ORIGINAL RESEARCH

Hospital Disaster Preparedness as Measured by Functional Capacity: a Comparison between Iran and Sweden

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Abbreviations:
HSI: Hospital Safety Index
WHO: World Health Organization
GDP: Gross Domestic Product

Abstract

Introduction: Hospitals are expected to continue to provide medical care during disasters. However, they often fail to function under these circumstances. Vulnerability to disasters has been shown to be related to the socioeconomic level of a country. This study compares hospital preparedness, as measured by functional capacity, between Iran and Sweden.

Methods: Hospital affiliation and size, and type of hazards, were compared between Iran and Sweden. The functional capacity was evaluated and calculated using the Hospital Safety Index (HSI) from the World Health Organization. The level and value of each element was determined, in consensus, by a group of evaluators. The sum of the elements for each sub-module led to a total sum, in turn, categorizing the functional capacity into one of three categories: A) functional; B) at risk; or C) inadequate.

Results: The Swedish hospitals (n = 4) were all level A, while the Iranian hospitals (n = 5) were all categorized as level B, with respect to functional capacity. A lack of contingency plans and the availability of resources were weaknesses of hospital preparedness. There was no association between the level of hospital preparedness and hospital affiliation or size for either country.

Conclusion: The results suggest that the level of hospital preparedness, as measured by functional capacity, is related to the socioeconomic level of the country. The challenge is therefore to enhance hospital preparedness in countries with a weaker economy, since all hospitals need to be prepared for a disaster. There is also room for improvement in more affluent countries.

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Introduction

Health care systems play an essential role in providing lifesaving services during disasters.[1] Hospitals are expected to be prepared to sustain a safe environment for patients as well as for staff, continue effective operations, and adequately provide for the medical needs of casualties in the face of a disaster.[1-3] Disaster management plans are essential in assuring hospital preparedness and response.[4] A disaster management plan is a set of procedures, policies, interaction patterns, roles, and contingencies which are to be implemented in the case of an event in accordance with predefined criteria.[1] A reliable disaster plan serves as the system for managing the response to disasters[1,4] and is the basis for an effective acute medical response.[4]

The assessment of hospital emergency preparedness is important in order to elucidate weaknesses in the hospital disaster plan and to guarantee effective hospital functions

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during disasters.[4,5] Assessment methods and checklists have been created by researchers and authorities.[1,4,6-8] However, there is no consensus on a both valid and reliable tool with which to measure hospital preparedness.[5,7,8,10] Moreover, most countries tend to use their own assessment tools.[1,6,7,10] The authors believe that using an international, validated tool, eg, the Hospital Safety Index (HSI) by the World Health Organization,[9] is useful and allows for standardized comparisons.

Failure of hospital function in disasters is more often due to a functional, rather than a structural failure. Functional capacity is a cornerstone of hospital preparedness and is defined as the level of preparedness of hospital staff for major emergencies, incidents and disasters, as well as the level of the implementation of the hospital disaster plan.[9] Therefore, functional capacity represents a comprehensive measure of hospital preparedness. The WHO HSI is a standardized tool with which it can be measured.[9] The evaluation of functional capacity in this tool consists of 61 "elements" that are grouped into hospital disaster committee and the emergency operations centre, operational plans, contingency plans, plans for critical services, and availability of resources.[9]

Several studies call attention to shortcomings in hospital preparedness with respect to the acute medical response to a disasters.[1,5-7,10-14] Deficient hospital disaster planning and preparedness is more pronounced in developing countries as compared to developed countries.[1] Moreover the majority of people who are injured and killed by natural disasters reside in developing countries.[15-17] Thus, the impact of poor disaster planning is more pronounced for developing countries.

In addition, prior studies have shown that the socioeconomic level of a community influences the vulnerability of its inhabitants and their medical requirements in the event of a disaster.[18-20] Moreover, hospital disaster preparedness has been shown to be dependent on socioeconomic factors, eg, funding, legal strategies, standards and rules for the health care.[2-3,21] Sweden represents a high income country[22] with a low human impact of disasters.[23] The annual average impact of disasters in Sweden is one death, eleven people affected by disaster, and an estimated cost of US $95 million.[24] The corresponding numbers for Iran, a middle income country[22] with a high human impact of disasters,[23,25,26] are 2,500 people who are killed, 1,376,000 affected and US $690 million in economic damage each year.[27]

No study has, to the authors' knowledge, previously compared the level of hospital preparedness, as measured by functional capacity,[9] between countries with different socioeconomic levels. The authors hypothesize that the level of hospital preparedness is related to socioeconomic status. The objective of this study is to compare hospital preparedness between Iran and Sweden, measured by functional capacity, using the WHO's HSI.[9]

Methods

Setting

This cross-sectional study was conducted in Iran and Sweden, from June 18, 2010 through November 11, 2011. Random sampling of all hospitals, nationwide, was not possible due to limited access on the basis of limits on openness and authority. Therefore, the selection of hospitals represents a convenience sample. The selection of participating hospitals was on permission from the authorities.

Inclusion criteria for this study were: general hospital and urban hospital. Exclusion criteria were: small hospital and private hospital.

The gross domestic product (GDP) per capita and life expectancy in 2008 (last available data),[22] type of disasters and their human impact during last decade (2000-2009)[23] were used as proxies for socioeconomic standard. The international disaster database was the data source for type of disasters and their human impacts.[23]

Evaluation

Affiliation (university or non-university hospital), size (as measured by the number of beds; small: less than 100 beds; medium: 100-400 beds; large: more than 400 beds), and the most common hazards are background variables and were measured for each participating hospital.

The Functional Capacity module of the HSI was evaluated and calculated using the HSI checklist from the World Health Organization (Pan American Health Organization/WHO)[9] without modifications. The structural and non-structural elements, which are also part of the HSI according to WHO, were not included in this study.

The functional capacity consists of 61 elements that are grouped into five sub-modules according to the HSI, as follows (see Appendix 1):[9]

1. Organization of the Hospital Disaster Committee and the Emergency Operations Centre;
2. Operational plan for internal or/and external disasters;
3. Contingency plans for medical treatment in disasters;
4. Plans for the operation, preventive maintenance, and restoration of critical services;
5. Availability of medicines, supplies, instruments, and other equipment for use in emergency.

Evaluation of Functional Capacity

The assessment was conducted by a group of three evaluators in Iran and a group of five evaluators in Sweden, but only one evaluator (ARD) was same in both countries. They were physicians or nurses with an education and expertise in hospital disaster management. The level and value of each element was determined by the evaluators in consensus. Each element has three levels: high, average, and low, as defined in the HSI evaluation guideline (see Appendix 1).[9] The value of each level was 1, 0.5 or 0, respectively. Scoring was performed in accordance with the guidelines (http://www.paho.org/english/dd/ped/SafeHospitalsChecklist.htm).

The maximum value for each sub-module is 0.2 (20%). All five sub-modules have equal weighting. Thus, the maximum total sum of the sub-modules is 1 (100%). The functional capacity is categorized, in accordance with the HSI evaluation guideline (see Supplement 1)[9] as follows:

Level A—the range of the functional capacity is 0.66-1 (66-100%). It is likely that the hospital will function in a disaster. It is recommended, however, to continue with measures to improve response capacity and to improve the functionality.

Level B—the range of the functional capacity is 0.36-0.65 (36-65%). Interventional measures are needed. The hospital's current functionality is such that the ability of the hospital to function during and after a disaster is potentially at risk.

Level C—the range of the functional capacity is 0-0.35 (0-35%). Urgent intervention is needed. The hospital's current functionality is inadequate during and after a disaster.

Type of Disaster	No. of Disasters	No. of Deaths
Earthquake	24	27,757
Transport Accident	87	2,604
Flood	21	744
Miscellaneous Accident	9	152
Industrial Accident	5	92
Epidemic	1	76
Storm	5	43
Mass Movement Wet	1	20
Wildfire	1	0
Drought	1	0
Total	155	31,488

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Table 1. Total Number of Disasters and Deaths by Disaster Type in Iran, 2000-2009
Source: EM-DAT: The OFDA/CRED International Disaster Database www.emdat.be - Université Catholique de Louvain - Brussels - Belgium

Type of Disaster	No. of Disasters	No. of Deaths
Storm	2	8
Epidemic	2	0
Extreme Temperature	1	0
Total	5	8

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Table 2. Total Number of Disasters and Deaths by Disaster Type in Sweden, 2000-2009
Source: EM-DAT: The OFDA/CRED International Disaster Database, www.emdat.be - Université Catholique de Louvain - Brussels - Belgium

Hospital			Iran	Sweden
Affiliation n (%)	University	6 (67%)	3	3
	Non-university	3 (33%)	2	1
Size n (%)	Large	5 (55%)	2	3
	Medium	4 (45%)	3	1

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Table 3. Background for the Nine Hospitals Evaluated

Statistical Analysis

Descriptive statistics were performed. Measures of central tendency were used for the value of functional capacity. The distribution of the functional capacity was not normal, as tested by the normality plot. Therefore, a Mann-Witney U test was used to compare medians of functional capacity score between hospitals with respect to their country, affiliation, and size. A P value <0.05, two tailed, was considered to be significant.

The SPSS 19 (IBM, Armonk, New York USA) was used for data analysis.

Ethical Review

This study was performed in accordance with WHO's recommendation that participating hospitals' names and exact locations are to be treated as confidential and not discussed to outside parties.[9]

Results

The most common hazards, which also portrayed the highest risk for Iranian hospitals, were earthquake, failure of infrastructure and epidemics, in declining order. For the Swedish hospitals, these were chemical accidents, epidemics and terrorism, also in declining order.

The main disaster in Iran, with the largest human impact, was earthquake, as measured by 27,757 deaths over the last decade (2000-2009) (Table 1).[23] Eight people died as a consequence of storms in Sweden during the corresponding period (Table 2).[23]

Gross Domestic Product (GDP) per capita was US $4,678 and US $52,731 in Iran and Sweden, respectively.[22] Life expectancy was 72 years of age in Iran and 81 years of age in Sweden.[22]

The GDP and life expectancy were used to categorize Sweden and Iran as a high and middle income country, respectively. Hazard and death in disaster were used to categorize the risk for disaster. These categorizations led to Sweden representing a high income country with a low risk of disasters and Iran a middle income country with a high risk for disasters.

Nine hospitals were included in this study. Five hospitals were from Iran and four from Sweden. A total of six hospitals were university hospitals. Five hospitals were large, defined as more than 400 beds (Table 3).

The highest functional capacity score was 53% and 40% was the lowest total score for the Iranian hospitals (Table 4). The highest functional capacity score was 81% and the lowest score was 75% for the Swedish hospitals (Table 4). All Iranian hospitals were level B, while all Sweden's hospitals qualified as level A (Figure 1). No hospitals from either country were at level C. The mean functional capacity score was 0.45 (SD = 0.05) for the Iranian hospitals and 0.77 (SD = 0.03) for the Swedish hospitals ($P = .016$).

The highest score was in the sub-module "Plans for the operation, preventive maintenance, and restoration of critical services" (0.11-0.14), and the lowest score was in "Contingency plans for medical treatment in disasters" (0.04-0.09) for the Iranian hospitals (see Table 4). Swedish hospitals had the highest score in sub-module "Organization of the Hospital Disaster Committee and the Emergency Operations Centre" (0.19-0.20), and the lowest score in sub-modules "Contingency plans for medical treatment in disasters" (0.10-0.13) and "Availability of medicines, supplies, instruments, and other equipment for use in emergency" (0.11-0.13) (see Table 4).

There was no difference between university and non-university hospitals with respect to the functional capacity score (0.59) for both groups (SD = 0.19).

The functional capacity score of large hospitals was 0.65 ± 0.15 SD as compared to medium sized hospitals with 0.52 ± 0.2 SD. The difference was not significant ($P = .28$). No small hospital was included in this study.

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Functional Capacity Score	Hospitals									*P* value (2-tailed)
	Sweden				Iran					
	1	2	3	4	1	2	3	4	5	
Sub-module 1	0.190	0.190	0.190	0.200	0.128	0.110	0.090	0.082	0.082	
Sub-module 2	0.158	0.162	0.154	0.142	0.092	0.080	0.088	0.066	0.080	
Sub-module 3	0.134	0.134	0.116	0.102	0.086	0.050	0.050	0.050	0.038	
Sub-module 4	0.200	0.176	0.176	0.200	0.138	0.138	0.112	0.112	0.112	
Sub-module 5	0.130	0.120	0.120	0.110	0.090	0.080	0.100	0.100	0.090	
Total Score	**0.812**	**0.782**	**0.756**	**0.754**	**0.534**	**0.458**	**0.440**	**0.410**	**0.402**	.016
Mean (SD)	0.77 (0.03)				0.45 (0.05)					

Table 4. Hospital Safety Index of Iranian and Swedish Hospitals, As Measured by Functional Capacity
Sub-module 1: Organization of the Hospital Disaster Committee and the Emergency Operations Centre
Sub-module 2: Operational plan for internal or/and external disasters
Sub-module 3: Contingency plans for medical treatment in disasters
Sub-module 4: Plans for the operation, preventive maintenance, and restoration of critical service
Sub-module 5: Availability of medicines, supplies, instruments, and other equipment for use in emergency
The highest value for each sub-module is 0.200.

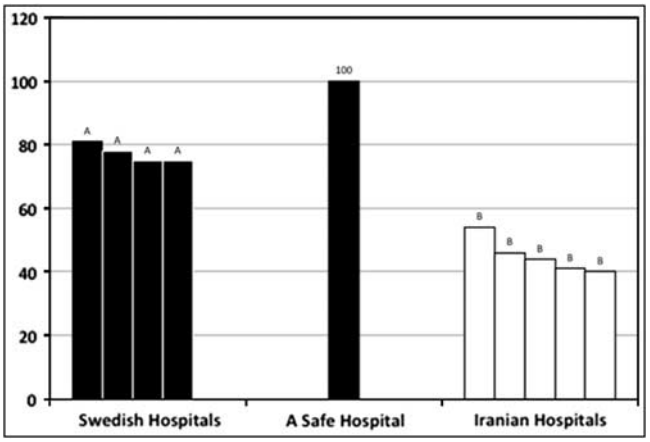

Figure 1. Preparedness Level, as Measured by Functional Capacity, of Iranian and Swedish Hospital Compared with a Safe Hospital
Abbreviations: A, Level A or safe; B, Level B or at risk

Discussion

This study showed that the hospital preparedness level, as measured by functional capacity, was higher in the Swedish hospitals when compared with the Iranian hospitals.

To the authors' knowledge, this is the first study using both an international tool for the evaluation of hospital preparedness, including an all disasters approach, and comparing preparedness in two countries.

This study showed that the overall level of hospital preparedness is functional for the Swedish hospitals included in this study, while those of Iran were at risk, as measured by functional capacity. Previous studies support this study's finding that countries with higher socioeconomic status also have a higher level of preparedness.[6-8,31,33] The previous studies[1,6-8,12,31-33] were, however, conducted in one country alone, using a national evaluation tool. Moreover, the national evaluation tools are typically designed for assessing preparedness for one type of disaster, while the WHO HSI used in this study represents an all-hazards approach.[9]

The impact of the socioeconomic standard on hospital preparedness is described in previous studies.[2,3,18,28-30] Middle-income countries, exemplified in studies from Turkey and China,[22] have both shown shortcomings with respect to hospital preparedness[1,33] and a high vulnerability to disasters.[23,34] Conversely, the level of hospital preparedness in the United States[6-8] and Canadian medium and large hospitals was similar to those of the hospitals evaluated in Sweden.[6-8,33] The financial plan can be a barrier or a facilitator for the planning, training, and developing of resources for hospitals with respect to mass-casualty incidents.[2,29] Providing funding for hospital emergency management activities enables hospitals to direct resources towards improving their emergency management preparedness.[3,30] This indicates that countries with a high socioeconomic standard also have prioritized investing sufficiently in their hospital preparedness plans in order to create safe and functional hospitals. Iran's Health Ministry has approved essential elements and financial resources for hospital disaster preparedness since 2007;[13] this has been considered by Swedish hospitals for a couple of decades.[35] The challenge is to enhance hospital preparedness despite a weak economic situation.

Inadequate contingency plans and insufficient availability of resources during disasters was, however, apparent for the Swedish hospitals despite an overall high level of preparedness. A similar inadequacy of contingency plans has also been reported in a national assessment of hospital preparedness in the US, in that 32% of the hospitals did not have contingency response plans for at least one of six hazards.[31] Also, similar conditions have been reported for trauma centers.[7,33] Thus, despite an overall high level of preparedness as measured by functional capacity, there is room for improvement. The implication of the results of this study is

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that the Swedish hospitals need to develop contingency response plans and to use systematic methods with which to calculate needs to guarantee the provision of necessary resources during disasters.[36]

This study's results revealed a somewhat different pattern with respect to the hospital preparedness for the Iranian hospitals. Inadequate contingency response plans was a noticeable shortcoming. Similar results are reported from other middle income countries.[1,31,37] Moreover, it is important that Iranian hospitals develop contingency response plans in addition to enhancing the overall hospital disaster preparedness. These plans should be based on an all-hazards approach.

There was no difference between university and non-university hospitals with respect to the level of preparedness in this study. Previous studies support the finding that hospital affiliation does not affect hospital preparedness, eg, plan characteristics, standard operational procedures, and surge capacity.[1,7,38] Another study showed that non-university hospitals' performance level is higher than university affiliated hospitals.[13] However, the latter study did not evaluate hospital preparedness specifically, but rather hospital incident command system performance in response to simulated disasters.[13]

Hospital preparedness appears to be a result of government focus and guidance, national policies and regulations, and community standards rather than affiliation.[2] All hospitals must be prepared to deal with disaster victims since it is not possible to predict which hospitals will be involved in the acute medical response to disasters.

The hospital size did not affect the preparedness level, which is consistent with previous studies.[1,13,38] Conversely, a study in Canada showed a low level of preparedness for small hospitals as compared to medium and large hospitals.[33] In the present study, however, no small hospitals were included. The authors believe that hospital preparedness is an effect of planning and not size per se. However, it is important to consider hospital size and surge capacity when considering the distribution of disaster victims among local hospitals.[36]

In summary, the level of hospital preparedness, as measured by functional capacity using the Hospital Safety Index was higher in the Swedish hospitals when compared with the Iranian hospitals. The hospitals were overall safe in Sweden and at risk in Iran. Inadequate contingency plans and insufficient availability of resources were the weaknesses for the Swedish hospitals, while inadequate contingency plans was the most pronounced weakness of the Iranian hospitals. There was no association between the hospital preparedness level and hospital affiliation, size or category for either country.

Limitations

One of the limitations of this study is the small number of participating hospitals. However, this study is the first study in both countries using the internationally standardized method[9] to evaluate hospital preparedness, in addition to using an all hazards approach.[9]

An additional limitation is that only one evaluator (ARD) paticipated in the assessment of both countries. Also, inter-rater reliablity was not measured. However, this study was the first study comparing two countries with respect to hospital preparedness and socioeconomic standard. Furthermore, the standardized format of the evaluation template[9] minimises potential variation due to subjective interpretation.

This study considers the socioeconomic condition of each country measured using general measures eg, GDP and life expectancy. Different national or even international factors that may confound the relationship between the level of hospital preparedness and socioeconomic condition were not specifically evaluated. However, this is, to the best of the authors' knowledge, the first study that compares two countries with different socioeconomic status with respect to hospital preparedness. In this comparison, interesting patterns were revealed that may not have been evident prior to this study. Inadequate contingency plans and insufficient availability of resources were the weaknesses for the Swedish hospitals, while inadequate contingency plans was the most pronounced weakness of the Iranian hospitals.

The selection of the participating hospitals was a convenience sample. Therefore selection bias needs to be considered. The limitation of the study design of convenience sampling was a consequence of authoritative constraints. However, hospitals in Iran all have the same disaster management plan, in addition to the same organisation and categorization with respect to size and function on the whole. In Sweden, also, there is similar condition for hospitals. The authors therefore believe that the results are generalizable. Moreover, all hospitals need to be prepared irrespective of type and no differences were seen with respect to preparedness and size and affiliation.

Furtheremore, the Hospital Safety Index is a model for assessing hospital preparedness and therefore requires an outcome based validation, eg, drills or real disasters.

Conclusions

The hospitals were overall safe in Sweden and at risk in Iran. The authors believe that the level of hospital preparedness is related to the socioeconomic level of the country, as represented by this comparison between Sweden and Iran. This leads one to believe that the challenge is therefore to enhance hospital preparedness in vulnerable countries despite a weaker economic situation. The authors also suggest that the Hospital Safety Index be used as an evaluation tool of hospital preparedness in order to make standardized comparisons between countries possible. Furthermore, functional capacity needs to be assessed in detail in addition to overall estimates in order understand shortcomings in hospital preparedness.

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Supplementary material

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Appendix 1: The Functional Capacity Variables as Grouped in Five Sub-modules

Sub-module 1	Organization of the Hospital Disaster Committee and the Emergency Operations Center (EOC)	Level of organization		
		Low	Average	High
1	Committee has been formally established to respond to major emergencies or disasters			
2	Committee membership is multi-disciplinary			
3	Each member is aware of his/her specific responsibilities			
4	Space is designated for the hospital EOC			
5	The EOC is in a protected and safe location			
6	The EOC has a computer system and computers			
7	Both internal and external communications systems in the EOC function properly			
8	The EOC has an alternative communications system			
9	The EOC has adequate equipment and furnishings			
10	An up-to-date telephone directory is available in the EOC			
11	"Action Cards" available for all personnel			

Sub-module 2	Operational plan for internal or external disasters	Level of implementation		
		Low	Average	High
12	Strengthen essential hospital services			
13	Procedures to activate and deactivate the plan			
14	Special administrative procedures for disasters			
15	Financial resources for emergencies are budgeted and guaranteed			
16	Procedures for expanding usable space, including the availability of extra beds			
17	Procedures for admission to the emergency department			
18	Procedures to expand emergency department and other critical services			
19	Procedures to protect patients' medical records			
20	Regular safety inspections are conducted by appropriate authority			
21	Procedures for hospital epidemiological surveillance			
22	Procedures for preparing sites for temporary placement of dead bodies and for forensic medicine			
23	Procedures for triage, resuscitation, stabilization, and treatment			
24	Transport and logistics support			
25	Food rations for hospital staff during the emergency			
26	Duties assigned for additional personnel mobilized during the emergency			
27	Measures to ensure the well-being of additional personnel mobilized during the emergency			
28	Cooperative arrangements with local emergency plan			
29	Mechanism to prepare a census of admitted patients and those referred to other hospitals			
30	System for referral and counter-referral of patients			
31	Procedures for communicating with the public and media			
32	Procedures for response during evening, weekend, and holidays			
33	Procedures for the evacuation of the facility			
34	Emergency and other exit routes are accessible			
35	Simulation exercises and drills			
Sub-module 3	**Contingency plans for medical treatment in disasters**	**Level of implementation**		
		Low	**Average**	**High**
36	Earthquakes, tsunamis, volcanoes, and landslides			
37	Social conflict and terrorism			
38	Floods and hurricanes			
39	Fires and explosions.			
40	Chemical accidents OR exposure to ionizing radiation			
41	Pathogens with epidemic potential			
42	Psycho-social treatment for patients, families, and health workers			
43	Control of hospital-acquired infections			

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Sub-module 4	Plans for the operation, preventive maintenance, and restoration of critical services	Level of availability		
		Low	Average	High
44	Electric power supply and back-up generators			
45	Drinking water supply			
46	Fuel reserves			
47	Medical gases			
48	Standard and back-up communications systems			
49	Wastewater systems			
50	Solid waste management			
51	Maintenance of the fi re protection system			
Sub-module 5	**Availability of medicines, supplies, instruments, and other equipment for use in emergency**	**Level of availability**		
		Low	**Average**	**High**
52	Medicines			
53	Items for treatment and other supplies			
54	Instruments			
55	Medical gases			
56 57	Mechanical volume ventilators Electro-medical equipment			
58	Life-support equipment			
59	Personal protection equipment for epidemics (disposable)			
60	Crash cart for cardiopulmonary arrest			
61	Triage tags and other supplies for managing mass casualties			

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