# Medical Needs in Minamisanriku Town after the Great East Japan Earthquake

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The medical records of service in disaster provided at a place other than a medical facility are defined as disaster medical records (DMRs). In this epidemiological study, to clarify medical need characteristics and trends after disaster, we analyzed the all anonymized DMRs of Minamisanriku Town that lost medical facilities in 2011 Great East Japan Earthquake and its consequent tsunami. After screening of duplicated or irrelevant documents, there were 10,464 DMRs with 18,532 diagnoses from March 11 through May 13. From 34 diagnostic groups according to International Classification of Diseases (ICD)-10, we integrated diagnostic groups into five modules that might require treatment concepts of different types: non-communicable disease (NCD), infectious disease, mental health issue, trauma, and maternal and child health (MCH). Age and sex distributions of the patients were similar to those of population before the disaster. The largest diagnostic module was NCD (68%), followed by infectious disease (21%), mental health issues (6%), trauma (4%), and MCH (0.2%). The age-specific rate of NCD exhibited a similar or suppressed level from that of nationwide survey, with higher rate of pollinosis among young population. Infectious disease increased in most age groups but there was no apparent outbreak because of early interventions. Sleep deprivation was twice as frequent in middle-aged women, compared with men. Trauma and MCH were less frequent, but each exhibited a unique time trend. Trauma onset was continuously recorded, while MCH visits were concentrated on a specific day. The medical need after disaster dynamically changes, and appropriate anticipatory countermeasures are necessary.

Keywords: disaster medical records; disaster medicine; evacuation center; Great East Japan Earthquake; medical needs

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# Introduction

The magnitude 9.0 Great East Japan Earthquake (GEJE) struck at 14:46 on March 11, 2011. As of March 5, 2018, reports describe that 19,630 people were killed, 6,230 were injured, and 2,569 remain missing (National Fire Department 2018). The deaths include 3,701 disaster-related deaths among earthquake and tsunami survivors (as of September 30, 2018, Reconstruction Agency 2018). The main cause of disaster-related death has been physical and mental expiration during the long and resource-deprived evacuation and transportation, especially for older people (Reconstruction Agency 2012). Despite being the strongest earthquake (M9.0) ever recorded in Japan, fewer injuries (n = 6,230 as of March 5, 2018) were recorded than from a large disaster striking two decades earlier: the 1995 Great

Hanshin Awaji Earthquake (M7.2, n = 43,792 as of May 19, 2006, Fire and Disaster Management Agency 2006). Earthquake-resistant buildings saved numerous people from injury by the later earthquake (Shibahara 2011). After GEJE, medical responders confronted medical needs other than injury of the affected residents.

Minamisanriku Town in Miyagi Prefecture, a coastal town of northeastern Japan, had a population of 17,429 before GEJE. The town was home to numerous older people: 29.3% of all residents were 65 years old or older (Minamisanriku Town 2012, 2013). The damage included 620 deaths and 211 missing residents; more than 60% of all households were partially or completely destroyed. The maximum number of evacuees accommodated was 9,753 at 33 evacuation centers (Minamisanriku Town 2012). The town lost its only hospital and all four of its clinics to the

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tsunami (Personal communication with Ms. Aiko Hoshi, Head Nurse of Minamisanriku Hospital and Dr. Masami Sasahara, Sasahara General Clinic). Medical teams provided medical services, mainly at the evacuation centers. Medical teams left handwritten disaster-related medical records of their service at the Minamisanriku Town office.

In 2015, a Joint Committee of related academic and medical associations reached a consensus that legal aspects of disaster medical records (DMRs) be temporally exempted from guidelines for medical records defined in Medical Practitioners' Act (Act No. 201 of July 30, 1948) and the Medical Care Act (Act No. 205 of July 30, 1948) (Joint Committee on Disaster Medical Records 2015). We, therefore, use the terminology "DMR" in this report to designate medical records of service provided at a place other than a medical facility.

On December 15, 2018, PubMed searches conducted using the sets of keywords "Great East Japan Earthquake, medical needs" and "prehospital medical needs in disaster" respectively yielded 40 and 91 reports of related studies. One medical team describing their experiences in Shiogama, Tagajo, and Kesennnuma Cities in Miyagi Prefecture, explaining that most medical needs involved exacerbation of preexisting conditions (Fuse et al. 2011). A study of 2005 Hurricane Katrina and Rita disasters integrated the paper reports of 3,329 patients during triage and treatment at evacuation shelters into a database. They documented hurricane-related risks, injuries, and the loss of continuity in the evacuees' prior and ongoing healthcare (Caillouet et al. 2012). Another report from a tsunamiaffected area described that, in spite of the existence of only a few major injuries, considerable medical needs included wide demands for medical treatment and public health assistance, in addition to measures for mental health care and for counteracting infection in Iwate Prefecture (Nohara 2011). Thereafter, Iwate Prefecture and Iwate Medical University summarized the evacuation center's medical statistics for Iwate Prefecture in Japanese. Using 80,578 DMRs obtained from 188 evacuation centers as subjects, they analyzed the trends and numbers of diagnostic groups and prescribed medicines (Mase 2015). No other report of the relevant literature describes a post-disaster study of medical needs using DMRs. This study was conducted to clarify the overall characteristics of medical needs using DMRs of Minamisanriku Town after GEJE. The results are expected to improve disaster medicine and public health preparedness for future disasters.

# **Materials and Methods**

### Establishment of the database

The study design is descriptive epidemiological research based on anonymized DMRs of Minamisanriku Town after GEJE. A company that acquired PrivacyMark (JIPDEC JIS Q 15001:2006, ID 23820061) concealed confidential personal information from handwritten DMRs and converted each anonymized DMR into a PDF file. The PDF file was imported as an image into a database (FileMaker Pro; FileMaker, Inc., Tokyo, Japan). Patient data were input manually: sex, age, evacuation place, date of consultation, diagnosis, date of diagnosis, symptom, treatment, and prescription.

#### Inclusion criteria

- We included the following anonymized DMRs for the analysis.
- 1. DMRs by any medical team.
- DMRs with at least one date of consultation (a day when the patient met a medical team). The earliest date of consultation was adopted as the first-visit day if no first-visit day was recorded.
- DMRs including only a description of symptoms, prescription, or medical treatment without a diagnosis.

#### Exclusion criteria

- We excluded the following documents.
- 1. DMRs with no date of consultation.
- 2. Duplicated copies of a record.
- 3. Record of death diagnosis
- 4. Documents other than DMR
- 5. Documents with the information about multiple patients

We counted one anonymized DMR (one PDF) as a record of one patient, although it is impossible to eliminate duplicate records or multiple records on a single patient completely because of anonymity. We counted the first appearance of diagnosis in the DMR as the onset of the disease, irrespective of the prior history. When the same diagnosis was listed twice or more for a patient, we did not count it as an onset.

#### DMR screening

Fig. 1 portrays a flowchart explaining the DMR screening. We conducted primary screening mainly to eliminate duplication and documents other than DMRs using sex, age, evacuation place, first consultation date, and PDF images. We conducted a secondary screening using detailed contents. Of 13,212 possible documents in Minamisanriku Town, 1,546 documents were excluded, leaving 10,464 DMRs recording 20,619 diagnoses. Of these, 2,087 diagnoses were excluded because the same diagnosis was made on a later date for a patient, leaving 18,532 separate diagnoses.

Table 1 presents the categorization of diagnoses according to the International Classification of Diseases – Tenth Revision (ICD-10) (WHO, World Health Organization 2016). We classified all diagnoses into 34 diagnostic groups. Additionally, we integrated diagnostic groups into five modules that might require treatment concepts of different types as follows: non-communicable disease (NCD), infectious disease, mental health issue, trauma, and maternal and child health (MCH) issues.

Two categorizations of modules that are excepted from ICD-10 are the following:

- a. Infectious respiratory diseases (J00-J22) were included in the "infectious disease" module, whereas other respiratory diseases (J30-J99) were included in the NCD module.
- b. Pregnant women and infants' medical examination were included in the "maternal and child health" module, whereas other "health services (Z00, Z33)" were included in the NCD module.

P		
Primary screening n =	=13,212	
Exclusion by primary screening criteria • Summary of daily practice • Duplicate with other medical record • Not a medical record	a n 1,113 ds 415 18	
Secondary screening n	=11,666	
Exclusion by secondary screening crite • No description of examination date • Not a medical record	eria n e at all 958 244	
Prehospital medical records	n = 10,464	
Disease diagnoses r	n = 20,619	
Exclusion of the same diagnosis in the same patient $n = 2,087$		
Final disease diagnoses r	18,532 = 1	

Fig. 1. Study flowchart of the disaster medical record (DMR) screening.

### Age/sex-specific disease prevalence rate

We used a publicly available triennial Japanese nationwide patient survey using ICD-10 as a control of age/sex-specific rate of certain diagnostic groups (dataset in Japanese: https://www.e-stat. go.jp/dbview?sid=0003070575) (Ministry of Health, Labour and Welfare (MHLW) 2011). The age/gender-specific rate in the town was calculated as the percentage of cumulative number of diagnosis from March 11 (Day 0) to May 13 (Day 63) within the pre-disaster population of that age/sex group. The monthly nationwide rate was calculated using the percentage of estimated patients per day multiplied by 30 among the total Japanese population of that age/gender group by the 2010 Census. For some diagnostic groups (pollinosis and sleep deprivation), the nationwide patient estimation in the corresponding ICD-10 subset was not available.

### Statistical analysis

We analyzed the data using software, JMP<sup>®</sup> 14 (SAS Institute Inc., Cary, NC, USA). Chi-squared tests were used to compare the categorical values. Values of p < 0.05 were inferred as statistically significant. The age/sex-specific rates in the town and the nationwide patient survey are not directly comparable. We, therefore, did not assess the statistical significance of the difference.

### Ethical considerations

This study was approved by the ethics committee of the Tohoku University Graduate School of Medicine (2015-1-690). No informed consent was obtained from any patient because the DMRs were created during the disaster. Therefore, all DMRs were anonymized and digitized by the PrivacyMark company. Because an anonymized database was used, this study protected the personal information of patients in accordance with "Ethical Guidelines for Medical and Health Research Involving Human Subjects" (Ministry of Education, Culture, Sports, Science and Technology (MEXT) and MHLW 2015).

### Results

# Demography of patients

Table 2 presents demographic information of patients after the disaster and of the background population before the disaster. Medical treatment was provided to 10,464 patients, 4,734 (45%) of whom were 60 years old or older. The patients included a larger number of women (50.5%), as is true also for the background population (51.6%). Some DMRs included no description of sex (7%) or age (3%). No significant difference was found by the sex (p > p)0.7) or age (p > 0.9) distribution of patients compared to the population before the disaster. The evacuation places of patients included evacuation centers (30.5%), homes (8.6%), welfare facilities (2.4%), and houses of friends and relatives (1.6%). Apparently, a certain share of patients had visited evacuation centers for medical treatment from their own home or other evacuation places. Some DMRs included no description of evacuation place (29.0%), but only the name of the district (27.5%). For this reason, the number of patients (n = 10,464) was greater than the reported maximum number of evacuees: 9,753.

# Time trend of visits and diagnoses

Fig. 2 portrays the trend of the first-visit day and the first day of diagnosis. Analyzable DMRs were those of March 11 (Day 0) through May 13 (Day 63). One patient was seen on Day 0, two patients on Day 1, and 20 patients on Day 2. After rapidly increasing from Day 5, the visits peaked at 559 visits on Day 9. The number of visits remained at approximately 100 patients per day for one month, gradually decreasing thereafter. Among the DMRs, 455 (4%) missed the first-visit days. Similarly, the number

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ICD Catagory	Diagnosis (n)	Diagnosti- C	Sub total	Madula
	A suta Castra antaritir (797)	Castroontiti-/	Sub-total	Infaction
AUU-BYY	Diarrhea (92)	diarrhee	944	disease
Certain infectious diseases	Viral intestingl infaction (64)	diarrnea		disease
	User a similar faction (50)	Othern in feations	104	
	P: (49)	Other infectious	194	
	Kingworm (48)	disease		
	Numps (18)			
000 B 40	Other (69)			NOD
C00-D48	Colon cancer (13)	Malignant tumor	51	NCD
Neoplasms	Gastric cancer (8)			
	Lung cancer (7)			
	Other (23)			
	Thyroid tumor (4)	Benign tumor	21	
	Other (17)			
D50-D89	Anemia (77)	Anemia	77	
Diseases of the blood				
E00-E90	Hyperlipidemia (905)	Metabolic	1,851	
Endocrine, nutritional and	Diabetes (595)	endocrine disease		
metabolic diseases	Disorder of thyroid (96)			
	Other (255)			
F00-F99	Schizophrenia (141)	Mental disorder	512	Mental
Mental and behavioral disorders	Anxiety disorder (116)			health
	Depression (90)			issue
	Other (165)			
	Sleep deprivation (590)	Sleep deprivation	590	
	Dementia (59)	Cognitive	61	
	Delirium (2)	impairment		
G00-G99	Epilepsy (49)	Neurological	128	NCD
Diseases of the nervous system	Neuropathy (27)	disease		
	Parkinson disease (15)			
	Other (37)			
Н00-Н59	Cataract (145)	Ophthalmic	469	
Diseases of the eve and adnexa	Conjunctivitis (139)	disease		
	Glaucoma (50)			
	Other (135)			
H60-H95	Otitis media (26)	Otologic disease	91	
Diseases of the ear and mastoid	Tinnitus (14)	o totogie disease		
process	Otitis externa (10)			
process	Other (41)			
100-199	Ischemic heart disease (250)	Cardiovascular	673	
Diseases of the circulatory	Arrhythmia (223)	disease		
system	Heart failure (69)			
	Other (131)			
	Hypertension (2678)	Hypertension	2 678	
	Cerebral infarction (108)	Cerebrovascular	130	
	Introcerchirel homorrhogo (10)	diagaga	150	
	Other (12)	uisease		
100 122	A oute upper respiratory infostion	Infectious	2 010	Infactions
Discourse of the according to an	(1425)	infectious	2,010	diagona
system	Common cold (602)	respiratory disease		uiscase
system	A suta trashaitis (252)			
	Acute trachettis (203)			
<b>VAO VOO</b>	Otner (530)			NOR
J30-J99	Asthma (266)	Chronic	412	NCD
Diseases of the respiratory	Chronic rhinitis (40)	respiratory disease		
system	Chronic obstructive pulmonary			
	disease (34)			
	Other (72)			
	Pollinosis (1590)	Pollinosis	1,590	

Table 1. Categorization of diagnoses according to ICD-10.

K00-K93 Diseases of the digestive system	Constipation (387) Reflux esophagitis (138) Duodenal ulcer (136) Other (394)	Gastrointestinal disease	1,055	
	Stomatitis (52) Periodontal disease (12) Dental caries (6) Other (13)	Dental oral surgical disease	83	
L00-L99 Diseases of the skin and subcutaneous tissue	Eczema (206) Dermatitis (104) Pruritus (94) Other (273)	Skin disease	677	
M00-M99 Diseases of the musculoskeletal system and connective tissue	Bedsore (26) Low back pain (349) Arthrosis (280) Osteoporosis (108) Other (526)	Bedsore Orthopedic disease	26 1,263	
N00-N99 Diseases of the genitourinary system	Nephritis (11) Renal failure (7) Other (10)	Kidney disease	28	
	Hyperplasia of prostate (83) Urinary tract infections (13) Other (46)	Male genitourinary disease	142	
	Urinary tract infections (46) Dysmenorrhea (14) Neurogenic bladder (14) Other (43)	Female genitourinary disease	117	
O00-O99 Pregnancy, childbirth and the puerperium Z00, Z33 Contact with health services	Pregnancy examination (22) Postpartum examination (4) Child health examination (2) Other (11)	Pregnancy/ Puerperium	39	Maternal and child health issue
R00-R99 Symptoms, signs and abnormal clinical and laboratory findings,	Headache (213) Dizziness (103) Other (14)	Head symptom	330	NCD
not elsewhere classified	Abdominal pain (19) Chest pain (13) Other (13)	Chest symptom	45	
	Fever (21) Anorexia (15) Other (62)	Another symptom	98	
S00-T98 Injury, poisoning and certain other consequences of external causes	Wound (284) Bruise (125) Sprain (70) Other (178)	Trauma	657	Trauma
	Burn (45) Frostbite (20) Other (3)	Burn/Frostbite	68	
Z10-Z30 Z34-Z99 Factors influencing health status	Blood pressure measurement (30) Blood glucose measurement (19) Other (8)	Treatment	57	NCD
and contact with health services	Regular prescription (565)	Prescription	565	

Table 1. Continued.

ICD-10, International Statistical Classification of Diseases and Related Health Problems Tenth Revision; NCD, non-communicable disease.

	After the disaster	Before the disaster	
	Prehospital patients (2011)	Total population in the town (2010)	p value*
	(n = 10,464)	(n = 17,429)	
Sex (%)			0.71
Male	4,463 (42.7)	8,431 (48.4)	
Female	5,288 (50.5)	8,998 (51.6)	
Unknown	713 (6.8)	0 (0)	
Age (%)			0.90
0-9	704 (6.7)	1,271 (7.3)	
10-19	796 (7.6)	1,694 (9.7)	
20-29	532 (5.1)	1,251 (7.2)	
30-39	819 (7.8)	1,749 (10.0)	
40-49	1,129 (10.8)	2,215 (12.7)	
50-59	1,445 (13.8)	2,632 (15.1)	
60-69	1,778 (17.0)	2,431 (13.9)	
70-79	1,774 (17.0)	2,384 (13.7)	
80-89	1,017 (9.7)	1,533 (8.8)	
90-100	165 (1.6)	267 (1.5)	
Unknown	305 (2.9)	2 (0.0)	
Location of patients (%)			
Evacuation center	3,191 (30.5)		
Unknown	3,025 (28.9)		
Place name only	2,881 (27.5)		
Own house	898 (8.6)		
Welfare facility	246 (2.4)		
Relatives, Friend's house	171 (1.6)		
Company	52 (0.5)		

Table 2. Demographics of post-disaster prehospital patients and pre-disaster background population.

\*Chi-square test.

Total population in the town by statistics of Minamisanriku Town in 2010.

https://www.town.minamisanriku.miyagi.jp/index.cfm/10,793,c,html/793/20140606-145628.pdf (in Japanese).

of diagnoses increased rapidly from Day 5 and peaked at 829 diagnoses on Day 9. The number of daily diagnoses remained at approximately 300 diagnoses per day for one month, and decreased gradually thereafter.

### Diagnostic group features

Table 1 presents the number of patients (n) with a diagnosis and the subtotal for each diagnostic group. Fig. 3 shows the number of diagnoses in each diagnostic group. Because most of the medical team did not bring laboratory machines or equipment for detailed diagnosis, the diagnoses were reached by the physicians based on primary symptoms, prior histories, and prescribed medications.

Fig. 4 presents the age/sex-specific rate of frequent diagnostic groups and its comparison to results of a nation-wide survey. Infectious respiratory disease was the most

frequent disease; gastroenteritis/diarrhea was the seventh most frequent. The sex/age-specific rate of these infectious diseases increased in all age/sex groups compared to the results of the nationwide survey (Fig. 4 #1 and #7). Influenza patients (n = 50) and pneumonia patients (n = 44) were particularly numerous although there was no reported outbreak. Pneumonia occurred mostly in people over 60 years old.

The age/sex-specific rates of hypertension (#2), metabolic disease (#3), pollinosis (#4), orthopedic disease (#5), non-infectious gastrointestinal disease (#6), skin disease (#8), and cardiovascular disease (#9) are shown in Fig. 4. The rate of hypertension increases as age progresses in both sexes, but the rate among patients 70 years old and older was lower than the result of the nationwide survey. Similarly, the rates of orthopedic disease, non-infectious



Fig. 2. Trends of the first-visit day and the first day of diagnosis.

One anonymized DMR represents a record of one patient. The first appearance of diagnosis in the DMR counts as one diagnosis.

Black bars, number of patients at first visit; grey bars, number of first diagnoses.





Black bars, number of diagnoses in male patients; grey bars, number of diagnoses in female patients; white bars, number of diagnoses in patients without description of sex.

gastrointestinal disease, skin disease, and cardiovascular disease were less than that in the results of the nationwide survey.

Pollinosis was the fourth most frequent diagnostic group. In Japan, pollinosis has seasonal variance: March is the season of greatest prevalence. The nationwide survey was administered in October, and the data for pollinosis were not available. As shown in Fig. 4 #4, pollinosis was more frequent among patients who were 50 years or

#### younger.

As shown in Fig. 4 #10, the ratio of patients with trauma was higher for men than for women in the town. The rate was lower among all age/sex groups than in the nationwide survey that is including injury and fractures.

The most frequent diagnostic group for mental health issues was sleep deprivation. As shown in Fig. 4 #11, female patients were twice as numerous as male patients for age groups 40-80.



Fig. 4. Comparison of prevalence rates in town and in a nationwide patient survey. Each graph shows the prevalence rates (%).

Closed circles, rate of male patients in town; open circles, rate of female patients in town; closed triangles, nationwide rate of male; and open triangles, nationwide rate of females. #1 infectious respiratory disease, #2 hypertension, #3 metabolic disease, #4 pollinosis (nationwide data not available), #5 orthopedic disease, #6 gastrointestinal disease (not infectious, not including malignancies), #7 gastroenteritis and diarrhea, #8 skin disease, #9 cardiovascular disease, #10 trauma, and #11 sleep deprivation (nationwide data not available).

Dataset of total population of Japan by 2010 Census:

https://www.e-stat.go.jp/stat-search/file-download?statInfId=000012660847&fileKind=0.

Dataset of triennial nationwide patient survey in 2011:

https://www.e-stat.go.jp/dbview?sid=0003070575.

The DMRs which cited only a prescription of regular medication with no description of the diagnosis were 565 (3%). Also, DMRs with only a treatment description with no description of a diagnosis were 57 (0.3%).

### *Features of modules*

Fig. 5 presents trends found for the respective modules. Fig. 6 shows age and sex distributions of the respective modules. Of the five modules, the largest diagnostic module was NCD (12,657, 68%), followed by infectious disease (3,948, 22%), mental health issues (1,163, 6%),



Fig. 5. Trends of respective modules. Black bars, number of diagnoses; A, non-communicable disease (NCD); B, infectious disease; C, mental health issues; D, trauma.



Fig. 6. Age and sex distribution of respective modules. Maximum values of Y-axes are adjusted automatically. Black bars, number of diagnoses in male patients; grey bars, number of diagnoses in female patients; white bars, number of diagnoses in patients without description of sex; A, non-communicable disease (NCD); B, infectious disease; C, mental health issues; D, trauma.

trauma (725, 4%), and maternal and child health issues (39, 0.2%). There was no statistically significant difference in ratio of modules between the place of evacuation.

# diagnoses (81%) were of patients who were older 40 years old; the most frequent ages were 70-79 (Fig. 6A). The patient number peaked at 604 on Day 9 and decreased gradually thereafter (Fig. 5A). The largest ICD-10 category was cardiovascular disease including hypertension (I00-I99), followed by non-communicable respiratory disease (J30-

# 1. NCD

Of the 12,657 diagnoses of the NCD module, 10,236

J99), metabolic disease (E00-E90), musculoskeletal disease (M00-M99), and non-communicable gastrointestinal disease (K00-K93). No significant difference in the sex (p > 0.7) or age (p > 0.9) distribution of NCD patients was found compared to the background population before the disaster (Table 2). The prior history was not always recorded. However, most diagnoses were presumed to be chronic diseases that were being treated before the earthquake. The NCD module includes DMRs with only prescription and treatment.

### 2. Infectious disease

Of the 3,948 diagnoses in this module, 821 (21%) patients were under 20 years old. This is the highest rate of younger people among all the modules (Fig. 6B). The time trend (Fig. 5B) reached the maximum patient number (n = 155) at Day 10 and decreased gradually thereafter. However, medical needs for infectious disease persisted for 2 months after the disaster, with 10-20 patients seen per day. The most frequent diagnostic group was respiratory infection (71%), followed by gastroenteritis/diarrhea (24%), and other infectious diseases (5%) (Table 1). No apparent outbreak of influenza or other infectious diseases occurred during the period.

# 3. Mental health issues

Of 1,163 diagnoses, the most frequent diagnostic group was sleep deprivation (51%). The patients were more likely to be women in their 60s and 70s (Fig. 4 #11, Fig. 6C). Among sleep deprivation patients, women were twice as numerous as men. Overall mental health issue module consultations peaked at Day 14 and decreased gradually thereafter. A small peak occurred on Day 39 when a designated psychiatric team provided consultation and medical care (Fig. 5C).

### 4. Trauma

Fig. 5D shows that patients with trauma were far fewer than those with NCD, infectious disease and mental health issue modules. Among 725 diagnoses, most patients were men (n = 404, 56%) and younger than 70 years old (Fig. 6D). The medical needs for trauma remained more than 2 months after the disaster. Trauma included wounds, sprains, bone fractures, insect bites, animal bites, burns, and frostbite, but we excluded lower back pain, arthrosis, osteoporosis, and others that should instead be included in the NCD module.

## 5. Maternal and child health (MCH) issues

Fig. 7 presents the trend of first-visit days of maternal and child health issues (MCH module). The total number was 39 cases, of whom 25 cases were medical examinations of pregnant women, 11 cases were abnormality during pregnancy, and 3 cases were newborn health checkups. The MCH module had a spike peak at 20 on Day 27, when an international medical team brought ultrasound equipment and offered checkups of pregnant women. No maternity hospital facility was available in Minamisanriku Town even before the disaster. Pregnant women who needed medical care were transported to another hospital outside of the affected area.

# Discussion

This study was conducted to elucidate health risks associated with a widespread disaster such as GEJE and to improve medical preparedness for efficient response, as indicated in the Priority of Action 4 in the Sendai Framework (United Nations International Strategy for Disaster Reduction 2015). Minamisanriku Town has the following characteristics: a high rate of elderly residents; declining total population; town located at a coastal bay with high tsunami risk; and fishery as the main industry.



Fig. 7. Trends of first-visit days of maternal and child health (MCH) issues.
The MCH module had a spike peak at 20 on Day 27 when an international medical team brought ultrasound equipment and offered checkups of pregnant women.
Black bars, number of diagnoses including mothers and babies.

Shizugawa Hospital was the only hospital in the town. Four private clinics in the town were all damaged by the tsunami. More than five years were needed to reconstruct the Shizugawa Hospital entirely in a new location as the Minamisanriku Hospital (Egawa et al. 2017). We chose Minamisanriku Town for the present study because of the availability of DMRs and because of its loss of all health care facilities. This report is the first of a study examining complete data of disaster medical needs using DMRs after GEJE. No similar report can be found in the literature, except for one in Japanese describing Iwate Prefecture (Mase 2015). The present study also, for the first time, presents a comparison of medical needs in the town with a nationwide patient survey to clarify the disaster effects.

This study clarified that the age/sex proportion of the background population and that of patients were not significantly different (Table 2), suggesting that a certain proportion of all affected people will become patients after a disaster. The numbers of patients and diagnoses remained quite low for the first two days after the earthquake and tsunami. This result accords with the Iwate Prefecture's report that visitors during the first week after the earthquake were few (Mase 2015) when people were unable to access medical services. Health problem severity might be another reason. It was impossible to make any DMR during that period. It is difficult to ascertain whether there were truly fewer medical needs.

## 1. NCD

Most diagnoses were continuous or newly developed NCDs in people in their 40s or older. Patients with NCD faced difficulties of continuing medical treatment, access to prescribed medications, poor living environment, stress, and lack of nutritious food and exercise opportunities (Murakami et al. 2018). The most frequent NCD-related diagnosis was cardiovascular disease including hypertension (28%). Occurrences of cardiovascular diseases of all types increased significantly after GEJE (Aoki et al. 2012). Evacuation and displacement were associated with increased cardiovascular risk factors (Ohira et al. 2017). The age/sex-specific rate indicates that consultation with a medical assistance team was completely or partially suppressed compared to the nationwide survey conducted in an ordinary time (Fig. 4 #2, 3, 5, 6, 8 and 9). This result suggests hidden needs of NCD because usual consultation was not possible or because patients hesitated to seek care in the aftermath of GEJE. Patients with hypertension or with metabolic and cardiovascular disease lost their daily medications and requested prescribed medications until local health care providers recovered. However, the rates of orthopedic disease and cancer care were not as high as in ordinary times. Those hidden needs of NCD should be borne in mind.

Young people were affected by another type of NCD. The most frequent diagnostic group was pollinosis (Table 1, Fig. 4 #4). Throughout Japan, spring is the regular season for pollinosis, especially by cedar pollen. Seven reports were found in PubMed using the key words "pollinosis, disaster," but no report describes pollinosis after a disaster. The environmental air in the affected area continued to be dusty because of rubble clearing, which might have increased the frequency of pollinosis. Bronchial asthma and eczema were other frequent allergic reactions (Table 1). Reporting of allergic conditions of the affected people must be borne in mind by post-disaster health providers. Questionnaire surveys administered to caregivers of children with allergic diseases revealed that lack of electricity, bathing, and special food were the main obstacles exacerbating allergic symptoms (Yamaoka et al. 2011).

The DMRs revealed 26 patients with bedsores: a minority diagnosis that is peculiar to elderly people. The high percentage of older people residing in the affected areas of Japan, combined with limited resources, caregiver labor, and absence of utilities increased the number of persons with bedsores after GEJE (Sato and Ichioka 2012). Even a few days staying in an evacuation shelter might degrade a patient's bedsore condition because of the low movement of older people. Makeshift cardboard beds are clinically effective to prevent the worsening of bedsores, and also to prevent deep vein thrombosis at evacuation shelters (Nara et al. 2013). Japan implemented a legal framework and guidelines of welfare evacuation centers for people who need special assistance in 2008 and revised it after GEJE for better care (Cabinet Office of Japan 2016). In an aging society, it is important to identify people who need welfare evacuation centers to prevent exacerbation of NCD (Help Age International 2014).

### 2. Infectious disease

The most common diagnosis was infectious respiratory disease (71%), followed by gastroenteritis/diarrhea (24%). The DMRs indicated 50 patients with influenza, but no remarkable outbreak of any type of infectious disease was found in this study. Infectious disease depends on seasonal factors and the environments at evacuation centers. Poor hygienic status attributable to a lack of water for toilets, hand-washing, and crowded living conditions raised concerns about outbreaks of highly contagious infections (Ochi et al. 2013). Although appropriate control measures based on proper risk assessment are necessary, no surveillance was functioning when the risk of infectious disease outbreak was highest (Oshitani and Kamigaki 2013). In Minamisanriku Town, the infectious disease module peaked at 155 diagnoses on Day 10 and decreased gradually thereafter. We speculate that prediction and push-type advocation and infection control prevented outbreaks. In Kesennuma, seven patients were found to be positive for Influenza A at a large evacuation center populated with 1800 evacuees. Appropriate isolation and intervention measures prevented further outbreak (Namiki et al. 2013).

Gastroenteritis/diarrhea was the second most common disease among infectious diseases (Table 1). Sanitation at

the evacuation center was inappropriate for days without a tap water supply. Temporary toilet supplies, manual hygiene with alcohol gel, designation of cooking and shoesoff areas, and supplies of temporary bathing were push-type support countermeasures supplied from outside. Promoting the nutrition of affected people is another important countermeasure designed to increase resistance to infectious disease (Inoue et al. 2014). The age/gender-specific rate indicates an increase of the two types of infectious disease above in all age/gender groups (Fig. 4 #1 and #7). A surveillance system must be established along with countermeasures from an early phase to promote prevention of infection for people of all generations.

### 3. Mental health issues

Although the Brazzaville Declaration (WHO 2011) includes mental health issues in NCDs, we separated the mental health module from the NCD module for this study because it requires specific care. Previous literature search revealed 72 articles related to exacerbation of psychiatric disease that newly developed after GEJE, such as post-traumatic stress disorder (PTSD), depression, anxiety, and sleep deprivation (Murakami et al. 2018). In the present study, sleep deprivation was the most frequent diagnosis (Table 1). Women of middle age or older with sleep deprivation were more than twice the number of men of the same age (Fig. 4 #11). People with sleep deprivation before the disaster might be included, but the first day of diagnosis peaked at 31 on Day 14 (data not shown). This finding suggests that new onset or worsening of sleep deprivation occurred a week or later after the disaster. Another study conducted with a questionnaire related to sleep difficulties in Ishinomaki City also revealed greater numbers of female patients. Lack of social support, especially emotional support, has a stronger association with prolonged sleep difficulties than only slightly modifiable consequences directly attributable to the disaster (Matsumoto et al. 2015). The age/sex-specific rate of sleep deprivation should also be borne in mind for better psychosocial support.

Worsening of pre-existing mental disorders was also noted (Table 1). More than 500 diagnoses of mental disorder were made. This result represents the potential needs of a designated psychiatry team to assist in helping with the specific needs of patients. The basal prevalence of common mental health disorders in Japanese communities was reported as 8.8%, of which 17% of cases were severe and 47% were moderate. However, only 19% of severe and moderate cases received medical treatment (Kawakami et al. 2005). It is possible that the disaster not only exacerbated pre-existing mental disorders; it also increased the clinical manifestation of untreated mental disorders.

A specialized team of the psychiatrists came to the affected area 2 weeks after GEJE. The number of mental disorder diagnoses was concentrated on that day of the visit by the specialized team of the psychiatrists. Many outpatients were left untreated because of the loss of medical records, loss of a patient's family member who had cared for them, and because of disrupted transportation (Moszynski 2011). It was apparent that patients with mental disorders needed the continuous treatment of experts. Therefore, the Disaster Psychiatric Assistance Team (DPAT) was established in 2013 to be dispatched at the time of a disaster (Kawashima 2017). Primarily, DPAT is aimed at supporting psychiatric hospitals and patients. They also support the mental health of affected people and responders.

Mental health difficulties lasted more than two years and required long-term mental health support (Ando et al. 2017). This study examined DMRs for only two months and lacks long-term information about the mental health issues. The peak of first diagnosis of the mental health issue module was at 63-72 on Days 9-14, after which it decreased gradually. The time trend indicates the first day of diagnosis. Therefore, the gradual decrease does not signify that the mental health difficulty was resolved. Individual outcomes should be investigated further.

### 4. Trauma

Compared to the number of deaths, GEJE and its consequent tsunami waves created a small number of trauma patients, including severely injured patients. Few injuries were caused directly by the earthquake. In this study, the onset of trauma remained longer, suggesting that the disaster aftermath continuously creates needs (Fig. 6D). A nationwide survey revealed trauma including injury and fracture as more frequent among teenagers and elderly people. The number of trauma patients in the town tend to be smaller, irrespective of age and sex. These data suggest the suppressed daily activities among the affected population after the disaster in all age groups and both sexes (Fig. 4 #10).

Most of the patients were men who were younger than 70 years old, and they might have been searching for victims and clearing rubble. In a report of trauma patients treated at the Red Cross Ishinomaki Hospital, no sex differences were reported. Most patients' conditions were not severe (Matsuzawa et al. 2016). We included back pain, knee pain, and other non-traumatic orthopedic disease groups in NCD. Patients were transported directly to a distant hospital in cases of severe trauma because Minamisanriku Town lost its main hospital: Shizugawa Hospital. Only minor injuries were treated at the evacuation centers.

### 5. Maternal and child health (MCH) issues

Emergency obstetric transport cases in Miyagi Prefecture increased to approximately 1.4 times the number of those before the disaster. Prehospital childbirth also increased to approximately three times the number of the prior year (Sugawara et al. 2016). In Minamisanriku Town, which had no maternity hospital facility, the pregnant woman needed to visit obstetrics facilities in other cities even before GEJE. After GEJE, pregnant women were expected to move to obstetrics facilities outside the town. The DMRs included no data of prehospital births.

The MCH module spike peaked on the day of a visit by an overseas medical team equipped with ultrasound devices. Information about the availability of MCH care triggered the large number of visits. Cases of MCH issues were fewer than those of other modules, but this medical need exists constantly. After GEJE, the prevalence of pregnant women with psychological distress was high in Miyagi Prefecture, especially in coastal areas that were affected directly by tsunami (Watanabe et al. 2016). Physical and psychological support are necessary for satisfactory perinatal outcomes.

### Study limitations

Duplicated DMRs were eliminated to the greatest extent possible. However, some patients might have been counted several times because the data were anonymized. The medical records of the patients directly transferred to a distant hospital are not included. Results of this study will therefore not represent the overall medical needs of GEJE. However, this is an example of a town that lost all of its medical facilities. Primary treatments were given at evacuation centers. In an environment affected by such diverse damage such as Ishinomaki or Kesennuma, where medical facilities remained functional, different results are possible. Analyzing the medical needs of other disaster-stricken areas remains as a future problem for investigation. Additionally, we used DMRs that cover the short time period of March 11 through May 13. This limited duration might have failed to reveal difficulties that must be confronted over the long term, such as mental health issue needs.

### Conclusion

For the aftermath of the Great East Japan Earthquake, this report is the first of a study analyzing DMRs for the entirety of Minamisanriku Town, an aging community that lost all of its medical facilities. This report is the first to describe a study comparing medical needs to results of a nationwide survey. The health needs of people who survived the tsunami were mainly NCD with less number of trauma. The respective modules of NCD, infectious disease, mental health issue, trauma, and MCH issues revealed dynamic medical needs which changed according to their own characteristics. Hidden medical needs might exist, especially in the areas of NCD and MCH. Infectious diseases increased among all age/sex groups. Appropriate push-type infection prevention is necessary. Sleep deprivation among women was remarkable and required appropriate psychosocial care. Bearing these results in mind, it is necessary to prepare for efficient disaster medical response and for a better future environment at evacuation centers.

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## **Conflict of Interest**

The authors declare no conflict of interest.

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