chromosomal abnormalities, is associated with an increased risk of many infectious diseases, including severe COVID-19 infection [45]. mCA is strongly associated with males and the elderly; however, the association was significant even after controlling for covariates such as age and sex. The presence of cancer enhanced this association. There was also a trend that the higher the patient's fraction of mCA, the higher the infection rate, suggesting that the expansion of cells with large mutations resulted in abnormal immune dysfunction. This mechanism is interesting; targeting abnormally expanded cells may present a new treatment for many infections, including COVID-19. It would be reasonable to stratify people by the presence or absence of mCA, carefully monitor the infections of those with mCA, and provide appropriate advice according to infection risk inferred from the presence or absence of mCA. SARS-CoV-2 RNA



in concentrated and purified saliva specimens was detected 37 days after onset, using sugar chain-immobilized gold nanoparticles. It was suggested that early morning saliva specimens are more likely to show positive results than those obtained later in the day [46].

An intravenous administration of the anti-interleukin-6 receptor antibody tocilizumab (TCZ; 400 mg) effectively treated a patient with COVID-19 pneumonia and a kidney injury. An early administration of TCZ was proposed to prevent pneumonia and kidney injury caused by COVID-19 from progressing to hyperinflammatory syndrome [47]. Plasma levels of FL-Gal9 and FL-OPN and their truncated forms (Tr-Gal9, Ud-OPN, respectively) represent inflammatory biomarkers. For COVID-19 infection, Spearman's correlation analysis showed that Tr-Gal9, Ud-OPN, but not FL-Gal9 and FL-OPN, were significantly associated with laboratory markers for lung function, inflammation, coagulopathy, and kidney function in CP patients. It was proposed that the cleaved forms of OPN and Gal-9 can be used to monitor the severity of pathological inflammation and therapeutic effects of TCZ in CP patients [48].

## 5. Discussion

Three times more natural disasters occurred from 2000 to 2009 than 1980 to 1989. Climate-related events have increased, accounting for nearly 80% [49]. It is urgent and critical to anticipate, plan for and reduce disaster risk to protect persons, communities, and countries, their livelihoods, health, cultural heritage, socioeconomic assets, and ecosystems effectively, thus strengthening their resilience [4]. We must initiate measures against Nankai Trough Mega Earthquake [3]. In this manuscript, we summarized 10 consecutive seminars on disaster-related infectious diseases. Various topics, including disaster risk reduction, were discussed. Speakers mentioned various pathogens associated with disasters; about 60% of them (17 out of 28) are viruses, and 14 out of 17 (82%) are RNA viruses. RNA viruses evolve rapidly. The high mutation frequency in RNA virus populations is one source of their ability to rapidly change. A high mutation frequency is a central tenet of the quasi-species theory. Unlike RNA viruses, DNA-based organisms generally have lower mutation frequencies and do not exist near the error threshold [50].

Among the many disaster-related infectious diseases, we proposed that AIDS associated with TB (AIDS/TB) is a disaster because deaths caused by AIDS and tuberculosis (TB) account for 47% of all deaths in South Africa [13]. The encroachment of HIV into TB endemic areas may expand AIDS/TB. We have been researching novel biomarkers to detect AIDS/TB in patients from India [51] and have continued our study as part of a JICA grass-roots project.

The recent COVID-19 pandemic caused by SARS-CoV2 is a global crisis. Genome sequencing early in the pandemic showed that single nucleotide mutations, multi-base insertions and deletions, recombination, and variation in surface glycans all generate the variability that, guided by natural selection, enables both HIV-1's extraordinary diversity and SARS-CoV-2's slower pace of mutation accumulation. Although SARS-CoV-2's diversity is more limited, recently emergent SARS-CoV-2 variants carry Spike mutations with important phenotypic consequences in antibody resistance and enhanced infectivity [52]. This rate of change is about half that of influenza, and one-quarter of HIV owing to the error-correcting enzyme coronaviruses possess, rare among other RNA viruses. There are probably thousands of viral particles in any given infection, each with unique single-letter mutations; however, few if any of these cause the virus to be more infectious. Omicron's rise may be largely due to its ability to infect people immune to Delta through vaccination or previous infection [53].

At the seminar discussed here, we shared our knowledge about the clinical manifestations of various infectious diseases, pathogens, and progress in diagnostic methods. In addition, the significance of matricellular proteins such as OPN and Gal-9, which were reported as markers of severity for tropical infectious diseases, was reconfirmed in COVID-19 infection. Further examination revealed that protease cleaves these proteins, suggesting that cleaved products exert new pathological functions and become new severity mark-

ers [54,55]. On the other hand, the countermeasures against COVID-19, which caused the disasters worldwide, have introduced a great deal of knowledge about the pathophysiology and infectious mode of disaster-related infectious diseases. Furthermore, measures against infectious diseases are different for each country. Therefore, it is necessary to conduct such disaster-related infection control seminars on an international scale and share knowledge from each country.

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## Abbreviations

JBCL	Japan Biosciences Co., Ltd.; (Sendai, Miyagi, Japan)
U.	University
IRIDeS	International Research Institute of Disaster Science; (Tohoku University, Sendai, Miyagi, Japan)
SMU	Sapporo Medical University; (Sapporo, Hokkaido, Japan)
SGH	Shizuoka General Hospital; (Shizuoka, Shizuoka, Japan)
SSH	Saiseikai Shizuoka Hospital; (Shizuoka, Shizuoka, Japan)
NCGM	National Center for Global Health and Medicine;(Tokyo, Japan)
SCHC	Shizuoka City Health Center; (Shizuoka, Shizuoka, Japan)
SSK	Saiseikai Kumamoto Hospital; (Kumamoto, Kumamoto, Japan)
TBA	Tohoku Bio-Array Co., Ltd.; (Sendai, Miyagi, Japan)
NIID	National Institute for Infectious Disease; (Tokyo, Japan)
KIUI	Kibi International University; (Takahashi, Okayama, Japan)
CMDS	Crisis Management Department Shizuoka; (Shizuoka, Shizuoka, Japan)
NIES	National Institute for Environmental Studies;(Tsukuba, Ibaragi, Japan)
KHSU	Kumamoto Health Science University; (Kumamoto, Kumamoto, Japan)
ShCH	Shizuoka City Hospital; (Shizuoka, Shizuoka, Japan)
IMS	The Institute of Medical Science;(Tokyo, Japan)
NMC	Nagoya Medical Center; (Nagoya, Aichi, Japan)
OGMC	Osaka General Medical Center; (Osaka, Osaka, Japan)
SDCH	Sendai City Hospital; (Sendai, Miyagi, Japan)
<i>E. coli</i>	<i>Esherichia coli</i>
DRI	Disaster related infectious diseases
DRR	Disaster risk reduction
Tropical	Tropical infectious diseases
DRHM	Disaster risk health management
MTB	Mycobacterium tuberculosis
HIV	Human immunodeficiency virus
POCT	Point of care test
Tick	Tick-borne diseases
Pet infection	Pet-derived infectious diseases
COVID-19	Coronavirus Disease in 2019

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