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A Virtual Study on the EMERGENCY MEDICAL Facility in Disaster Site

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Abstract

Recently, as interest in disaster-safety has been rising, contents regarding disaster medical service have been presented in various related guidelines. However, the presentation of criteria related to the facility input has been insufficient. In the case of contents regarding site selecting methods related to field emergency medical facility input, the criteria and procedures necessary for decision making have not been systematically organized. In this study, as a basic study related to field emergency medical facility input site selection among matters requiring decision making related to disaster field emergency medical facility input, factors that must be considered necessary for site selection and the process were derived. In addition, the field emergency medical facility input site selecting process was actually presented based on a virtual site. In the future, quantitative criteria for disaster field emergency medical facility input should be presented according to diverse disaster types.

[Keywords] ***Emergency Medical Facility, Disaster, Virtual Development, Site Selection, Criteria***

1. Introduction

1.1. Background and purpose of the study

In cases where a large number of patients occurred in a disaster site, the three-stage medical system such as severity classification, first aid treatment and transportation should be operated. However, problems such as patient transportation without considering capacity of the disaster base hospital and delayed input of facilities and equipment for emergency rescue patients are occurring. Despite that rapid medical treatment should be conducted for the victims transported to the field emergency medical facility in the event of a disaster, cases where large damage for humans is brought about due to the lack of facilities for the input of the medical personnel are occurring.

Although some studies have been carried out regarding the selection of the location of the medical facility[1][2][3], studies that considered disaster situations are quite insufficient and various guidelines related to disaster management do not present concrete criteria in relation to field emergency medical facility input. In the case of South Korea, the installation standards for facilities for emergency medical service at disaster sites are ambiguous and difficulties are experienced in communication with the field commander during the installation process[4]. Therefore, relevant systematic input methods should be presented.

Therefore, this study aims to present a field emergency medical facility site selection process to support rapid decision making in relation to field emergency medical facility input in the event of a disaster.

1.2. Scope and method of the study

In this study, site selection criteria were presented considering the installation of a

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new facility among the field emergency medical facility input methods, and the criteria for field emergency medical facility input were presented referring to the shelter designation criteria in the case of occurrence of a disaster because there is no separate guideline. The detailed method of this study is as follows.

First, to consider disaster medical service response systems, the present situation of disaster field emergency medical facility input, and the safety of the injured and emergency medical service personnel in field emergency medical facility site selection, existing shelter selection criteria are identified.

Second, considering the shelter selection criteria, location selection items for field emergency medical facility site selection are derived.

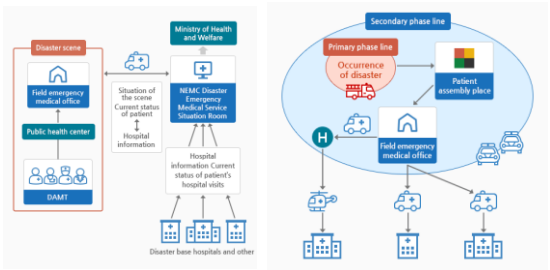
Third, the decision making process for selection of field emergency medical facility location and a field emergency medical facility site selecting assuming the occurrence of an actual disaster are presented.

2. Disaster Medical Service Related Present Situation

2.1. Disaster medical service response system

Laws regarding disaster medical service include the Framework Act on the Management of Disasters and Safety, the Emergency Medical Service Act, and Rules Regarding Emergency Relief Response Activities and Site Command. The Rules Regarding Emergency Relief Response Activities and Site Command are intended to unify dispersed regulations regarding medical aid when a disaster has occurred and the disaster emergency medical service response manual includes contents regarding the roles of individual institutions related to emergency medical service aid at disaster site at the national level and at the local government level, information on command systems, and emergency medical service systems at disaster sites.

Figure 1. Disaster response report system in the event of a disaster[5].



As shown in <Figure 1> above, the disaster emergency medical service response manual indicates the roles of individual organization in the event of a disaster. The Ministry of Health and Welfare is in charge of general management in relation to disaster medical service support and the Central Emergency Medical Service Center is in charge of the determination of the initial response level, the operation of disaster emergency medical service situation room, and support of disaster medical service supplies. With regard to the DMAT dispatch, the manual specifies that the Central Emergency Medical Service Center shall determine the dispatch of the central DMAT while individual city and do government shall determine the dispatch of local DMATs.

The disaster emergency medical service response manual stipulates that the site emergency medical service implementation place should be selected through discussion with the site command post or should be determined as instructed by the head of the health center in cases where the emergency relief control group has not yet been organized. As for the method of installation of the site emergency medical facility, the manual specifies that an existing building should be used if possible, should install tents if no building is available, and outdoor activities should be conducted if tents cannot be installed. The manual also specifies that if there is a medical institution in the vicinity of the disaster site and the access and gathering of patients and ambulances are easy, the medical institution may be utilized as a site emergency medical facility.

2.2. Present situation of field emergency medical facility

The field emergency medical facility operation scale is determined based on the number of casualties. When the operating organization has been maximally expanded, it consists of a severity classifying team, a first aid team, a transportation team, a medical resource support team, and a temporary mortuary. After the Sewol ferry accident, the functions of regional emergency medical service centers were reinforced and Disaster Medical Assistance Teams have been operated.

Currently, in the event of a disaster, medical air tents are mainly used as site emergency medical facilities such as selective clinics and negative pressure tents. Medical air tents can be also used as an interim command center, temporary hospitals, refugee concentration camps, or temporary barracks, and are actually operated by the Korea Disaster Relief Team(KDRT) in situations where overseas medical support is necessary. The KDRT has been trained on the installation and operation of mobile hospitals and has deployed mobile hospitals in the form of tents. KDRT's mobile hospitals are divided into three categories: Basic Health Care center, Rapid deployment emergency hospital, Referral hospital, which are divided into 13 modules including administration, technology, Lab & Pharmacy, outpatient, medical device, medical consumables, and medicines[6]. <Figure 2> below shows photograph data on mobile hospital installation and operation training.

Figure 2. Views of mobile hospital installation and operation training[7].

2.3. Shelter designation criteria

In the initial stage after occurrence of a disaster, human life rescue activities should be conducted and safety should be ensured to prevent secondary damage. Victims become to reside in emergency shelters such as schools, town halls, and government offices until temporary residential facilities for victims are prepared[8]. Site emergency medical facilities should also have evacuation functions to ensure the safety of patients occurred and emergency medical services workers.

In the case of the United States, the American Red Cross's standards for hurricane evacuation shelter selection states that the medical service area should be 40ft2 per resident. The guidelines present the identification of areas that can be selected with the standards for hurricane evacuation shelter selection, consideration of matters related to measures for evacuation and means of transportation, and completion of evaluation of possible areas. In addition, the Evacuee Support Planning Guide of the Federal Emergency Management Agency also specifies shelter support for medical and health care. In the case of Japan, the Guidelines for the Management and Operation of Shelters were revised based on the Basic Law for Disaster Preparedness in 2013, and the operating standards and methods of shelters are presented. According to the shelter and secondary shelter designation criteria set out in the Guidelines for the Management and Operation of Shelters, in the case of shelters, public buildings(schools, etc.) equipped with earthquake proofing, fireproofing, and reinforced concrete structures should be used. The number of victims accommodated in shelters is limited to two persons per 3.3 ㎡ of the living room. In the case of the secondary shelters, the guidelines suggest to conclude preliminary agreements with related institutions(medical institutions, etc.) in order to secure facilities. In the case of Australia, 43 disaster-related manuals were prepared to be prepared for emergencies. The manuals present matters to be considered when rescue service center locations are selected such as accommodation capacity, electric power, sewage, water, telecommunications, long-term availability, medical care (possibility to provide medical service), access roads, means of transportation accessibility, and parking lots.

In the case of South Korea, shelter designation standards have been established as part

of the disaster relief plan in the event of a disaster based on Article 4-2 of the 「Disaster Relief Act」. According to the foregoing, information on the evacuation site that must be investigated includes general information such as name, address, telephone number, and manager and available space, capacity, evacuation route and distance. The location of the evacuation site should be designated and installed within 1km as the walking distance. The subjects of designation as places for evacuation first are public facilities such as elementary schools, middle schools, and si/gun/gu village halls and churches.

3. Factors That must be Considered for Site Selection

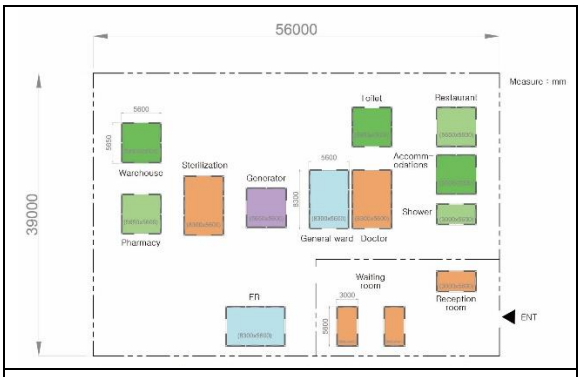
The disaster emergency medical service response manual presents requirements for places for field emergency medical facility installation as follows; 1) the tent area and appropriate area necessary for installation should be secured, 2) medical staff safety should be ensured, 3) place where the ambulance traffic line and the patient moving line intersect with each other, 4) places with good drainage, 5) places where winds blow from the back (in the case of fire and chemical disaster), and 6) places close to electrical and water facilities[9].

According to the above requirements, item 1) is related to the area. The area of the field emergency medical facility is determined based on the number of persons that must be rescued and the medical staff input scale. Since the number of the injured may increase or decrease over time, in this study, the input scale of medical staff(DMAT) was selected as a criterion for areas. Item 2) is a matter related to safety and the area of the field emergency medical facility module and the facility to secure spaces were selected as criteria for selection of the site referring to the shelter designation criteria. In the case of item 3), the distance between the disaster occurrence site and the disaster base hospital and the road width on the route were selected as site selection criteria, taking into account the ambulance movement route and the travel time between the disaster occurrence site and the disaster base hospital. Items 4), 5) and 6) were excluded from the site selection criteria, as these are matters for which the time of occurrence of the disaster and climates should be considered. In addition, under the judgment that the demand for emergency medical services in the disaster site is proportional to the population density, population density was selected as a site selection criterion.

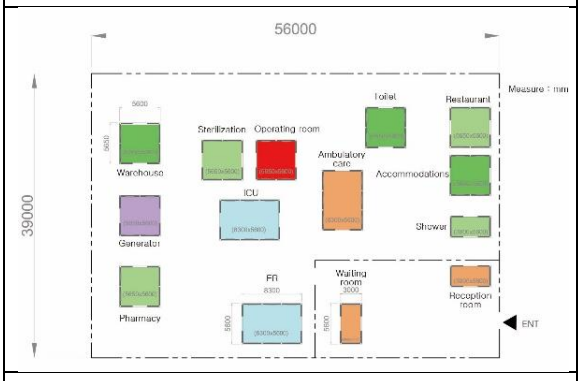
3.1. DMAT input scale

This study presented a plan to prepare facilities and equipment for DMAT input from the time when a request from a disaster site occurred to install the facilities and equipment at the disaster site, construct facilities necessary for DMAT 1 team, and input additional facilities when necessary.

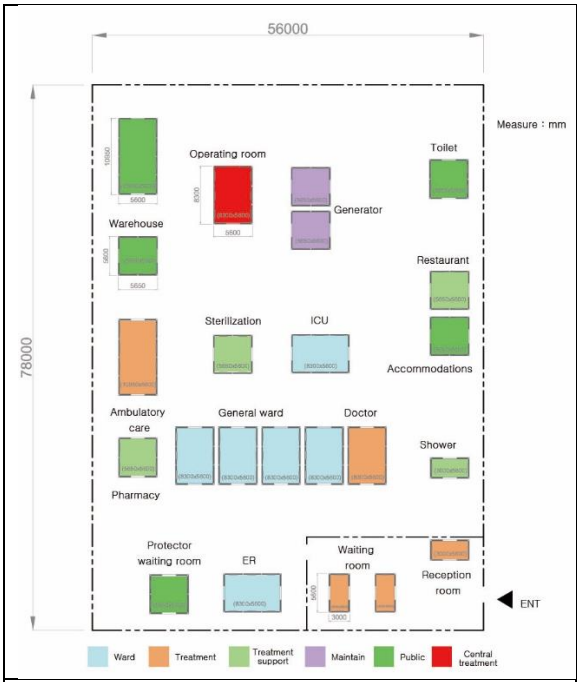
Figure 3. KDRT filed hospital layout conceptual diagram[8].



A. Basic Healthcare(primary input module)



B. Emergency hospital(secondary input module)



C. Referral hospital(tertiary input module)

The above Figure shows the types of field emergency medical facility modules organized by these researchers through comparison with site hospitals of Finnish Red Cross that show the most similar forms referring to the layout image of KDRT Field Hospital. The field emergency medical facility modules divided into three types(A-Basic Health Care Module, B-Rapid Deployment Emergency Hospital Module, and C-Referral Hospital Module) are presented. The A-B-C modules have the functional configurations necessary for severity classification, patient treatment, and patient transportation, respectively, and the sizes of sites by function are approximately 39M × 56M, 39M × 56M, and 78M × 56M, respectively.

3.2. Safety space

In this study, public facilities are first considered as the field emergency medical facility site considering the shelter designation standard. In order to designate a shelter site, site selection should be made considering information on the public facility area and surrounding building information. Since the method of applying the shelter-designation standards may be different depending on whether the disaster occurrence area is an urban area or not, information on public facilities equipped with a playground and a gym should be linked for management. Among the shelter-designation standards, there is a requirement to designate a shelter through discussion with the building owner or manager. However, since there is no time to select a field emergency medical facility site through a separate consultation process in the event of the occurrence of a disaster, utilizing shelter spaces designated through prior discussion with building owners or managers is desirable. In cases where spaces that meet the shelter-designation standards do not meet the field emergency medical facility standards such as the distance to transport patients, the primary input module space that enables severity classification should be first selected and spaces should be secured considering future expansion in parallel. In addition, the contents related to electricity and water among the field emergency medical facility standard currently presented based on tents should be applied to space arrangement in cases where unit modules are installed utilizing using utility modules(management modules).

3.3. Distance to the disaster base hospital

The distance standards for the field emergency medical facility site selection were presented separately for distances to the disaster base hospital and distances from the disaster occurrence point. The distances to the disaster base hospital are the most commonly used method in the current disaster management method, and in the case of the distances from the disaster occurrence point, different standards are presented according to the disaster types. For example, in cases where the ground is unstable, such as an earthquake, a field emergency medical facility should be constructed outside of a certain range, and if it is inevitable to limit the movement of injured persons such as infections, a field emergency medical facility should be constructed within a certain range.

3.4. Road widths by route

Road widths should be determined considering the number of the sides of the candidate field emergency medical facility site in contact with roads and the kinds of roads is determined based on the mobility of the facility and the patient, depending on the type of road in contact. Road widths should be considered in linkage with routes to the disaster base hospital reflecting the means of transportation for patient transfer. Since movements between the field emergency medical facility the disaster base hospital are expected to be frequent, road widths by route should be identified. This is to predict travel times by route between the field emergency medical facility and the disaster base hospital.

3.5. Candidate site population density

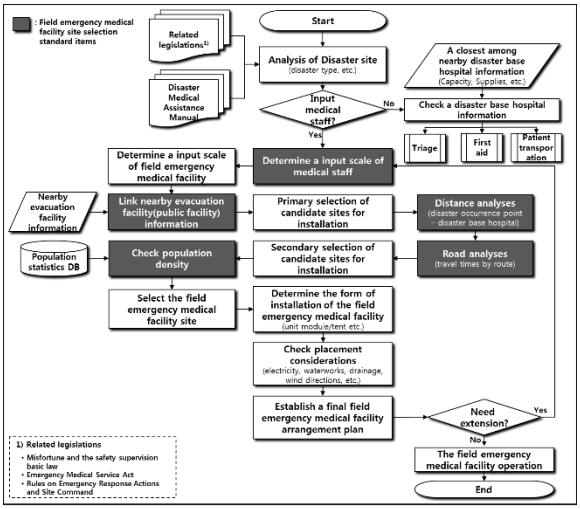
The population density of the candidate site for the field emergency medical facility is a standard for prediction of the number of the injured in proportion to the population density of the disaster occurrence site. A method to consider areas with high population density first when selecting a field emergency medical facility site is presented. This is not considered in cases where candidate sites are in the same area(the same area based on the standard for population density statistics) because the population densities are the same.

4. Virtual Development of Site Selection

The decision making process related to the site selection for the field emergency medical facility is shown in <Figure 4>. The site selection process for the field emergency medical facility consists of three steps and the final arrangement plan is finalized thereafter considering the form of installation and placement considerations.

In this study, a site for emergency medical facility construction was selected based on the assumption of an earthquake occurrence near Gachon University, Seongnam city, Gyeonggi-do.

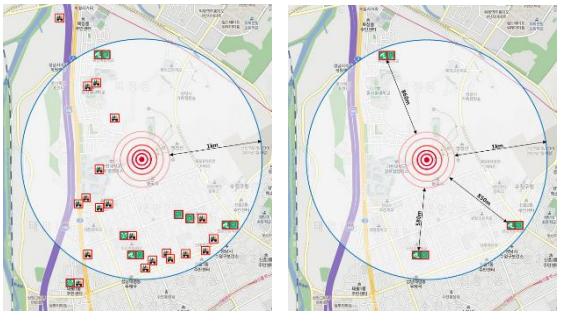
Figure 4. Field emergency medical facility input decision making process.



4.1. Primary selection of candidate sites for installation

First, assuming a region within a radius of 300m as a disaster area, temporary residential facilities for victims, outdoor earthquake shelters, indoor earthquake medical relief stations, indoor shelters, and civil defense evacuation facilities located within 1km, which is a shelter selection criterion, were checked and through the results, evacuation facilities existing as shown in <Figure 5>(A) below could be identified. Among them, three elementary school facilities equipped with an outdoor playground where a field emergency medical facility can be installed were selected(see <Figure 5> (B)).

Figure 5. Shelters near an area of earthquake damage.



(A) (B)

As shown in the picture above, the three elementary schools show distances of 860m (Bokjeong Elementary School), 850m(Seong-

nam Elementary School), and 580m(Sujin Elementary School), respectively from the disaster point.

Although Sujin Elementary School is the most suitable based on general shelter selection criteria, the site should be selected considering the distance to the disaster base hospital for patient transportation.

4.2. Secondary selection of candidate sites for installation

In cases where multiple candidate sites were derived through primary selection, the travel times between the disaster site and the disaster base hospital by route should be identified through distance and road analyses. The following table shows a summary of travel distances between the three elementary schools(Sujin, Seongnam, Bokjeong elementary schools) and nearby disaster base hospitals, which were identified based on 12:00 on weekdays, and the present situations of surrounding roads of individual elementary schools.

Table 1. Distance information of candidate sites for field emergency medical facility installation(Based on 12:00 weekdays, shortest distances).

Hospital name	Sujin elementary school		Seongnam elementary school		Bokjeong elementary school	
	Km	Min	Km	Min	Km	Min
Seoul national university hospital	22.0	84	22.3	83	19.8	79
Korea university medical center (Anam hospital)	20.7	72	20.9	69	18.4	65
Seoul medical center, Seoul	21.3	69	21.5	67	19.0	62
Hanyang university medical center	17.1	57	17.4	56	14.9	51
Ajou university hospital	22.4	56	23.2	57	24.3	58
Hallym university. Sungsim hospital,	20.7	29	21.5	30	22.6	31
Seoul national university Bundang hospital,	12.2	30	13.0	31	14.1	33
Bundang CHA medical center,	4.5	16	5.3	17	6.4	18
Wide main road 25m or wider medium road 12~25m, Small road 8~12m minute road 8m	Site in contact with small road		Site in contact with wide main road and minute road		Site in contact with medium road	

As shown in the above table, Sujin Elementary School is 4.5km away from Bundang Cha Medical Center, which is the closest among nearby disaster base hospitals, and a travel time of 16 minutes is required on the bases of 12:00 on weekdays considering the road width(site in contact with small roads). Therefore, selecting Sujin Elementary School as a field emergency medical facility installation site can be regarded to be valid as patients can be transported the most swiftly.

4.3. Field emergency medical facility site selection

In cases where multiple candidate sites have been selected, selecting the site for the field emergency medical facility through population density is desirable. However, population density was not considered in this study since the cases in this study have the same population density. When a site for the field emergency medical facility has been the form of installation of the field emergency medical facility should be determined(utilization of an existing building, unit module, tent, etc.) and a final field emergency medical facility arrangement plan is established considering electricity, drainage, and wind directions. When a field emergency medical facility should be expanded, the scale of additionally input should be considered and when the site should be changed or additionally secured when the facility is expanded, the existing candidate sites(Bokjeong Elementary School, Seongnam Elementary School) should be considered first.

5. Conclusion

Although the input of emergency medical service should be determined very quickly at the disaster site, standards in relation to facilities that must be input together with medical service workers have not been systematically prepared. In the case of site selection for field emergency medical facilities, only ambiguous criteria that the area and safety should be secured have been presented. Therefore, the criteria should be improved.

In this study, site selection criteria items related to field emergency medical facility input were derived, a site selection process was presented based on the foregoing, and virtual

development of site selection was performed. Major study results are as follows.

First, the status of disaster site emergency medical facilities was analyzed for site selection related to field emergency medical facility input in the event of a disaster and shelter designation standards were analyzed to secure safe sites. According to the results, the use of public facilities was considered first in most cases.

Second, field emergency medical facility site selection standard items derived in this study include the scale of medical staff input for determination of the facility area, space information for safe facility input(nearby public facility information - evacuation facility information), distances for smooth medical staff input and patient transportation(Distance between the disaster occurrence point and the disaster base hospital), and road widths by route(road widths by route between the disaster occurrence point and the disaster base hospital). In addition, population density was included under the assumption that the number of the injured during disasters is proportional to population density.

Third, this study presented processes to select primary candidate sites considering medical work input scales and spaces, select secondary candidate sites considering travel times between the disaster occurrence point and the disaster base hospital, select the final site considering population density, and select the disaster emergency medical facility site considering future expansion.

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