Systematization of countermeasures to improve business continuity of regional healthcare in a disaster

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Abstract:

It is necessary for every organization in Japan to address the risks of natural disasters, Japan being a high-risk area. Recently, local governments have been required to maintain not only the level of administrative services, but also the level of medical services that is required if a disaster occurs. However, no previous studies have clarified what countermeasures for maintaining the level of medical services should be taken by a local government. This study identifies important concepts, such as “medical needs required when a disaster occurs,” “medical service delivery capabilities to correspond to medical needs,” and “the gap between needs and delivery.” The purpose of the countermeasures is to eliminate the gap between needs and delivery. From these concepts, we derive five types of countermeasures. For example, Type 4 means that it is necessary to obtain the additional medical resources from other organizations in the area or other areas to improve medical services’ delivery capability. Moreover, 15 more detailed countermeasures are clarified by taking into account the medical features of the organization. Finally, we verify the effectiveness of the proposed countermeasure types in a hospital setting.

Keywords

Business continuity, disaster countermeasure, disaster prevention plan

1. Introduction

It is necessary for all organizations to prepare against risks because Japan has higher natural disaster risks than other regions. Especially after the Great East Japan Earthquake of March 11, 2011, many local governments devised a business continuity plan (BCP). Because regional medical services have an important role in rescuing injured people, it is necessary for local governments to continuously provide not only administrative services, but also regional medical services.

Typically, many people are injured when a natural disaster happens. Therefore, medical institutions have to continue their services despite damages. In fact, during the Great East Japan Earthquake there were 380 hospitals in three prefectures: Iwate, Miyagi, and Fukushima; 11 were “totally collapsed,” 289 “partly damaged,” 45 “not able to accept outpatients,” while 84 were “not able to accept inpatients.” However, on the occasions patients were brought to the hospitals accepting patients, these treated them despite utilities disruption and lack of resources. Since individual hospital cannot overcome the issues of a natural disaster on their own, regional actions for the continuity of medical services are required.

There are business continuity management systems (BCMS) and BCPs available as tools for service continuation provision. However, the ISO standard for BCMS (Ichiro N et al., 2013) has not standardized BCPs, nor is there detailed standardization on the course of action after a business impact analysis and risk assessment. As such, it is impossible to devise improvement for medical services. Moreover, local governments and regional

organizations cannot improve their continuity by themselves. Thus, an improvement method is necessary. In this study, as part of the solution to this problem, we systematize countermeasures for improving the continuity of regional medical services. The countermeasures in this study do not propose specific treatments and actions for maintaining resources for specific treatments, but provide a general direction of countermeasures. We also propose an overview of countermeasures available to local governments and individual organizations.

2. Approaches in existing research and the current study

Existing research has BCP guidelines for hospitals (Bureau of Social Welfare and Public Health, 2012; The Cabinet Office of Japan, 2005; Hidekazu T, 2012), but it only advises on certain formats and examples and general BCP guidelines only focus on damage restoration. Furthermore, countermeasures carried out before a disaster are rarely described in these guidelines. Moreover, most disaster prevention plans of local governments only describe some countermeasures, such as the evacuation of local residents.

In general BCP studies (Hitoshi K, 2013; Masaaki T et al., 2013; Michiyo S et al., 2009), the focus is on shortening the recovery time, which is the time necessary to recover to an ordinary state after a disaster; however, that is not suitable for medical services, because they characteristically change to disaster medical systems when a disaster occurs and delivery of services continues in extraordinary ways. Nonetheless, existing research (Kyoichi I et al., 1998) on disaster medical systems estimates the number of people who are not able to receive a medical service based on the number injured by the disaster and the amount of available resources in a hospital. However, this study does not propose countermeasures for increasing the number of people who are able to receive medical services.

Although research on countermeasures for emergency situations exists (Mitsuru Y, 2008), this study focuses on methods to treat specific patients after disasters. There are studies for hospital's resilience evaluation (Cimellaro GP et al., 2009; Junko I, 2008; Zhong S et al., 2014), which establish viewpoints and methods for such evaluations. However, they do not propose ways to improve hospital or region resilience after the evaluation. Therefore, the general direction of countermeasures that improve and keep the continuity of medical services in an emergent situation is not clarified.

Consequently, no study presents comprehensive actions courses after or before a disaster happens, and there are no resources from which to derive what to do. Thus, in this study, we first focus on the continuity of medical services after a disaster. Subsequently, we systematize continuity of medical services countermeasures with respect to a specific area. This system includes countermeasures that are carried out both before and after a disaster.

3. Systematization of countermeasures

The research steps to countermeasure systematization are shown in Figure 1.

Figure 1: Construction of procedures for a countermeasure system

Step 1: Construction of a basic concept for healthcare continuity

Step 1-1: Construction of basic concept elements

In this study, we construct a basic continuity of medical services concept based on three elements. The first element is "amount of need for medical services." This indicates a scale of medical needs after a disaster, which is composed of the number of patients, degree of injury, etc. Medical needs after a disaster has occurred are the sum of the medical needs that are newly generated by the disaster, as well as ordinary medical needs. In general, hospitals are required to provide food for patients to survive and play the role of refugees after disasters. However,

the medical services in this study do not include those functions and related actions.

The second element is “medical service delivery capabilities,” which is estimated from the amount of available resources in a hospital. For example, if electricity is disrupted and machines stop working, the number of available machines becomes lower than before the disaster. The result is that the medical services provided by using these machines will be interrupted. Similarly, the medical service capabilities decline if there are fewer available resources. Regionally, these capabilities are composed of related organizations, such as hospitals, police, local government, the disaster medical assistance team, and the medical associations in that region.

The last element is “the gap between medical needs and the capability of medical services,” which means that organizations are unable to provide enough medical services to a region. If not enough medical services are provided, negative results occur, and patients and local residents are at risk.

Step 1-2: Basic concept visualization for healthcare continuity

If a risk becomes apparent, the “amount of need for medical services” and “medical service delivery capabilities” are changed from ordinary levels to post-disaster levels, and the gap between them is expanded. After a disaster has occurred, hospitals and other organizations improve their capabilities temporarily by their initial response or by recovery. However, if this gap is not eliminated, a negative impact results for patients and local residents. This sequence is shown in Figure 2.

Figure 2: Gap model of medical needs and service capability

Step 2: Systematization of countermeasures for continuity of healthcare

Step 2-1: Construction of countermeasure type based on a gap model

Figure 3: Countermeasures mapped onto the gap model

The continuity of medical services should not be interrupted by the gap presented above, and countermeasures are actions to decrease this gap. We systematize these countermeasures as illustrated in Figure 2. The countermeasure type corresponds to the arrows in the figure. Countermeasure types mitigate the negative influences from a risk, such as increase of injured people, decline of medical service capability, and negative impact on the patient. Moreover, a countermeasure type also improves the capability of the post-disaster response. These five countermeasure types are shown in Figure 3.

Step 2-2: Derivation of detailed countermeasure types

Detailed countermeasure types shown in Figure 3. For example, countermeasure type 4, action to improve capability after a disaster happens, targets medical resources and is only carried out after a disaster occurs. Detailed actions provide two ways of using resources effectively and obtaining external resources. From this classification, we deploy countermeasure type 4 (4-1. Outsourcing to outsiders to 4-4. Redistribution of internal resources). Similarly, we deploy 15 detailed countermeasure subtypes from the five major types, as illustrated in Table 1.

Table 1: The countermeasure type deployment

Countermeasure type	Countermeasure subtype	Occasion
1 Countermeasure of a risk itself	1-1) Avoiding appearance of risks	Before a disaster occurs
	1-2) Imputation of risks	Before a disaster occurs
2 Suppressing an increase in medical needs	2-1) Improvement of living environment safety	Before a disaster occurs
	2-2) Self-defense by residence	After a disaster occurs
	2-3) First-aid by residence	After a disaster occurs
	2-4) Ensuring human safety by each organization	After a disaster occurs
	2-5) Prevention of infectious disease and its increase	After a disaster occurs
3 Reducing to decline in capability	3-1) Tolerance strengthening	Before a disaster occurs
	3-2) Prevention of damage spreading	Before and after a disaster occurs
	3-3) Ensuring redundancy	Before and after a disaster occurs
4 Capability improvement when a disaster occurs	4-1) Outsourcing to outsiders	Before and after a disaster occurs
	4-2) Obtaining resources from outside	After a disaster occurs
	4-3) Recovering resources	After a disaster occurs
	4-4) Redistribution of internal resources	After a disaster occurs
5 Alleviating the negative influence	5-1) Rapid apologies and public relations	After a disaster occurs

Countermeasure type 1 is a measure against risk itself; it involves avoiding apparent risks, not incurring damage, and assigning responsibility for disaster damage. Countermeasure type 2 is intended to suppress the increase in medical needs associated with a disaster. It is aimed at strengthening the local residents' resistance and have them respond well to the disaster. These countermeasures involve the necessity of encouraging fewer injuries in order to suppress increasing medical needs. Countermeasures of type 2 also include the responses of

each organization in that region and precautionary countermeasures for additional medical needs, such as protection against infectious diseases. Countermeasure type 3 reduces the decline in capability. The capability to provide medical services is equal to the level of available resources, and countermeasure type 3 aims to protect resources before a disaster, to ensure the redundancy of those resources, to initiate responses contingent on the resources available, etc. Countermeasure type 4 responds to regional medical needs after a disaster has occurred. Countermeasures of this type are separated from others to ensure effective use and obtain external resources, or to ensure effective use and recovery from their own resources. Countermeasure type 5 alleviates the negative influence of having a gap between medical needs and capability, by providing explanations to local resident and patients regarding services. Actions that plan, prepare, check, and improve these countermeasures are not presented in these countermeasure types.

Step 2-3: Specification of countermeasure items associated with medical services

Since medical services have unique characteristics that are different from industrial products', countermeasure types are required to consider those characteristics in order to ensure the continuity of medical services in a disaster. We consider characteristics of medical services in making a deployment table of countermeasure types. Medical characteristics are referenced from existing research (Masaaki K et al., 2014). In this table, classification, characteristics of the service, characteristics of the medical service, and a feature that should be emphasized as compared to peacetime, are quoted from an existing research. We then derive the points for consideration from those characteristics and associated countermeasure types with each medical characteristic. The results are shown in Table 2.

Table 2: Association of countermeasures and features of medical services

Classification	Characteristics of the service	Medical service characteristics	A feature that should be emphasized as compared to peacetime	Consideration	How it is reflected	Related Countermeasure types
Characteristics associated with customer and their need	Heterogeneity	Individuality of a patient		Because the individual background is different, there is a need to prioritize.	Give the priority to the patient and concentrate resources on high-priority patients by "4-4) Redistribution of internal resources."	4-4) Redistribution of internal resources
		A change in the patient's condition.		Subsequent results vary depending on the rapidity of the corresponding post-accident events.	Give the priority to the patient and concentrate resources on high-priority patients by "4-4) Redistribution of internal resources." To respond quickly by "2-4) Ensuring human safety by each organization."	4-4) Redistribution of internal resources 2-4) Ensuring human safety by each organization
			surge or change a need to a specific medical service.	It is necessary to correspond to the rapidly increased needs.	Medical needs to not increase by "2 Suppressing to increase medical needs."	2 Suppressing an increase in medical needs
			It is a service that has a social aspect.	Compared with other industries, interruption of services is not easily forgiven. For social infrastructure, cooperation is sought with more organizations.	To actively utilize external cooperation 2-1), 2-2), 2-3), 4-1), and 4-2).	2-1) Improvement of living environment safety 2-2) Self-defense by residence 2-3) First-aid by residence 4-1) Outsourcing to outsiders 4-2) Obtaining resources from outside
Characteristics of medical service itself	Intangibility				It is necessary to obtain an understanding of local residents for the treatment by "5-1) Rapid apologies and public relations."	5-1) Rapid apologies and public relations
		Accompanied by the invasion of pain.		It is difficult to recognize the pre-treatment contents.		
	Inseparability		It is a personal service.	Accessibility to the hospital is important. For hospitalized patients, it is necessary to maintain life and ensure the safety of the medical service.	It is difficult to implement "1-1) Avoiding appearance of risks." It is necessary to ensure the living environment as a treatment by "2-4) Ensuring human safety by each organization."	1-1) Avoiding appearance of risks 2-4) Ensuring human safety by each organization
		Redo does not work.		If the environment cannot provide safe services, there is a case for cancelling the services provided.	While discontinuing the treatment, safety is not secured, and there's need to focus resources into feasible practice by "4-4) Redistribution of internal resources."	4-4) Redistribution of internal resources
		There is urgency.	There is an extreme urgency.	Avoid having a finished goods inventory and hard to beat measures.	Give the priority of the patient, and to concentrate resources on high-priority patients by "4-4) Redistribution of internal resources".	4-4) Redistribution of internal resources
	Perishability			To not have finished goods inventories, and hard to beat measures.	There is no countermeasure about finished product inventory in countermeasure type 5. It has remained only to retain the understanding of local residents by "5-1) Rapid apologies and public relations."	5-1) Rapid apologies and public relations
Characteristics associated the organization		It has expertise.				
		It is carried out by departmentalized organization.		Human resources are especially important in the medical service. It is necessary to devise a plan to ensure resources after the accident.	Especially emphasize human resources in "4 Capability improvement when a disaster occurs."	4 Capability improvement when a disaster occurs
			They are labor-intensive industries.			

For example, existing research claims that there is a difference in the background of each patient that relates to their individuality and the heterogeneity of the service. In this study, this characteristic is considered in "4-4. Redistribution of internal resources." In medical disaster systems, directions are changed from providing maximum medical services to each patient, to providing medical services to the maximum number of patients; thus, it is necessary to decide on patients' priorities. In this study, this is decided as part of "4-4. Redistribution of internal resources," priorities being allocated considering the patient's background. Subsequently, we focus resources in accordance with priorities, taking into account each patient's background.

4. Verification of countermeasure types

We have verified the validity of the countermeasure system by analyzing the basic concept of continuity, the countermeasure types derived from the gap model, and the coverage of the countermeasure system. To confirm the coverage of the countermeasure types, we checked the correspondence of the countermeasure types

and the countermeasures that hospital A has implemented. Based on the result of the correspondence, we interviewed doctors who provide medical services in their practices after a disaster. We selected a city hospital and two of its doctors as interview participants, because the selected hospital is a center of regional healthcare. This municipal hospital is a polyclinic hospital and takes on a role as a core disaster medical hospital. Therefore, sufficient countermeasures have been prepared in this hospital.

Table 3: Contents of the interview and hospital A

Organization	Hospital A
Details of the organization	<ul style="list-style-type: none"> • Core disaster medical hospital center • Number of beds: 539 <ul style="list-style-type: none"> • For general patients: 514 • For critical care: 8 • Neonatal intensive care unit: 9 • ICU • CCU: 8
Interviewees	<ul style="list-style-type: none"> • A deputy director, a member of the regional council for disaster prevention • A management doctor, leader for making the response procedures for disasters
Figures and tables in the interview	<ul style="list-style-type: none"> • Figure of A gap model • The countermeasure type deployment • Result of correspondence with countermeasure types and the response procedures

We obtained a list of 55 disaster prevention actions from the hospital, and checked the correspondence between countermeasure type and each action. There are four actions that correspond to two countermeasure types. This means that the number of correspondences increased to 59. Subsequently, we associated objectives for these actions with countermeasure types, because each type is not consistent with practice actions. This correspondence results are shown in Table 4.

Table 4: Number of actions corresponding with the countermeasure types

Countermeasure type	Countermeasure subtype	Occasion	Number of correspondences	Sum
1 Countermeasure of a risk itself	1-1) Avoiding appearance of risks	Before a disaster occurs	0	59
	1-2) Imputation of risks	Before a disaster occurs	0	
2 Suppressing an increase in medical needs	2-1) Improvement of living environment	Before a disaster occurs	0	
	2-2) Self-defense by residence	After a disaster occurs	0	
	2-3) First-aid by residence	After a disaster occurs	0	
	2-4) Ensuring human safety by each organization	After a disaster occurs	7	
	2-5) Prevention of infectious disease and its increase	After a disaster occurs	2	
3 Reducing the decline in capability	3-1) Tolerance strengthening	Before a disaster occurs	0	
	3-2) Prevention of damage spreading	Before and after a disaster occurs	1	
	3-3) Ensuring redundancy	Before and after a disaster occurs	3	
4 Capability improvement when a disaster occurs	4-1) Outsourcing to outsiders	Before and after a disaster	2	
	4-2) Obtaining resources from outside	After a disaster occurs	8	
	4-3) Recovering resources	After a disaster occurs	5	
	4-4) Redistribution of internal resources	After a disaster occurs	27	
5 Alleviating the negative influence	5-1) Rapid apologies and public relations	After a disaster occurs	0	
No correspondence				4

In Table 4, the number of correspondences is different among detailed countermeasure types. Specifically, there are many actions that belong to type 4-4, redistribution of internal resources. They are to be implemented after the disaster. On the other hand, the countermeasure types that do not correspond to any actions are 1-1, 1-2, 2-2, 2-3, 3-1, and 5-1. For example, the countermeasure type 1-1 is a direction of countermeasures to remove the risk radically, such as changing the location of the hospital. Type 1-2 includes the countermeasure of a disaster loan. Actions belonging to these types need more funds to be implemented. Feedback from the

doctors suggests that these large-scale actions are not easy to implement in the operational hospital. The types from 2-1 to 2-3 are definitely important; however, these type's actions require the cooperation among local government, hospitals, and residents. Therefore, the actions should become effective in cooperation with hospitals, other organizations, and residents. That is because hospital A has not prepared this type of countermeasures. On the other hand, it is necessary to consider the countermeasures that are included in type 5-1 immediately, because hospital A has not hitherto considered these actions.

Based on the above obtained comments, the non-corresponding countermeasure types come from the priority of countermeasures for this hospital. Their reasons being shown in in Table 5.

Table 5: Reasons for non-correspondence

Actions prepared in a hospital	Reason for "No corresponding"
Rapidly setting up the headquarters for a disaster	This operation is not applicable as it concerns the organization after the disaster occurred. Thus, it does not correspond to countermeasure types.
To rescue people confined in an elevator	This operation is not applicable as it does not concern the gap between medical needs and medical service delivery capability. Thus, it does not correspond to countermeasure types.
Supplying food for inpatients	
Distribution of emergency foods	

The reason for the lack of correspondence is that the actions to control the situation post disaster are not the same as the countermeasures in this study. To ensure the safety of the people trapped in an elevator, to supply food to inpatients, and to distribute the emergency foods are actions required by the hospital. However, these actions are not intended to eliminate the gap between the medical needs and the capability of the medical services provided, thus, these actions do not correspond with countermeasure types. Countermeasure types corresponds all actions except for those four actions. Consequently, we verify that the countermeasure system in this study has adequate coverage.

The finally result of the discussion based on the correspondences is shown in Table 6. We obtained two opinions from the interviews: first, that it is valid to understand the continuity of medical service after disaster according to three elements, medical needs, the capacity to provide medical service, and the gap between those elements; second is the opinion that five countermeasure types are also appropriate. Nonetheless, it is difficult for doctors to understand detailed components based on this countermeasure system because the system is not clear about these.

Table 6: Summary of the interview

Point of confirmation	Ways to confirm	Result
Appropriateness of the concept of medical services is based on medical needs, service delivery capability and these gaps.	interview directly.	This concept is appropriate.
Appropriateness of countermeasure types.	interview directly.	That classification is appropriate. But it is better that more detailed components be shown.
Coverage of the countermeasure system of this study.	Correspond the action prepared in hospital and countemeasure type.	We can almost correspond actions to countermeasure types. So, the countermeasure system has some coverage. We have found that there are some actions that contain the countermeasures proposed this study.

5. Discussion

5.1. Importance of this study

Since Japan faces comparatively higher natural disaster risks, specification of disaster countermeasure is a pressing issue. However, existing research is composed of case studies or actions for some specific resources, the general directions of countermeasures not being clarified. In this study, we constructed a general gap model that is based on three elements, that is "the needs for medical services," "the capability of a hospital," and "the gap between needs and capability." Subsequently, we systematized the directions of countermeasures to fill that gap, and verified these countermeasure types in a disaster control advanced hospital.

In conclusion, hospital A recognized the lack of current countermeasures, and started examining new additional actions to improve their disaster resilience. Therefore, the proposed countermeasure types are useful

for hospitals to clarify the required countermeasures.

5.2. The need for specialized countermeasure for each management resource

In this study, we propose the countermeasure type as a fundamental direction of countermeasure to a disaster. Specifically, types 3 and 4 maintain management resources in a disaster. For example, actual countermeasures for working medical staff are to refuge to a safe place, but for a machine would be to stop safely or bring back in good condition. Both of them are included in type 3-2. Therefore, it is necessary to list specific countermeasures for each management resource. In other words, a hospital has to consider countermeasures related with types 3 and 4 for each management resource.

In the future, hospitals and other related organizations need to understand post disaster actions by proposing a systematized countermeasure list that covers the actions in existing research, which attribute actions to specific resources.

5.3. Future research

In this paper, the first element of the gap model is “needs for medical services.” However, supplying food for nutritional support can be dealt with in the same framework by taking the needs for medical services as the needs for food. Additionally, since the effectiveness of the countermeasure type was verified in only one hospital, it is necessary to generalize. However, the countermeasure type should not be limited to application in hospital A, because it is derived from the gap model and the characteristics of the medical service. Moreover, by constructing the detailed countermeasure list, it is possible to evaluate the need for countermeasure sufficiency that is previously implemented by a hospital and other related organizations in a certain region.

6. Conclusions and future issues

As a first step in the construction of a methodology for countermeasure planning, we have provided a countermeasure system using the basic concept of medical service continuity. Additionally, the five countermeasure types improve continuity, and systematize the countermeasure system by deriving 15 more detailed countermeasure types. In doing so, we provide an overview of the countermeasures necessary for medical service continuity. Future issues to be addressed include more detailed countermeasure lists, and constructing the corresponding methodology for using this countermeasure system. In addition, it is necessary to clarify the regional functions after disasters. Those functions include food supply, to maintain resident’s living environment, etc. Since the verification is conducted in one hospital, it is necessary to implement the system in other hospitals and organizations.

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