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Analysis of the Quality and Quantity of Antiepileptic Drugs Required in Communities during Large-Scale Disasters: Focused on a Small Local City in Japan

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Abstract: The Tohoku earthquake off the Pacific coast in March 2011 led to massive medical requirements. Although the availability of drugs is essential in the disaster-affected area, a shortage of drugs and a lack of supply of drugs were reported. Moreover, in Japan, there are concerns regarding the occurrence of a large-scale earthquake, such as the Nankai Trough megathrust earthquake, in the near future. Therefore, drug requirements in a disaster-affected area need to be determined in advance. This study uses national health insurance data (KDB), which are medical big data, to determine the drug requirements in the region from insurance claim information. This study focuses on epilepsy as the target disease and determines the quantity and quality of antiepileptic drugs required in the region via analysis.

Keywords: medical needs; large-scale disaster; antiepileptic drugs; medical big data; small local city

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1. Introduction

Research Background

The Tohoku earthquake off the Pacific coast that occurred in March 2011 in Japan had a magnitude of Mw9.0 and caused enormous damage to the country. This earthquake and its after-effects are collectively referred to as the Great East Japan Earthquake. This earthquake led to a large number of human casualties and enormous medical needs. Owing to the tsunami and the radiation problems at the Fukushima Daiichi Nuclear Power Plant, the scope of damage has increased as the victims have lived in shelters for significantly long periods. During the aftermath of the Great East Japan Earthquake, patients with chronic diseases had greater medical needs than those suffering from injuries [1,2]. Drugs are essential for treating patients with chronic diseases. However, when the Great East Japan Earthquake led to a massive number of victims, the drug needs of each patient could not be properly grasped and consolidated, owing to a mismatch between drug supply and demand at first-aid centers and evacuation shelters [1]. Figure 1 shows the main scheme of the drug supply system followed in Japan in the event of a disaster. When a large-scale disaster occurs, disaster medical teams such as DMAT, JMAT, and JRCS play central roles in medical support. Each team brings medical supplies as relief and provides medical care at evacuation shelters and first-aid centers. These teams also treat patients with chronic diseases and prescribe medicines and drugs. Medical supplies are also supplied by drug wholesalers, drug companies, and local governments outside the disaster-affected area. Drugs delivered to disaster-affected areas are accumulated in large-scale evacuation shelters and first-aid centers, which also serve as distribution centers, from where they are distributed to smaller evacuation shelters and first-aid centers. Decisions regarding the request and supply of medical supplies in the disaster area are made by the

local government officials who manage the evacuation centers and the dispatched doctors and pharmacists. In addition, the Disaster Countermeasures Headquarters established in the disaster-stricken area make decisions on the general framework, such as requests for dispatching doctors and setting up evacuation shelters. As described above, there are two major drug supply routes during disasters. The supply and demand balance of drugs is not optimized because the needs of disaster victims are not properly determined in this supply route.

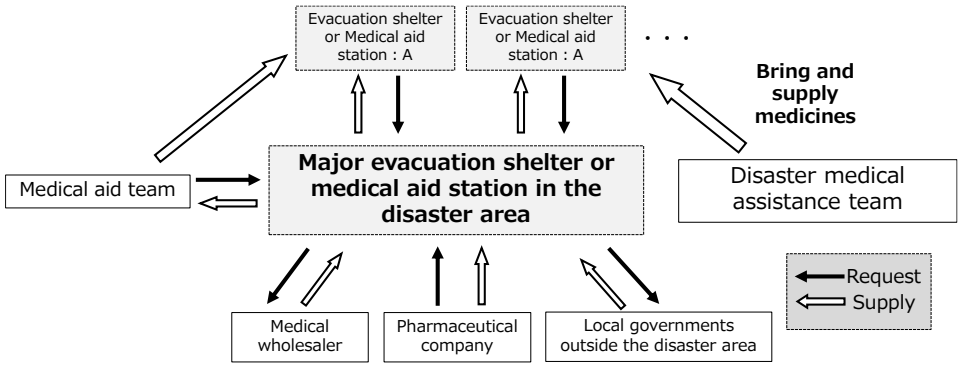

Figure 1. Major medical supply system scheme in Japan.

The above-mentioned problem of drug supply and demand occurred during the Great East Japan Earthquake. In Japan, there are concerns regarding the occurrence of large-scale and wide-area earthquakes, such as the Nankai Trough megathrust earthquake, in the near future. Therefore, the problem of drug supply and demand balance in Japan should be studied and addressed. It is believed that an effective and efficient drug supply in the event of a disaster requires an accurate determination of the medical needs of the region before the disaster occurs. The supply–demand route shown in Figure 1 is a general scheme. In other cases, pharmacies in the affected areas may directly supply the medicine to the victims. Regardless of the scheme, however, the supply–demand balance of pharmaceuticals in Japan has not yet been optimized. In addition, there are no drastic plans or measures that would optimize the balance between the supply and demand of pharmaceuticals.

This study uses the national health insurance data [3] ("KDB"), which are medical big data, to measure the quantity and quality of drugs prescribed to local residents on a town level. Furthermore, as shown in Figure 1, drugs are distributed to first-aid centers and evacuation shelters in the disaster-affected area and are delivered to victims. Therefore, estimating the amount of each drug that may be required at each first-aid center/evacuation shelter is essential. The purpose of this study is to determine the drug needs in each town and estimate the amount of each drug that may be required at each designated evacuation shelter in the event of a disaster. In this study, the "quality of drugs" refers to the types of main ingredients of the drugs. An overview of the KDB, analysis target area, and analysis flow are described in detail in the following section.

In Japan, a large number of drugs that are required in the event of a disaster have been examined in previous studies [4,5]. These drugs are mainly classified according to their requirement within the time elapsed after the occurrence of a disaster. According to Wakabayashi [5], these are broadly classified into the following three types:

I. Drugs required within three days after the occurrence of the disaster (hyperacute phase);
II. Drugs required after the third day of the disaster, when external support is expected;
III. Drugs required for long-term evacuation shelter life.

Category I drugs are mainly used for surgical procedures and for treating injuries, such as multiple external wounds, burns, crush wounds, incisions, bruises, and bone fractures. Category II drugs are primarily used for acute disease management. The diseases

treated using these drugs include post-traumatic stress disorder (PTSD), anxiety, insomnia, overwork, constipation, anorexia, low back pain, colds, and secondary infection from gastrointestinal disease and trauma. Category III drugs are primarily used for treating chronic diseases. The diseases treated using Category III drugs include hypertension, respiratory and liver diseases, diabetes, and heart diseases. This study focuses on drug supply and demand for chronic diseases because it has been reported that the drugs required to treat patients with chronic diseases are of greater need than those required to treat physical injuries caused during the Great East Japan Earthquake. Another reason for the focus on drug supply and demand for chronic diseases is that medical needs for patients with chronic diseases are expected to increase in the event of the Nankai Trough megathrust earthquake, which is expected to occur in the future. Furthermore, this study particularly focuses on antiepileptic drugs, among other drugs used for treating chronic diseases. These drugs are selected for analysis in this study because the incidence of epileptic seizures is likely to increase in the event of a disaster owing to stress and sleep deprivation due to changes in the environment; moreover, if antiepileptic drugs are not taken for long periods, it poses a life-threatening risk to patients. Kobayashi et al. [6] also mentioned the importance of antiepileptic drugs in the event of a disaster. Kobayashi et al. investigated the shortage of antiepileptic drugs and the exacerbation of seizures in people with disabilities and epilepsy following the Great East Japan Earthquake. The results showed that patients who did not take antiepileptic drugs for long periods experienced an exacerbation of seizures. This highlights the importance of antiepileptic drugs in times of disaster. Therefore, this analysis focused on antiepileptic drugs.

Thus far, the KDB has been extensively used to conduct research on estimating the extent of damage and difficulty in evacuating people who require support from a third party during a disaster (i.e., vulnerable people) [7,8]. In a previous study on estimating the extent of damage using the KDB [7], the authors extracted information on dialysis, ischemic heart disease, and cerebrovascular disease patients from the KDB and estimated the circumstances under which they would be affected during an earthquake. Another study investigated the difficulty of evacuating people requiring special care [8], i.e., patients with orthopedic diseases whose evacuation on foot was considered difficult; information on such patients was extracted from the KDB. An evacuation difficulty index was calculated for each region, and the difficulty that patients with orthopedic diseases faced during evacuation was estimated. Thus, the authors used the KDB to extract information on people requiring special care during a disaster with various attributes. The present study focuses on drugs needed in the event of a disaster, especially antiepileptic drugs.

A study by Nakajima [9] describes the necessity of stockpiling drugs in the event of a disaster. This study conducted an internet questionnaire survey and acquired information from doctors and pharmacists. Further, it determined the types of drugs that should be stockpiled in medical institutions. Additionally, Nakajima [10] conducted a study to clarify the issue of stockpiling drugs for those engaged in nursing care. These studies highlighted the importance of stockpiling various drugs and explained the importance of antiepileptic drugs. Another study focused on antiepileptic drugs during disasters; it has a similar perspective to the present study. The previously mentioned study by Kobayashi et al. [6] clarified the shortage of antiepileptic drugs and the exacerbation of seizures in people with disabilities and epilepsy during the Great East Japan Earthquake. Moreover, the results of the study conducted by Shibahara et al. [11] indicated an increase in epileptic patients after the Great East Japan Earthquake. Additionally, Yilmazel [12] conducted a study during April–May 2022, targeting 270 epileptic patients, aged 18 and above, residing in the Central Black Sea region of Turkey, to clarify the relationship between disaster preparedness and health literacy.

The existing literature mentioned above focuses on the stockpiling of drugs that are needed in the event of a disaster, understanding of the actual circumstances during the Great East Japan Earthquake, and awareness among epileptic patients to prepare for disasters. However, no study was conducted to examine the regional distribution of people

taking antiepileptic drugs using medical big data. Therefore, the present study examines the quality and quantity of antiepileptic drugs that are needed in communities in the event of a disaster. The results of this study are expected to help optimize the drug supply and demand balance in the event of a major earthquake that may occur in Japan in the future.

2. Materials and Methods: Study Area and Overview of KDB

2.1. Overview of Hakui City, Ishikawa Prefecture

This study targeted Hakui City, Ishikawa Prefecture, and information on the residents was acquired from the KDB. Figure 2 shows the map of Ishikawa Prefecture and Hakui City, an outline of Hakui City, and the locations of evacuation shelters in Hakui City. Ishikawa Prefecture is located in the central part of the Japanese archipelago, and Hakui City is located at the base of the west side of the Noto Peninsula. Hakui City has a population of 21,364 people, and its number of households is 8537 (as of 1 December 2019). The city area is 81.85 km^2, and it can be classified into 65 towns. According to the FY2015 National Census [13], the elderly population rate, which is the ratio of the elderly to the general population, is approximately 36.8%, which is extremely high (the national average is approximately 26.6%). Additionally, according to the National Land Numerical Information Download Site, which provides basic information on national land, such as topography, land use, and public facilities in Japan free of charge, there are 40 designated evacuation shelters in Hakui City (Figure 2, upper left).

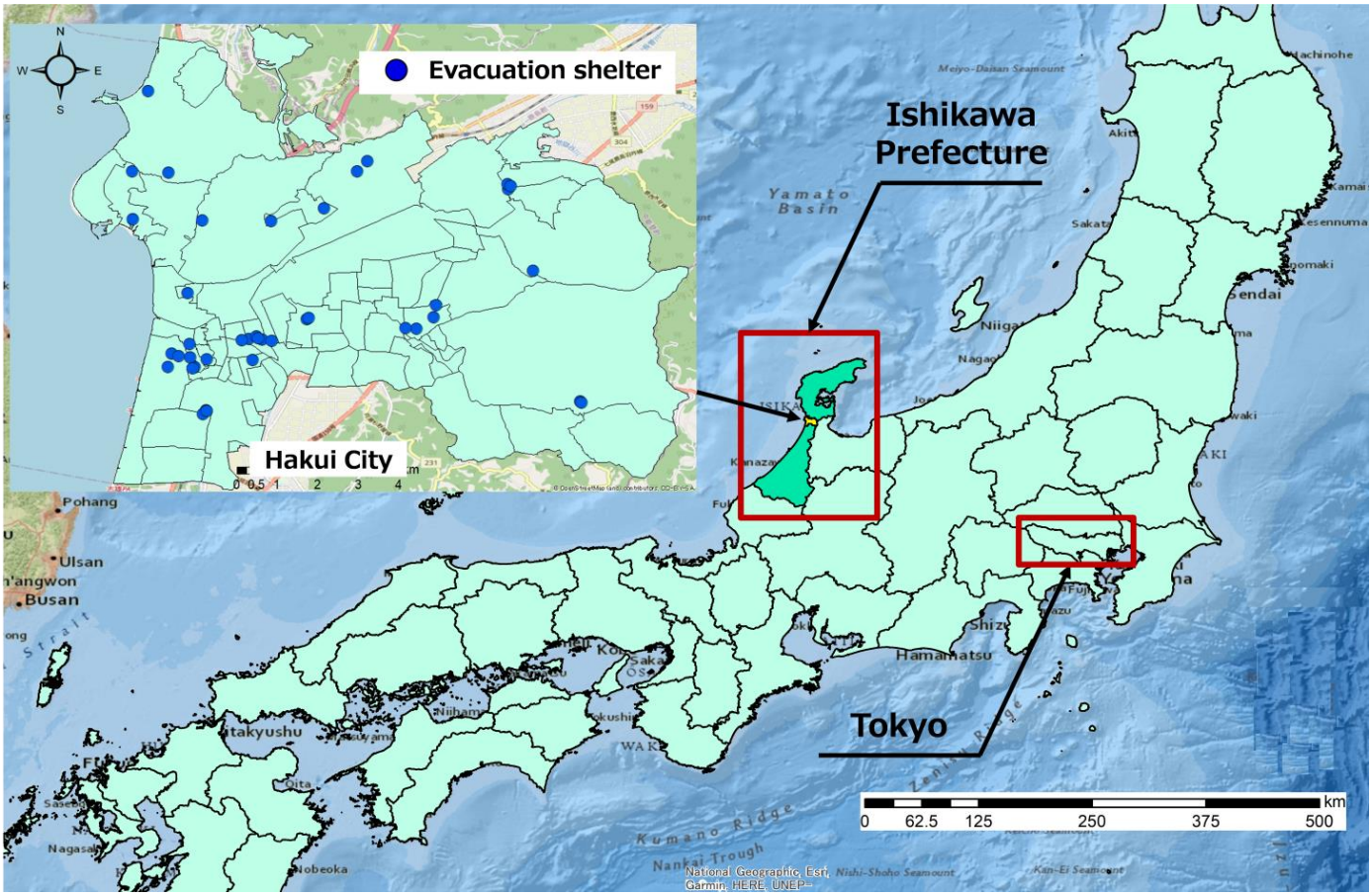

Figure 2. Location of Ishikawa Prefecture and Hakui City, and locations of designated evacuation shelters in Hakui City.

Kanazawa University, with which the authors are affiliated, and Hakui City, Ishikawa Prefecture, concluded a comprehensive partnership agreement, and a data acquisition environment was established. Under the comprehensive partnership agreement, the KDB

used in this study was provided to the authors, and thus, Hakui City, Ishikawa Prefecture, was selected as the analysis target area. When the KDB is used, it is processed to protect personal information, and the authors cannot identify any personal information. Hakui City in Ishikawa Prefecture has also consented to our use of the KDB for academic research.

Here, we explain the concerns regarding the largest earthquake disaster that is assumed to hit Hakui City, Ishikawa Prefecture, in the future. The Japan Seismic Hazard Information Station (J-SHIS) [14] provides seismic hazard maps specifying seismic source faults, thus enabling the specification of seismic source faults that are expected to result in large seismic intensities in Hakui City. In addition, the seismic intensity distribution when an earthquake occurs on the specified fault can be determined. This study considers the case where a large-scale earthquake occurs in the Ochigata fault zone, which is expected to generate greater vibrations and shaking in Hakui City. Figure 3 shows the magnitude of the seismic intensity that Hakui City would experience when an earthquake with an asperity of Case 4 among the earthquakes assumed by J-SHIS occurs in the area, with additions made by the author to the data provided by J-SHIS. From Figure 3, the instrumental seismic intensity can be determined in 250 m mesh units; however, it can be seen that it is assumed that the entire Hakui City area would be struck by strong shaking of 6 lower and 6 upper. The earthquake that is assumed to occur in the Ochigata fault zone has a maximum Mw of 7.0 and a 50-year occurrence probability of 3.17% [14].

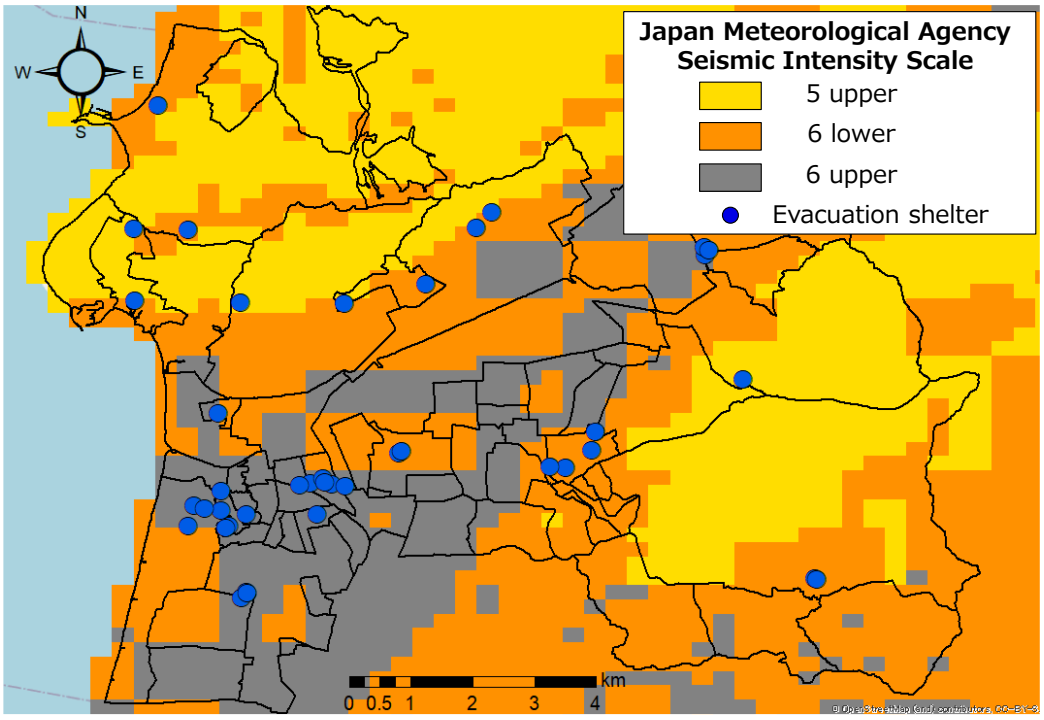

Figure 3. Predicted seismic intensity and designated evacuation shelters in Hakui City when earthquake occurs in Ochigata fault zone.

2.2. Overview of KDB

The KDB consists of medical, health, and nursing care information provided to all municipalities in Japan to support the creation and implementation of data health plans in line with the PDCA cycle. Figure 4 shows the structure of the data provided by the administration of Hakui City to the authors. The KDB is broadly divided into three groups of data: insured person management ledger, insurance claim data, and long-term care insurance data. All these data were ID-coded to prevent information from being identified and processed such that addresses can only be determined up to the town level. These data groups can be used to obtain information on medical, health, and nursing care on an individual basis. The insured person management ledger contains the IDs of persons

enrolled in national health insurance in Hakui City, the address up to the town level, age, and date of national health insurance enrollment or loss; it can be referred to as a list of insured people recorded in the KDB. Insurance claim data are divided into medical insurance claim management data, score data by medical resource ICD, and medical summary data. These are data for which insurance claim information is accumulated for each medical practice. Data such as the ICD-10 code, which is an international classification standard for diseases, injuries, symptoms, patient conditions, and medical practices, as well as the code of the medical institution visited and prescribed drug names, can be determined for each individual. Additionally, long-term care insurance data are data where the contents of long-term care services received by those who have been certified as requiring long-term care in Japan as well as the incurred costs are recorded. All data have been accumulated on a monthly basis since April 2012. The authors could access the data from April 2012 to September 2020 from Hakui City.

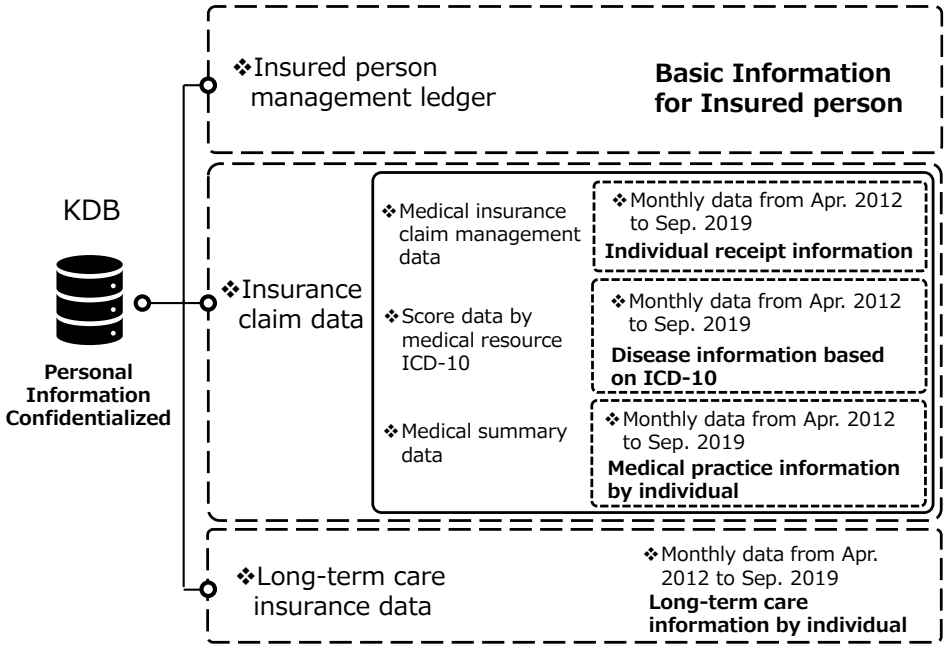

Figure 4. KDB data structure.

This analysis requires the drug prescription information of the national-health-insurance-insured people. Such information is described in the "medical summary data" within the insurance claim data; therefore, this analysis uses only the "medical summary data" of the provided KDB. Table 1 shows an example of the medical summary data. The first and second columns of the data contain the individual ID and the address up to the town (the author has deleted this in the table), respectively. From the fourth column onwards, the medical practice code and the prescribed drug name are described. In this analysis, the medical practice code was used to extract information regarding those who were prescribed antiepileptic drugs.

2.3. Analysis Methodology

As mentioned in Section 2.2, two analyses were mainly conducted in this study. In the first analysis (henceforth called "Step.1"), the KDB was used to calculate the number of people with prescribed antiepileptic drugs in Hakui City, and the regional distribution of those people was clarified; subsequently, the names of the main ingredients of the antiepileptic drugs were determined. Regarding the data period to be used, in Japan, the maximum number of prescription days for drugs is generally 90 days in most cases; therefore, if a 90-day (three-month) KDB is used, it is possible to calculate the number of antiepileptic drugs users without omission to the maximum extent possible. Therefore, in

this analysis, the data for July, August, and September 2020, the latest three months of the data period (April 2012–September 2020) provided by the Hakui City administration, were used.

Table 1. Examples of medical summary data used in this analysis.

KDB ID	Address	Medical Institute Code	Classified Name	Pharmaceutical Information	Quantity	Number of Times
		1710211242	Antiepileptic drug	Depakene R Tablets 100 mg	1	1
		1710121359	Antiepileptic drug	Lamictal Tablets 100 mg	2	7
		1718010083	Antiepileptic drug	Vimpats Tablets 50 mg	8	30
		1712110004	Antiepileptic drug	Depakene R Tablets 200 mg	3	30
		1712110004	Antiepileptic drug	Landsen Tablets 0.5 mg	1	44
		1712110004	Antiepileptic drug	Depakene R Tablets 200 mg	4	30
		1712110004	Antiepileptic drug	Depakene R Tablets 200 mg	5	30

In the second analysis (henceforth called "Step.2"), the number of epileptic patients to be evacuated to each designated evacuation shelter was estimated based on the regional distribution of antiepileptic drug users calculated in Step.1. In Japan, each municipality decides the designated evacuation shelters based on the Basic Act on Disaster Management. When a large-scale disaster occurs, these designated evacuation shelters are opened, and the victims are evacuated to these shelters; however, in several cases, the drug supply location for the victims and the evacuation shelter are the same. Therefore, we assumed that epileptic patients would evacuate to the 40 designated evacuation shelters in Hakui City, as shown in Figures 2 and 3. However, it is difficult to estimate the number of epileptic patients among the estimated number of evacuees when an earthquake occurs in the Ochigata fault zone. Therefore, in this analysis, we assume that all epileptic patients that were calculated from the KDB are evacuated to the designated shelters.

Additionally, we describe the method for estimating the number of evacuees to designated evacuation shelters in the analysis of Step.2. In this analysis, the location–allocation analysis by ArcGIS [15] was used for estimating both cases. Location–allocation analysis is categorized as a transportation network analysis, and it is a method for calculating the optimal facility layout from the relationship between the candidate location of the facility and the demand site (movement cost, attractiveness of facility, and supply capacity of facility). In this analysis, the center of gravity of a house in Hakui City was selected as the candidate site for the facility, and the designated evacuation shelters shown in Figures 2 and 3 were used as the demand sites. Additionally, the costs to be set were such that the travel distance between the candidate point (center of gravity of the house) and the closest demand site (designated evacuation shelter) was the shortest. Figure 5 shows a diagram of the specific estimation method. First, the nearest designated evacuation shelter was selected from all the houses in Hakui City from the location–allocation analysis. The nearest evacuation shelter was determined for all houses by implementing this analysis. Subsequently, the ratio of the selected evacuation shelters to the total house area within the town was calculated. The number of epileptic patients per town, calculated from the KDB, was divided proportionally with respect to this ratio, and the number of evacuees to each designated evacuation shelter was estimated. This method is used for estimating evacuees to the designated evacuation shelters for epileptic patients calculated from the KDB.

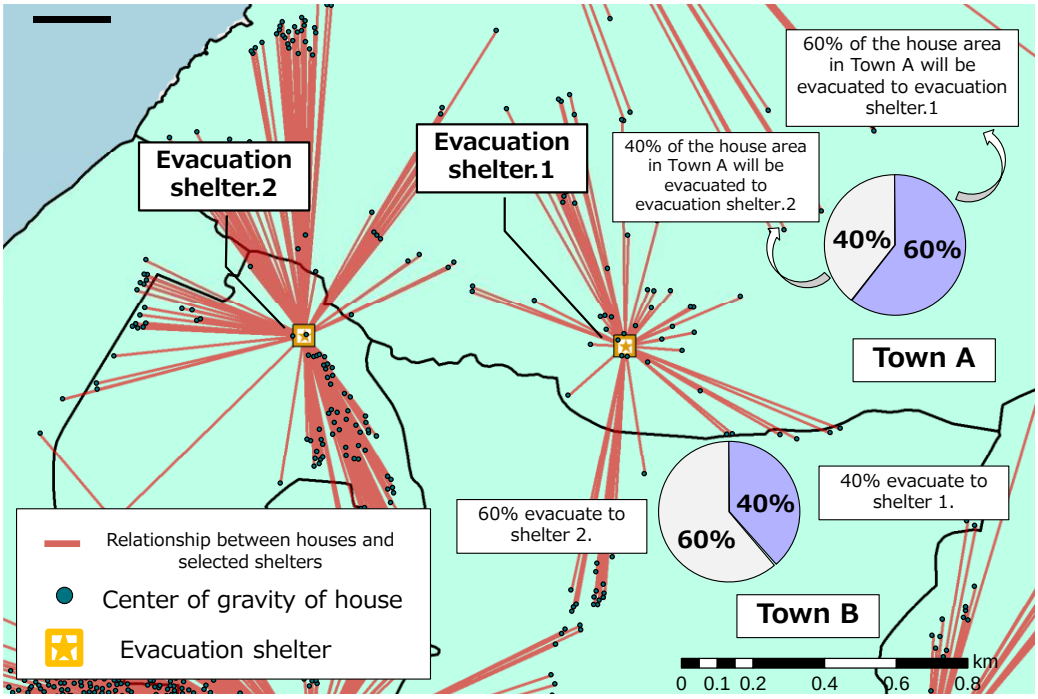

Figure 5. Method of estimating evacuees by location–allocation analysis.

3. Result: Calculation Results of Antiepileptic Drug Users from KDB

3.1. Regional Distribution of Antiepileptic Drug Users

The KDB for the three months of July, August, and September 2020 was used to calculate the number of people taking antiepileptic drugs in Hakui City, which yielded a total of 267 people. Figure 6 shows the population distribution in 65 towns in Hakui City. The darker colors in the figure indicate that a greater number of people are taking antiepileptic drugs in the town. Based on the results, there were many people taking antiepileptic drugs in the southwestern part of Hakui City. The town with the most epileptic patients was Chirihama Town, with 29 patients. Near Chirihama Town, there were 8 epileptic patients in Awara Town, and 14 in Okawa Town, indicating that epileptic patients were mostly concentrated in the southwestern part of Hakui City. Additionally, there were 13 epileptic patients in Yanagida Town and 9 patients in Motoe Town, indicating that epileptic patients were scattered and living in towns relatively far from the southwestern part of Hakui City as well. The regional distribution shown in Figure 6 shows real numbers, not percentages of the population. This is because, in terms of disaster prevention engineering, it is important to pinpoint the exact number of epileptic patients residing in each town, as the information on the specific number of people is usually deleted when indicating the population ratio within the town.

3.2. Calculation Results of Main Ingredients of Antiepileptic Drugs

Figure 7 shows the details of the main ingredients of the prescribed antiepileptic drugs for the antiepileptic drug users calculated from the KDB. Of the 267 people, 99 (approximately 37.1%) were confirmed to be using antiepileptic drugs that contain sodium valproate as the main ingredient. Sodium valproate is a drug that is widely used as a first-line treatment and is mainly used for treating generalized epileptic seizures. As a general rule, this drug is contraindicated for administration to pregnant women or women who may be pregnant and requires relative caution. It can also be confirmed that 62 people (approximately 23.2%) were taking antiepileptic drugs containing clonazepam as the main ingredient. As a general rule, this drug is contraindicated to patients with acute angle-closure glaucoma or myasthenia gravis. Further, 41 people (approximately 15.4%) were taking antiepileptic drugs containing carbamazepine as the main ingredient. This drug

is often used as a first-line treatment for partial-onset epileptic seizures. Furthermore, 23 people (approximately 8.6%) used levetiracetam, and 14 people (approximately 5.2%) used zonisamide, indicating that various antiepileptic drugs were used. As described earlier, we used the KDB to clarify the population distribution of antiepileptic drug users by town and the major ingredients of the antiepileptic drugs that they were taking. As mentioned above, antiepileptic drugs have many contraindications in principle, and the amount and type of antiepileptic drugs are generally determined with utmost care. In the event of a disaster, victims are placed in situations where epileptic seizures are likely to occur due to stress and lack of sleep. Therefore, doctors and pharmacists who prescribe antiepileptic drugs need to be more cautious when prescribing them during disasters when compared to normal times. This analysis showed the calculation results of the main ingredients of antiepileptic drugs for 267 patients as basic information for this purpose.

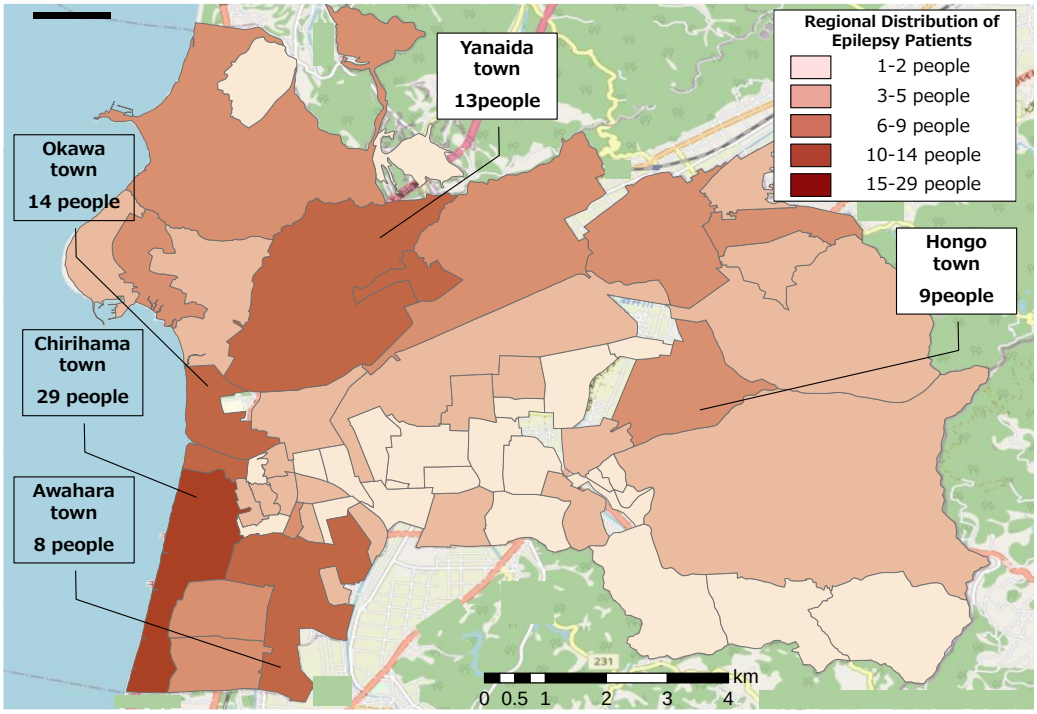

Figure 6. Visualization of population distribution of antiepileptic drug users.

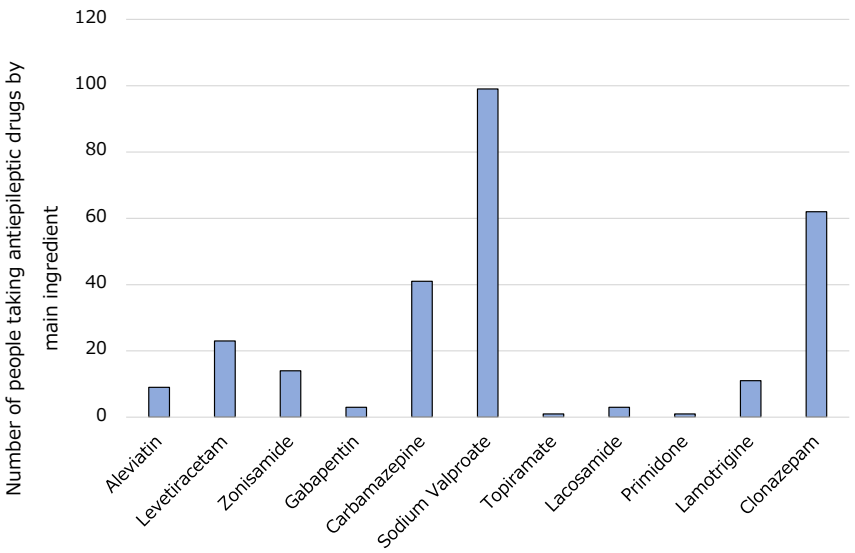

Figure 7. Calculation results of the number of people taking antiepileptic drugs by main ingredient.

As described earlier, medical big data were used to calculate the population distribution of users of drugs that are needed during a disaster and the main ingredients of drugs. Thus far, questionnaires and interview surveys have been mainly used to understand the drug needs of local residents. Although questionnaires and interview surveys can obtain detailed information, they cannot comprehensively determine the drug needs in a given region. Therefore, medical big data, such as the KDB, which can comprehensively determine the population distribution and main ingredients of drugs needed in the region in the event of a disaster, are used in this study. Additionally, although this study only focuses on antiepileptic drugs, the target drug can be appropriately changed according to the needs of local government crisis management departments, which are the main axes of disaster response. Further, the analysis conducted in this study demonstrated an example in which medical big data could be applied to disaster mitigation measures related to disaster medicine.

4. Result: Estimation Results of Number of Evacuees Who Are Epileptic Patients

The number of epileptic patients who could evacuate to each evacuation shelter was estimated using the method described in Section 2.3. Figure 8 shows the visualization of the maximum number of epileptic patients who can evacuate to the 40 designated evacuation shelters in Hakui City; these shelters are set as demand sites. Table 2 also shows an example of the top five evacuation shelters with the largest estimated number of evacuees among the 40 evacuation shelters. As shown in Figure 6, the southwestern part of Hakui City is an urban area with a large population. As it is an urban area with a concentrated population, many designated evacuation shelters are present in this area (Figure 3). The results of estimating the number of evacuees showed that the Hakui Community Center near Chirihama Town had the largest number of evacuees, at approximately 25.7 people, followed by the Ishikawa Prefectural Hakui Technical High School (approximately 17.2 evacuees), Ishikawa Prefectural Hakui High School (approximately 16.8 evacuees), and Awanoho Elementary School (approximately 16.7 evacuees). These designated evacuation shelters were areas where the calculations showed many epileptic patients in Hakui City. As shown in Figures 2 and 8, the designated evacuation shelters were also concentrated in this area. However, this estimation suggested that a large number of epileptic patients could be evacuated to the Hakui Community Center, Ishikawa Prefectural Hakui Technical High School, Ishikawa Prefectural Hakui High School, and Awanoho Elementary School. Additionally, in the northeastern part of Hakui City, Yoki Elementary School (approximately 13.1 people) had a large number of evacuees. As the Yoki Elementary School is relatively far from the center of Hakui City, the supply of drugs may be delayed compared to the center. Therefore, doctors and physicians must pay particular attention to the supply of drugs.

Table 2. Top five facilities with a large number of estimated epileptic patient evacuees.

Evacuation Shelter	Estimated Number of Evacuees with Epilepsy
Hakui Community Center	25.7
Ishikawa Prefectural Hakui Technical High School	17.2
Ishikawa Prefectural Hakui High School	16.8
Awanoho Elementary School	16.7
Yoki Elementary School	13.1

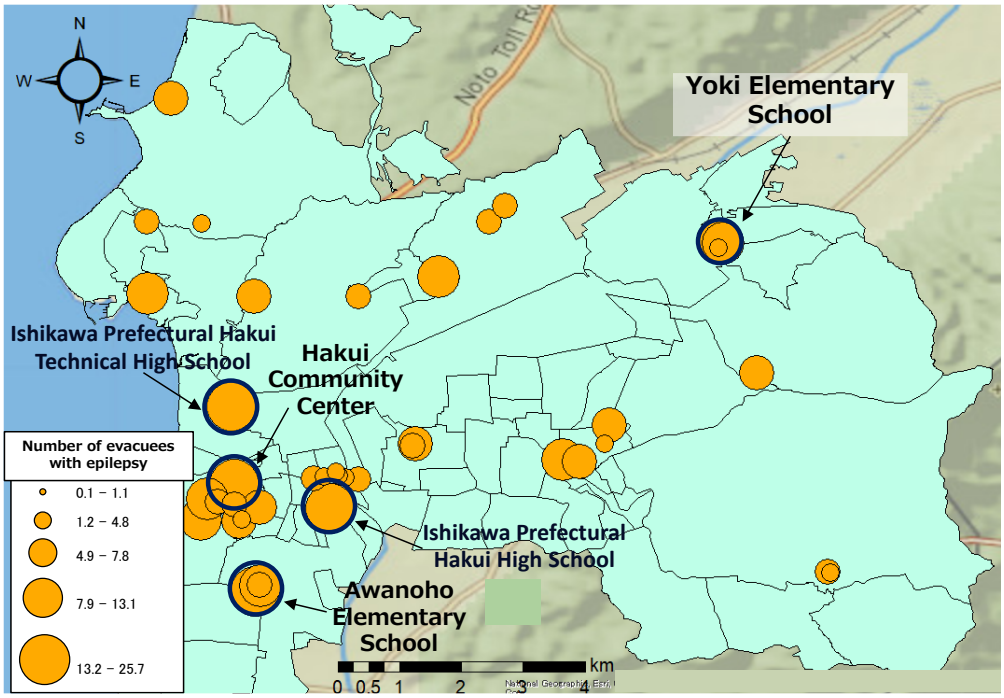

Figure 8. Estimation results of the number of evacuees for epileptic patients based on location–allocation analysis.

This study estimated the maximum number of epileptic patient evacuees to each designated evacuation shelter using the analysis described in this section. This work is expected to help doctors and pharmacists in maintaining the information regarding a balanced supply of drugs to designated evacuation shelters and first-aid centers.

5. Conclusions and Future Works

5.1. Conclusions

This study attempted to comprehensively determine the drug demand in the region using the KDB, which is a type of medical big data, to solve the problem of a collapsed drug supply and demand balance for victims of the 2011 Tohoku earthquake off the Pacific coast. This analysis was a case study that focused on antiepileptic drugs; however, the KDB was used to clarify the population distribution of epileptic patients by town and the main ingredients of antiepileptic drugs. The highest number of antiepileptic drug users in Hakui City was in Chirihama Town, with 29 people. It was also confirmed that antiepileptic drug users were concentrated in the southwestern part of Hakui City. Meanwhile, it was clarified that there were relatively many people taking antiepileptic drugs even in towns far from the center of Hakui City, such as Yanagida Town and Motoe Town. Furthermore, the KDB was used to determine the main ingredients of the antiepileptic drugs used in Hakui City. Antiepileptic drugs have contraindications depending on their main ingredients, and doctors and pharmacists should consider the stressful and sleep-deprived environment at the time of a disaster when prescribing such drugs. The calculation of the main ingredients of antiepileptic drugs in Hakui City through this analysis can help provide information to doctors and pharmacists when prescribing the drugs. In addition, this study estimated the maximum number of evacuees to designated evacuation shelters for antiepileptic drug users through location–allocation analysis using ArcGIS. The results showed that there were indeed a large number of evacuees in the southwestern part of Hakui City; further, this study clarified the designated evacuation shelters where evacuees were particularly concentrated (Hakui Community Center, Ishikawa Prefectural Hakui Technical High School, Ishikawa Prefectural Hakui High School, Awanoho Elementary School, and Yoki Elementary School). Through the above, the regional distribution of

antiepileptic drug users and the estimation of the maximum number of evacuees were achieved.

The results of this study indicate the effectiveness of medical big data, including the KDB, in disaster prevention and mitigation. Thus far, questionnaires and interview surveys were commonly used to determine the drug needs in a region. However, in this study, the use of the KDB enabled the comprehensive calculation of the population distribution and the main ingredients of the antiepileptic drugs taken by people in a small city in Japan. Medical big data other than the KDB are also actively used worldwide. Although various data items are included in medical big data, data that can be applied to disaster prevention and mitigation measures, similar to the data used in the present study, are considered insufficient, depending on how they are used. The results of this study are expected to increase the application of medical big data in disaster prevention and mitigation.

5.2. Future Works

A major limitation of this study is that it only focused on antiepileptic drugs and did not analyze other types of drugs. However, information on other drugs can also be extracted from the KDB. For instance, the unavailability of drugs for treating diabetes and heart diseases can also lead to life-threatening situations. Therefore, it is necessary to select drugs for analysis in consultation with doctors and pharmacists, thus improving the analysis process. In addition, there was a great need for ventilators and other equipment during the COVID-19 pandemic. Although this study focused on earthquakes, it would be possible to conduct an analysis that also takes into account the need for medicine and medical equipment during the COVID-19 pandemic.

Additionally, it was assumed in the location–allocation analysis that all antiepileptic drug users were evacuated to the designated shelters. This assumption was made so that the maximum amount of antiepileptic drugs required at each designated evacuation shelter could be calculated. However, as the predicted seismic intensity that each house may experience is different, the possibility of evacuation of the victims may differ. Therefore, it is necessary to refine the estimate of the number of evacuees by considering the predicted seismic intensity experienced in each region and house, as well as the probability of the collapse of houses.

This study estimated the population distribution of people taking antiepileptic drugs and the number of evacuees to designated evacuation shelters in each town. However, it does not consider stockpiling drugs at medical facilities in Hakui City and the amount of each drug owned by households. In the future, a large-scale questionnaire survey will be conducted in Hakui City to clarify the amount of each drug stockpiled in medical facilities and households.

Although this study assumes a disaster, the quality and quantity of antiepileptic drugs were calculated under normal conditions using the KDB. However, it is conceivable that physical conditions could deteriorate during a disaster due to stress, sanitation, and other factors. Epileptic seizures are also more likely to occur during disasters, and therefore, it is possible that the number of antiepileptic drugs required may be higher than in normal times. Therefore, it is necessary to estimate the quantity of pharmaceuticals demanded considering the worsening of physical conditions during a disaster.

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