

## Use of Medical Materials at Disaster Sites: Looking Back on the Great East Japan Earthquake

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After the Great Hanshin Earthquake in 1995, the disaster medical assistance team and disaster base hospitals were established; however, the tsunami and radioactive pollution that accompanied the Great East Japan Earthquake in March 11<sup>th</sup>, 2011 had a significant impact. There were fewer victims of crush syndrome by collapse compared with the Great Hanshin Earthquake. Consequently, we hypothesized that there was a lesser need for immediate medical care following the disaster. A questionnaire survey was mailed to 588 disaster base hospitals. This study investigated the stocking of medical supplies for disasters and their use during the Great East Japan Earthquake and highlighted many related problems. Many hospitals did not receive adequate public support for supplies of medical materials, and many reported a heavy administrative burden for fiscal reasons. This survey demonstrated that there was a heavy demand for public hygiene medical materials. Regardless of the disaster type, after a certain amount of time following the disaster, medical care facilities undergo a transition to evacuation facilities. Thus, to appropriately manage chronic afflictions and long-term evacuees in disasters, it is necessary to make appropriate preparations for the supply of medical materials for the citizens of disaster-affected areas as well as for everyday medical treatment.

**Key Words:** disaster medicine, Great East Japan Earthquake, medical materials, stock system, disaster base hospitals

### Introduction

Japan is one of the most earthquake-prone countries in the world. The past 20 years alone have seen major earthquakes such as the Great Hanshin Earthquake, the Niigata Chuetsu Earthquake, and the Great East Japan Earthquake, all of which caused severe damage (Table 1)<sup>1)</sup>. Therefore, only a few Japanese citizens would argue that disaster preparation is unimportant.

Last year will be the 20th anniversary of the Great Hanshin Earthquake, a fitting time to reflect on the lessons learned from the natural disasters of the past. Even 5 years after the Great East Japan Earthquake, the last major earthquake, analyzing

the state of affairs surrounding the earthquake and drawing lessons from this holds great significance. In such a major disaster, not only everyday infrastructure, such as electric, gas, and sewer services, but also basic social services, such as medical care, nursing, and public hygiene, are threatened.

Considering the possibility of a natural disaster that would outstrip the disasters of the past, we need to constantly ask ourselves whether our current state of preparation is sufficient not only the administrative level but also at the civic level.

To respond to the extent of the damage caused by the Great Hanshin Earthquake in 1995, disaster-response manual was prepared by the Ministry of

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**Table 1** Details about damages of famous earthquakes in Japan

	Great Hanshin Earthquake	Niigata Chuetsu Earthquake	Great East Japan Earthquake
Date of onset	1995/1/17	2004/10/23	2011/3/11
Number of injured	43,792	4,805	6,220
Number of missing or dead	6,437	68	22,010
Magunitude	6.9	6.8	9.0

By Japanese Meteorological Agency.

Health, Labour and Welfare<sup>2)</sup>. Additionally, disaster base hospitals and assistance team dispatch systems, such as the disaster medical assistance team (DMAT), were established<sup>2)~4)</sup>.

At the time of the Great East Japan Earthquake in 2011, it would be fair to say that lessons for earthquake preparedness had been drawn from the Great Hanshin Earthquake<sup>4)</sup>. Nevertheless, the countermeasures proved completely ineffective during the Great East Japan Earthquake.

In particular, unlike in the Great Hanshin Earthquake, few structures collapsed during the Great East Japan Earthquake due to the earthquake itself, although considerable damage was caused by secondary disasters such as the large-scale tsunami and radioactive pollution arising from the Fukushima Daiichi nuclear power plant<sup>5)</sup>. Consequently, numerous victims were forced to live as evacuees for an extended period of time, and it is estimated that the medical needs of those with chronic afflictions exceeded the need for emergency care immediately following the disaster<sup>6)7)</sup>. Although institutions that dispense medical care have issued analysis reports regarding the supply of medical equipment to disaster-stricken areas, we were unable to find any investigations focusing specifically on medical materials<sup>8)9)</sup>.

Therefore, we aimed to investigate the stock of medical materials for use during disasters in disaster base hospitals, as well as the use of medical materials following the Great East Japan Earthquake. Moreover, we also consider the problems of providing disaster medical care.

### Materials and Methods

With assistance from the Supply Processing and Distribution (SPD) Research Institute a questionnaire survey was mailed to 588 disaster base hospi-

tals from November 2011 to January 2012. The SPD Research Institute a collaborative research group, is a voluntary organization that comprises cross-sectoral members and was formed as a platform for exchanging views and conducting research for allowing SPD service providers to contribute to the industry by improving SPD service quality<sup>10)</sup>. In the implementation of this study, there was no conflict of interest with the SPD Research Institute. Disaster base hospitals were the main providers of medical care at the time of the Great East Japan Earthquake; there are approximately 600 such facilities throughout Japan, including approximately 70 in Tokyo. Disaster base hospitals are designated by governors of metropolises and prefectures. At the time of the earthquake, disaster base hospitals were required to meet the following requirements: (1) being a medical institution equipped for emergencies with 200 or more beds; (2) being located in an earthquake- and fire-resistant building; (3) having a large enough facility that would permit halls, offices, and other such areas to be used to accommodate the severely injured; (4) having a helicopter landing pad on the property or within the neighboring area; (5) having facilities for treating critically injured emergency patients; and (6) being permanently equipped with items, such as portable emergency response equipment and materials, emergency response medications, tents, and generators that enable the facility to be self-sufficient at disaster sites<sup>11)</sup>. Requirements (1), (2), (3), and (5) are geared toward treatment within the hospital, whereas requirement (6) target activities at disaster sites and requirement (4) covers activities at both the hospital and disaster sites.

The survey questions concerned the attributes of medical institutions, state of available supplies, and

use of available supplies at disaster sites during the Great East Japan Earthquake, among other issues. The completed survey forms were collected via mail by the Department of Hospital and Healthcare Administration, School of Medicine, Tokyo Women's Medical University, and subjected to statistical analysis.

SPSS version 20.0 (IBM SPSS Japan Inc., Tokyo, Japan) was used for statistical analysis. In addition to a simple total and  $\chi^2$  test, an interval estimate of the population proportion was made to compare the stock ratio of each medical material, the ratio of materials transported to sites vs. stock, and the ratio of materials provided vs. stock. The ratio of materials transported to sites vs. stock serves as a baseline for medical institutions' estimates of the need for medical materials. The ratio of materials provided vs. stock serves as a baseline for medical institutions' estimates of the actual need for medical materials at disaster sites. In addition, to examine the relationship between the type of hospital and their results in these analyses, we divided the disaster base hospitals into four groups: (1) public hospitals, such as national hospitals and municipal hospitals, (2) university hospitals, (3) large-scale group hospitals with a public personality such as Red Cross hospitals, and (4) private hospitals. The term medical materials, as used in this study, is synonymous with quasisdrugs and treatment apparatuses referred to in the Act on Assuring the Quality, Efficacy, and Safety of Medicinal Goods and Treatment Apparatuses.

Because this survey concerned the conditions of the medical institutions and did not target individuals, an ethical review was not conducted.

In this survey, the SPD Research Institute and Uetsuka performed the role of determining and drafting the survey questions. The SPD Research Institute distributed the survey forms, and Nakajima managed the collection of forms and data analysis. All the agencies participated in discussing the results.

## Results

### 1. Attributes of medical institutions (Table 2)

Responses were obtained from 165 medical insti-

tutions, with a collection rate of 28.06 %.

#### 1) Location

The number of facilities responding by location was as follows: 28 facilities in the Hokkaido/Tohoku block (17.0 %), 15 facilities in the Kanto Koshinetsu block (9.1 %), 35 institutes in the Tokyo metropolitan block (21.2 %), 31 facilities in the Chubu Tokai block (18.8 %), 14 facilities in the Kinki block (8.5 %), 10 facilities in the Chugoku block (6.1 %), seven facilities in the Shikoku block (4.2 %), and 25 facilities in the Kyushu/Okinawa block (15.2 %).

#### 2) Managing body

The number of facilities responding according to managing body was as follows: four facilities managed by the national government (including independent administered corporations; 2.4 %); 81 facilities managed by prefectures, cities, towns, and villages (including regional independent administered corporations; 49.1 %); 13 facilities managed by public national universities (7.9 %); 17 facilities managed by private universities (10.3 %); 28 Japanese Red Cross hospitals, Saiseikai hospitals, former Social Insurance hospitals, Rosai hospitals, and Kouseiren hospitals (17.0 %); 20 facilities managed by private organizations (such as foundations, corporations, and medical corporations; 12.1 %), and two facilities whose management was not known (did not answer; 1.2 %).

### 2. System for stocking medical materials (Table 2)

#### 1) Ratio of holding stock for use in disaster and stocking methods

A majority of the medical institutions (66.3 %) held a stock of medical materials for use in disasters. Regarding stocking methods, 47.4 % of the institutions distinguished between stock for use during a disaster and everyday stock.

#### 2) Investment from public administration and financial drain

Regarding the presence or absence of government aid for stocking medical materials, 22.6 % of facilities responded that they received aid whereas 77.4 % responded that they did not receive aid. In 88.2 % of the institutions, funds for purchasing medical materials to be stocked came from the hos-

Table 2 Attributes associated with hospitals

Attributes of medical institutions	n	Medical materials stock	%	Financial terms	%
<Location>		<Stock for use in disasters>		<Do you accept an investment from public administration ? >	
Hokkaido/Tohoku block	28	Holding	66.25	Yes	22.58
Kanto Koshinetsu block	15	Not holding	33.75	No	77.42
Tokyo metropolitan block	35				
Chubu Tokai block	31	<Stocking methods>			
Kinki block	14	Distinguished between stock for use during a disaster and every day stock	47.41	<Financial drain>	
Chugoku block	10			Prefectures	21.82
Sikoku block	7			Cities, Towns, and Villages	2.73
Kyushu/Okinawa block	25	Set in everyday stock	53.45	Hospital	88.18
				Supplier	2.73
<Managing body>		<Basis of selection>		Other	2.73
National government (Independent administered corporation)	4	Within the guidelines of nation or prefectures	21.43		
Prefectures, Cities, Towns, and Villages (including regional independent administered corporations)	81	Confer with public administration	5.36		
		Based on the independent judgment of hospital	79.46		
Public national universities	13	Other	7.14		
Private universities	17				
Japanese Red Cross hospitals, Saiseikai hospitals, Former Social Insurance hospitals, Rosai hospitals, and Kouseiren hospitals	28				
Private organizations (by Foundations, Corporations, Medical corporations, etc.)	20				
No answer	2				

pital, whereas 21.8 % reported that the metropolitan or prefectural government provided some funding.

### 3) Processing method of inventory that has expired

Most facilities (85.4 %) reported that they used stocked materials in everyday medical care before their expiration date to ensure that the sterilization of stocked materials was still valid, whereas 50.0 % answered that they discarded or incurred a loss on expired materials and purchased new materials.

### 4) Selection of medical materials

A high percentage of medical institutions (79.5 %) report that they selected stock materials at their own discretion, whereas 21.4 % responded that they selected stock materials based on conditions or guidelines from metropolitan or prefectural governments.

### 5) Trend by type of hospital

Private hospitals complied with government guidelines more than other types of hospitals ( $p < 0.01$ ). In addition, these hospitals consulted the drug department of the government more than any other type of hospitals ( $p < 0.05$ ). Hospitals in these

groups did not select their stock themselves ( $p < 0.01$ ). A high proportion of private hospitals were subsidized by the government ( $p < 0.01$ ).

### 6) Other results

To the question "Who is responsible for permitting the use of the stock?", a majority of facilities, 65.9 %, answered that the hospital manager (hospital president) held the authority to permit the usage of stocked materials, and 28.1 % of institutions answered that they had no particular guidelines regarding this.

In addition, to the question "Have you guidelines on when to use the stock?", the majority of medical institutions (65.2 %) responded that they had no particular guidelines. Among the institutions that had guidelines, 34.1 % answered that they followed the rule that the materials must be used for disaster victims transported to/arriving at the hospital.

To the question, "How do you decide the amount of the stock?", The highest percentage of facilities (72.5 %) responded that they relied on prior experience and precedent when determining the amount of supplies to be stocked, and only 0.9 % reported

that they made projections based on an estimated hospital population.

### 3. Proportion of stock by item (Table 3)

We requested the proportion of items in stock for 56 stocked items. The average proportion for all items was 44.3 %. We calculated 95 % confidence intervals for the proportions of all stocked items using an interval projection of the population proportion and identified items with stock proportions significantly higher or lower than the average.

Items with higher than average stock proportions were alcohol swabs, indwelling needles, syringes, transfusion sets, injection needles, adhesive tape, elastic bandages, surgical masks, gloves (miscellaneous), sterile gloves, and 4-ply/8-ply gauze. Items with lower than average stock proportions were sterilization sets, syringe caps, face towels, three-way stopcocks for use in gastric tubes, cuff syringes, SpO2 monitors, Esmarch bandages, SAM splints, neck collars, and transparent film.

### 4. Use of stock (Table 3)

Regarding stocked items, we requested the proportion of materials transported to Great East Japan Earthquake disaster sites as well as the proportion of materials supplied for each stocked item at the medical institution.

The average proportions of materials transported to disaster sites was 66.5 % for all items. Items with higher than average proportions of transported to disaster sites were alcohol swabs, syringes, transfusion sets, needle disposal boxes, surgical masks, gloves (miscellaneous), 4-ply/8-ply gauze, aluminum sheets, and SpO2 monitors. Items with lower than average proportions transported to disaster sites were insulin syringes, syringe caps, net bandages, medical caps, urine drainage bags, sheets, CV kits, and chest drainage bags.

The average provision rate for all items was 13.3 %. The items with a provision rate significantly higher than average were transfusion sets, isolation gowns, surgical masks, gloves (miscellaneous), and flat diapers, and only syringe caps had a rate of supply lower than average.

### 5. Free description results (Table 4)

Details concerning the free description of stocked

materials and their use at disaster sites are listed in Table 4. As shown, some answers mentioned the need for public support in stocking materials and the presence of budgetary restrictions. Regarding the use of stocked materials at the Great East Japan Earthquake disaster sites, although some reported that medical materials were generally in sufficient supply at disaster sites, others reported that some supplies were more available than others and the lack of certain supplies with high demand reduced the efficiency of supply use.

### Discussion

The interruption of medical care by the earthquake was a serious problem for citizens affected by the disaster. This occurred because despite the increased demand for medical care caused by external injuries resulting from the disaster and chronic disease and public health problems in shelters, an imbalance arose in which the medical care providers were also affected by the disaster and were unable to provide a consistent supply.

According to our survey, many medical institutions had no particular rules regarding the use of stocked materials, and a number of respondents who replied that such rules existed also indicated that the rules were limited, stating that they were used for disaster victims transported/admitted to the hospital. This indicates that many disaster base hospitals lack clear standards for determining the use of stocked materials and tend to determine the use of materials upon the outbreak of a disaster in the area where the hospital is located. According to a report by the Committee for Investigating Medical Care in Disasters compiled in October 2011, the majority of disaster base hospitals in and around the region stricken by the Great East Japan Earthquake continued to provide medical care and admit disaster victims<sup>12)</sup>. Therefore, it appears that disaster base hospitals in the earthquake-stricken Tohoku area were able to effectively use stocked medical materials in treating the admitted patients. However, as demonstrated by requirement (6) in introductory chapter, hospitals at disaster sites are expected to perform relief activities outside disaster-stricken areas. In addition, they are ex-

**Table 3** Medical materials stock list and use of medical materials at disaster sites

Category	Items	The stock ratio of each medical material (%)	95%CI	The ratio of materials transported to sites vs. stock (%)	95%CI	The ratio of materials provided vs. stock (%)	95%CI
Injections Infusions Alcohol swabs	Alcohol swabs	57.02	(47.79 - 66.24) ‡	89.23	(79.06 - 95.56) ‡	21.54	(12.31 - 33.49)
	Insulin syringes	41.23	(32.05 - 50.40)	48.94	(34.08 - 63.94) †	17.02	(7.65 - 30.81)
	Cathelin needle	40.35	(31.21 - 49.49)	52.17	(36.95 - 67.11)	8.70	(2.42 - 20.79)
	Suction catheters	51.75	(42.44 - 61.07)	66.10	(52.61 - 77.92)	18.64	(9.69 - 30.91)
	Indwelling needles	57.89	(48.69 - 67.10) ‡	66.67	(53.99 - 77.80)	13.64	(6.43 - 24.31)
	3-way stopcock extension tubes	46.49	(37.20 - 55.79)	73.58	(59.67 - 84.74)	16.98	(8.07 - 29.80)
	Sterilization sets	31.58	(22.92 - 40.24) †	97.22	(85.47 - 99.93)	22.22	(10.12 - 39.15)
	Syringes	60.53	(51.42 - 69.64) ‡	78.26	(66.69 - 87.29) ‡	21.74	(12.71 - 33.31)
	Transfusion sets	64.91	(56.02 - 73.81) ‡	81.08	(70.30 - 89.25) ‡	22.97	(13.99 - 34.21) ‡
	Needle disposal boxes	43.86	(34.61 - 53.11)	86.00	(73.26 - 94.18) ‡	12.00	(4.53 - 24.31)
	Syringe caps	30.70	(22.11 - 39.30) †	34.29	(19.13 - 52.21) †	0.00	(0.00 - 0.10) †
	Sterilization drape	41.23	(32.05 - 50.40)	76.60	(61.97 - 87.70)	17.02	(7.65 - 30.81)
	Injection needles	61.40	(52.33 - 70.48) ‡	77.14	(65.55 - 86.33)	20.00	(11.39 - 31.27)
	Intravenous injection needle with blades	53.51	(44.21 - 62.80)	72.13	(59.17 - 82.85)	13.11	(5.84 - 24.22)
Bandages Tapes Dressings	Net bandages	44.74	(35.47 - 54.00)	50.98	(36.60 - 65.25) †	9.80	(3.26 - 21.41)
	Various dressings	50.00	(40.68 - 59.32)	75.44	(62.24 - 85.87)	17.54	(8.75 - 29.91)
	Adhesive tape	63.16	(54.17 - 72.15) ‡	75.00	(63.40 - 84.46)	18.06	(9.98 - 28.89)
	Elastic bandages	62.28	(53.25 - 71.31) ‡	64.79	(52.54 - 75.76)	15.49	(8.00 - 26.03)
	Face towels	28.07	(19.70 - 36.44) †	53.13	(34.74 - 70.91)	12.50	(3.51 - 28.99)
Sanitary goods Gloves Masks Gowns	Isolation gowns	49.12	(39.81 - 58.44)	55.36	(41.47 - 68.66)	25.00	(14.39 - 38.37) ‡
	Surgical masks	64.04	(55.09 - 72.98) ‡	100.00	(95.07 - 100.00) ‡	28.77	(18.77 - 40.55) ‡
	Triangular bandages	48.25	(38.93 - 57.56)	74.55	(61.00 - 85.33)	10.91	(4.11 - 22.25)
	Gloves (miscellaneous)	57.89	(48.69 - 67.10) ‡	100.00	(94.56 - 100.00) ‡	30.30	(19.59 - 42.85) ‡
	Sterile gloves	63.16	(54.17 - 72.15) ‡	75.00	(63.40 - 84.46)	18.06	(9.98 - 28.89)
	Medical caps	42.11	(32.90 - 51.31)	22.92	(12.03 - 37.31) †	6.25	(1.31 - 17.20)
Gastric tube sets	Urine drainage bags	50.00	(40.68 - 59.32)	47.37	(33.98 - 61.03) †	12.28	(5.08 - 23.68)
	Gastric tubes	41.23	(32.05 - 50.40)	59.57	(44.27 - 73.63)	14.89	(6.20 - 28.31)
	3-way stopcocks for use in gastric tubes	19.30	(11.94 - 26.65) †	63.64	(40.66 - 82.80)	4.55	(0.12 - 22.84)
Class of Gauzes	4-ply/8-ply gauze	63.16	(54.17 - 72.15) ‡	81.94	(71.11 - 90.02) ‡	19.44	(11.06 - 30.47)
	Aluminum sheets	17.54	(10.46 - 24.63) †	100.00	(83.16 - 100.00) ‡	10.00	(1.23 - 31.70)
	Sheets	43.86	(34.61 - 53.11)	42.00	(28.19 - 56.79) †	10.00	(3.32 - 21.81)
	Swabs	50.88	(41.56 - 60.19)	56.90	(43.23 - 69.84)	8.62	(2.86 - 18.98)
	Cotton applicator	49.12	(39.81 - 58.44)	60.71	(46.75 - 73.50)	10.71	(4.03 - 21.88)
Intubation sets	Cuff syringes	31.58	(22.92 - 40.24) †	75.00	(57.80 - 87.88)	8.33	(1.75 - 22.47)
	Tracheal tubes	52.63	(43.33 - 61.94)	65.00	(51.60 - 76.87)	8.33	(2.76 - 18.39)
Dissection and suture sets	Skin staplers	36.84	(27.85 - 45.83)	54.76	(38.67 - 70.15)	4.76	(0.58 - 16.16)
	Disposable scalpels	48.25	(38.93 - 57.56)	65.45	(51.42 - 77.76)	9.09	(3.02 - 19.95)
	Nylons	50.00	(40.68 - 59.32)	64.91	(51.13 - 77.09)	10.53	(3.96 - 21.52)
	Braid silks	48.25	(38.93 - 57.56)	54.55	(40.55 - 68.03)	7.27	(2.02 - 17.59)
	Drapes with a hole	42.11	(32.90 - 51.31)	68.75	(53.75 - 81.34)	10.42	(3.47 - 22.66)
	Sewing needles	39.47	(30.36 - 48.58)	64.44	(48.78 - 78.13)	13.33	(5.05 - 26.79)
Chest drainage sets	CV kits	40.35	(31.21 - 49.49)	28.26	(15.99 - 43.46) †	4.35	(0.53 - 14.84)
	Chest drainages	36.84	(27.85 - 45.83)	61.90	(45.64 - 76.43)	11.90	(3.98 - 25.63)
	Chest drainage bags	36.84	(27.85 - 45.83)	47.62	(32.00 - 63.58) †	11.90	(3.98 - 25.63)
Oxygen-related goods	Oxygen extension tubes	40.35	(31.21 - 49.49)	67.39	(51.98 - 80.47)	6.52	(1.37 - 17.90)
	Oxygen tubing extension connectors	35.96	(27.02 - 44.91)	58.54	(42.11 - 73.68)	4.88	(0.60 - 16.53)
	Aerosol masks	42.98	(33.76 - 52.21)	71.43	(56.74 - 83.42)	10.20	(3.40 - 22.23)
Others	SpO2 monitors	29.82	(21.30 - 38.35) †	100.00	(89.72 - 100.00) ‡	14.71	(4.95 - 31.06)
	Esmarch bandages	25.44	(17.32 - 33.56) †	48.28	(29.45 - 67.47)	6.90	(0.85 - 22.77)
	SAM splints	21.93	(14.22 - 29.64) †	60.00	(38.67 - 78.87)	4.00	(0.10 - 20.35)
	Nasal Airway	40.35	(31.21 - 49.49)	65.22	(49.75 - 78.65)	10.87	(3.62 - 23.57)
	Neck collars	34.21	(25.37 - 43.05) †	51.28	(34.78 - 67.58)	2.56	(0.06 - 13.48)
	Bite block	45.61	(36.33 - 54.90)	59.62	(45.10 - 72.99)	7.69	(2.14 - 18.54)
	Tone depressors	50.00	(40.68 - 59.32)	85.96	(74.21 - 93.74) ‡	21.05	(11.38 - 33.89)
	Transparent film	21.05	(13.45 - 28.65) †	75.00	(53.29 - 90.23)	16.67	(4.74 - 37.38)
	Flat diapers	38.60	(29.52 - 47.67)	56.82	(41.03 - 71.65)	27.27	(14.96 - 42.79) ‡
MEAN of All materials		44.28		66.45		13.26	

Interval estimation of population rate † &lt; Mean, ‡ &gt; Mean.

## Appendix Questionnaire entries

Category	Items	Medical materials stock	Great East Japan Earthquake	
		in stock or out of stock	materials transported to sites	materials provided
Example	Syringes	○	○	×
Injectons Infusions Alcohol swabs	Alcohol swabs Insulin syringes Cathelin needle Suction catheters Indwelling needles 3-way stopcock extension tubes Sterilization sets Syringes Transfusion sets Needle disposal boxes Syringe caps Sterilization drape Injection needles Intravenous injection needle with blades			
Bandages Tapes Dressings	Net bandages Various dressings Adhesive tape Elastic bandages Face towels			
Sanitary goods Gloves Masks Gowns	Isolation gowns Surgical masks Triangular bandages Gloves (miscellaneous) Sterile gloves Medical caps			
Gastric tube sets	Urine drainage bags Gastric tubes 3-way stopcocks for use in gastric tubes			
Class of Gauzes	4-ply/8-ply gauze Aluminum sheets Sheets Swabs Cotton applicator			
Intubation sets	Cuff syringes Tracheal tubes			
Dissection and suture sets	Skin staplers Disposable scalpels Nylons Braid silks Drapes with a hole Sewing needles			
Chest drainage sets	CV kits Chest drainages Chest drainage bags			
Oxygen-related goods	Oxygen extension tubes Oxygen tubing extension connectors Aerosol masks			
Others	SpO2 monitors Esmarch bandages SAM splints Nasal Airway Neck collars Bite block Tone depressors Transparent film Flat diapers			

Presence or absence of stock, materials transported site and materials provided of each medical material.

Please contact Nakajima (e-mail: nakajima.norihiro@twmu.ac.jp) If you want to know about the contents of all of the questionnaire.

**Table 4** Free description

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<p><b>[Current status of stocked medical materials]</b></p> <ul style="list-style-type: none"> <li>• We only have a certain fixed amount of stock of medical materials at the hospital because the hospital has implemented SPD; however, according to our system, the SPD vendor's warehouse stocks large amounts of major medical materials, which are dispensed during disasters. The fixed amount of stock under SPD is approximately a one-week supply under regular conditions.</li> <li>• We use a three-day supply as a rough guideline for stocking materials, but I am not confident that we have enough of a variety of items or that the quantity is sufficient. Because stocked materials are kept on the first floor, in the event of a tsunami, it is likely that the stock would become unusable. We try to use the stocked materials at the hospital prior to their expiration date, but in many cases we are forced to discard them.</li> <li>• Because both the warehouse for stock and the pharmacy department are on the first floor, I am worried that in case of a flood, it would become unusable.</li> <li>• The SPD Business Center manages stocked medical materials.</li> <li>• Stocked medical materials are stored and managed by the Emergency Medical Center warehouse.</li> </ul>
<p><b>[Burden of making stocked medical materials hold]</b></p> <ul style="list-style-type: none"> <li>• We need public assistance. In particular, for staff members such as DMATs who offer on-the-ground medical care, it is important to quickly achieve nationwide consistency regarding medical materials. (For instance, with one particular transfusion route, it is not possible to substitute an alternative injection of drug solutions via bypass.)</li> <li>• Based on experiences with difficulties in providing materials following the earthquake, I strongly feel that it is necessary to stock materials. In reality, however, practical difficulties still exist with the methods of organizing stock, handling finances, ensuring stock availability, and so on.</li> <li>• Maintaining large amounts of stock for a long period of time places a heavy burden on us.</li> <li>• Without a subsidy, it is not possible to maintain stock for use in disasters.</li> <li>• Medical materials for use in the hospital are shared, and we only have a 1.5-2 day supply. We would like to maintain a one-week supply, but it is not possible financially.</li> <li>• According to the rules regarding stocked materials, the relief party uses the materials at the location to which they are dispatched. The value of the stock is 200,000 yen, including medicines and medical materials.</li> </ul>
<p><b>[Limitation of medical activity at disaster sites]</b></p> <ul style="list-style-type: none"> <li>• When DMATs were dispatched, medical materials were transported to sites, but almost none of these materials were used.</li> <li>• Stock was transported to the site for DMATs to use, but no medical treatment took place.</li> <li>• Expecting a large amount of relief activity at sites was affected by the tsunami. We carried large amounts of towels, paper diapers, and other materials, but were unable to reach the affected sites. Our main activity was to make the rounds of evacuation facilities and offer treatment there; therefore, we found few external injuries.</li> </ul>
<p><b>[Securement of medical materials at disaster sites]</b></p> <ul style="list-style-type: none"> <li>• When the prefecture and the city jointly dispatched personnel, the prefecture directly sent general medical materials and medicines to disaster sites. Special materials and medicines that were not included in those sent to the site were prepared at the hospital, brought to the site or sent there, and used effectively.</li> <li>• We also gathered some items (particularly medical materials) from everyday stock, not just stock in the warehouse.</li> </ul>
<p><b>[Demands of medical materials at disaster sites]</b></p> <ul style="list-style-type: none"> <li>• Stomas in particular were used effectively.</li> <li>• The DMAT team did not carry enough oxygen cylinders to disaster sites, so we delivered them there.</li> <li>• Because aid was mainly given at associated hospitals, the quantities were sufficient; however, there were more of some medical materials than those of others, and the process was ineffective (we were only able to receive information via satellite phone for the first week, and information on what we needed was delayed).</li> <li>• We ran out of influenza diagnosis kits, urinalysis kits, cold medicine, antibiotics, anti-allergy medication, and bag valve masks.</li> </ul>
<p><b>[Other comments]</b></p> <ul style="list-style-type: none"> <li>• It was not possible to transport large amounts of materials. We were allowed to use materials at the sites, but we had to leave extra materials at the site.</li> <li>• When categorizing medical items and ensuring that we had alternative medications, we had to sort enormous piles of items, and it was difficult to organize everything.</li> </ul>

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pected to establish rules to enable the use of stocked medical materials for a wide range of applications.

In this survey, even among disaster base hospitals, the main facilities providing medical care in disasters, only 66.3 % held stock for use in disasters. Based on the high proportion of institutions that did

not distinguish between everyday stock and stock for use in disasters, even when the institution did possess the latter, it is clear that administrative effort was needed to reduce the risk of the expiration of medical materials by continuously stocking a surplus of several days' worth of medical materials used in everyday operation. In the survey, within



the free description section, a large number of respondents indicated that they felt it was a burden to maintain stock. Regarding fees for stocking materials, many respondents indicated that they did not receive aid from the government. Therefore, it appears that numerous medical institutions maintained a relatively higher quantity of stock for everyday use and did not hold stock for use in disasters. Yokoe et al have reported that due to the recent cuts in medical care fees, it is difficult for medical institutions to stock medicines for maintaining functionality in disasters, and the opinions expressed in the free description section about the stock for use in disasters seem to support this<sup>13)</sup>.

In this study, private disaster base hospitals consult the drug department of the government and are subsidized by the state. Meanwhile, it is considered that other types of hospitals lack government support, for the following three reasons: (1) local government has to set priorities for offering finite grant funds, (2) the relationships of local government as a subsidizing agency and other public management bodies are complicated, (3) public hospitals are expected to be involved in activities without government support. Nevertheless, our study indicates that 33.8 % of hospitals do not have a stock of medical materials for disaster and some hospitals have a hard time maintaining a stock of medical materials out of government grants.

The opinions expressed in the free description section indicate feelings of anxiety about hospitals that receive no government grants. For the reasons stated above, we think that disaster base hospitals should get national government grants. Additionally, prefectural governments determining health-care planning should make decisions regarding the scale and content of medical materials to stock for a potential disaster. Hospitals must refer to the behavior of and statistical data regarding local residents when deciding about medical materials to stock for a potential disaster.

When medical institutions use medical materials for everyday use in disasters, the medical materials carried to the disaster sites are more diverse as the number of providers increases. One respondent in-

dicated in the free description of what kind of problems might occur in disaster areas that "with one particular transfusion route, it is not possible to substitute an alternative injection of drug solutions via bypass." This appears to be the reason why numerous transfusion kits were transported to the disaster sites.

Therefore, a nationwide consistency in stocked medical materials is needed. However, as described above, because large quantities of medical materials for everyday use are currently being stocked, If nationwide consistency of stocked medical materials is achieved and a list is prepared, it will be preferable for ensuring operational efficiency to select the medical materials on the stock list as medical materials for everyday use. Although this is outside the scope of this study, such a situation hinders fair competition in the market for medical materials, which could change the circumstances for providing care for patients in the region as the primary task of medical institutions. Therefore, it appears that it would be appropriate for public funding to cover the bulk of the fees associated with stocking materials for use in disasters.

This study clarifies the stock ratio of medical materials, the ratio of materials transported vs. stock, and the ratio of materials supplied vs. stock. Because no study has investigated this before, the results of this study appear to be novel. In addition, this study calculated the 95 % confidence interval for the interval estimate of the population proportion, and items were categorized as those for which the ratios were high and low. Some may prefer to transport all medical materials with concerns; however, because there are inevitably limits to the quantities of materials that can be transported to disaster sites, it is desirable to prioritize medical materials.

The study makes clear that many items with a high stock ratio are medical materials for external injuries and public hygiene. Few medical institutions stock SpO2 monitors, however because the ratio of monitors transported vs. stock is high, it is possible that disaster base hospitals envision situations wherein monitoring would be necessary to

manage anesthesia or surgical operations.

In the Great East Japan Earthquake, most of the aid appears to have gone to disaster victims who were forced to evacuate for long periods of time owing to the tsunami or radioactive pollution<sup>6)7)</sup>. According to prior studies, most earthquake-related deaths in the Great East Japan Earthquake involved the respiratory or circulatory system, and it is reported that excessive stress of living as an evacuee caused patients to develop high blood pressure as a direct result of the earthquake<sup>14)</sup>. Other reports have mentioned that in 2011, the year the disaster struck, 18.2 % of onsite patients suffered from respiratory afflictions, a significant increase over 2009 and 2010. Furthermore, it was reported that in addition to a marked increase in pneumonia, acute exacerbations of chronic obstructive pulmonary disease, and asthma attacks after the earthquake, there was also a risk of developing pneumonia from the tsunami<sup>15)</sup>.

This study shows that among the items required at disaster sites after the Great East Japan Earthquake, there were a large number of medical materials needed for public hygiene. The medical materials that were supplied at disaster sites were transfusion sets, isolation gowns, surgical masks, gloves (miscellaneous), and flat diapers, indicating that there was a high demand for these items at sites. In addition to transfusion sets, which have a wide range of uses when combined with appropriate medications, the fact that medical materials for public hygiene were needed at sites is in agreement with the state of affairs at disaster sites reported in previous studies<sup>16)</sup>.

Our survey indicates that few medical institutions transported flat diapers to sites. Moreover, the rate of supply of flat diapers from disaster base hospitals was high, and because they can be put to a wide range of uses, from preventing leakage of fluids following treatment of external wounds to being used for urine elimination by those under nursing care, it appears that there was a high demand for flat diapers.

Many patients in the Great East Japan Earthquake are reported to have been senior citizens

$\geq 65$  years old<sup>17)</sup>. Therefore, we should re-evaluate the materials to be stocked in light of the aging Japanese population. Because many people are forced to live as evacuees for long periods of time after large-scale natural disasters, under ordinary conditions, treatment undergoes a transition to evacuation facilities after a certain amount of time following the disaster. Therefore, preparations must be made in line with the everyday supply of medical care to the citizens of the affected area.

There are some limitations to this study. Firstly, different disaster base hospitals were not active at disaster sites for the same period, and many medical institutions did not list the periods for which their staffs were dispatched. Therefore, it was not possible to conduct a detailed investigation of the use of medical materials during different periods such as the acute period immediately following the disaster and the subsequent period of treating chronic afflictions. It would appear that determining which medical materials need to be transported to sites is done after obtaining information in advance when dispatching staff in response to disasters, and it may be significant that there is a clear difference between the determinations of disaster base hospitals at the time depending on the actual situation at disaster sites.

Secondly, the reasons for transporting medical materials to disaster sites are unclear. The medical materials present at storage facilities at disaster sites are sufficient, however it is possible that the materials cannot be moved from storage facilities to disaster sites due to lack of gasoline or other reasons; if this is the case, it will be necessary to focus on this as a separate issue. Furthermore, as indicated in the free description section, it is possible that unused medical materials were left behind at disaster sites to ease departure, which would indicate the opposite conclusion, i.e., the materials transported were those for which there was little need at disaster sites. However, several previous studies have reported the characteristics of medical requirements in the Great East Japan Earthquake, and because no contradictions are apparent with respect to these trends and the uses of medical mate-

rials provided for disaster sites, there does not seem to be a problem with interpreting the data in this study<sup>8)9)16)</sup>.

Thirdly additional medical materials were possibly sent to disaster sites either at the group level by the Japanese Red Cross Society or the National Hospital Organization or at the prefectural level. In fact, free descriptions indicated that materials were provided in bulk. Thus, it is possible that disaster base hospitals belonging to the above-mentioned groups as well as other disaster base hospitals made different judgments regarding the necessity of medical materials. To obtain an accurate assessment of this issue, it will be necessary to conduct a survey to further investigate the types of medical materials provided by each organization.

Fourthly, because the data used to discuss the degree of necessity for medical materials in terms of the proportion of stock, the proportion of materials transported to sites vs. stock, and the proportion of materials supplied vs. stock were binary, consisting of either yes or no answers, it is not possible to discuss the degree of necessity in terms of the quantities of medical materials. Although the survey forms included a section for listing the actual quantities of medical materials, the medical institutions used different formats and units, which made it difficult to use these answers for data analysis. When conducting similar surveys in the future, it will be necessary to improve the survey form.

### Conclusion

Disaster base hospitals at disaster sites mainly admit and treat severely injured patients. In addition to treating patients during the acute period by dispatching DMATs to disaster sites, disaster base hospitals that are not located at disaster sites are expected to provide treatment to patients with chronic afflictions in evacuation facilities owing to the possibility that medical institutions at the disaster site may not recover. The stock of medical materials that supports these activities should be covered by public funds because of the heavy economic burden on medical institutions. This survey demonstrates that there was a heavy demand for public hygiene medical materials, and it would seem that

storing these medical materials at evacuation facilities would not only lighten the burden on disaster base hospitals but would benefit disaster victims as well.

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### 災害拠点病院の医療材料活用状況—東日本大震災を振り返る—

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1995年の阪神淡路大震災を契機にDMAT（disaster medical assistance team）や災害拠点病院が整備されてきた。2011年3月11日に発生した東日本大震災の被災は、主たる影響が津波や放射能であり、阪神淡路大震災時に発生した建物倒壊に伴う挫滅症候群患者は少なく、発災直後の医療ニーズは少なかったと推測される。本研究の目的は、災害拠点病院における医療材料の災害用備蓄の状況と東日本大震災における医療材料の活用状況を調査し、災害医療を提供する上での課題について検討を行うこととした。今回、全国の災害拠点病院588施設に対して郵送法によるアンケート調査を行い、災害用医療材料の備蓄状況と東日本大震災での活用状況について調査を行った。医療材料の備蓄に対して公的な補助を受けていなかった医療機関が多く、経営面で負担になっているという意見も多かった。また、今回の調査では、東日本大震災における公衆衛生系医療材料の需要が高かったことを明らかにした。大規模な自然災害下においては長期の避難生活者が多くなるため、通常は発災から一定期間経過後、避難所における診療へと移行していく。したがって、当該地域住民の日頃の医療受給状況に即した備えが必要になってくる。災害時の慢性疾患や長期の避難生活への対応という点からも実情に沿った備蓄計画が望まれる。