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Analysis of good practice of public health Emergency Operations Centers

Min Xu, Shi-Xue Li[*]

Department of Public Health, Shandong University, Jinan, Shandong Province 250012, China

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ABSTRACT

Objective: To study the public health Emergency Operations Centers (EOCs)in the US, the European Union, the UK and Australia, and summarize the good practice for the improvement of National Health Emergency Response Command Center in Chinese National Health and Family Planning Commission.
Methods: Literature review was conducted to explore the EOCs of selected countries.
Results: The study focused on EOC function, organizational structure, human resources and information management. The selected EOCs had the basic EOC functions of coordinating and commanding as well as the public health related functions such as monitoring the situation, risk assessment, and epidemiological briefings. The organizational structures of the EOCs were standardized, scalable and flexible. Incident Command System was the widely applied organizational structure with a strong preference. The EOCs were managed by a unit of emergency management during routine time and surge staff were engaged upon emergencies. The selected EOCs had clear information management framework including information collection, assessment and dissemination.
Conclusions: The performance of National Health Emergency Response Command Center can be improved by learning from the good practice of the selected EOCs, including setting clear functions, standardizing the organizational structure, enhancing the human resource capacity and strengthening information management.

1. Introduction

Risk has become more and more of a concern by governments and the public in the past few decades. Especially in the past 10 years, from terrorist attacks such as 9.11 event to public health emergencies such as SARS and pandemic influenza, countries and international communities have paid great attention to risk response. The United States set up the Department of Homeland Security as a stand-alone, Cabinet-level department to coordinate and unify national homeland security work in 2003. China established the health emergency management system from national level to local level to be responsible for emergency preparedness, and response in 2004 after SARS. The World Health Organization revised the International Health Regulation and started to implement the new version on June 2007, which put great emphasis on the coordination and the management of events that may constitute a public health emergency of international concern.

Among all the general risks, health emergencies, emerging diseases mostly, are increasingly attracting the attention from the public as they tend to frequently occur [1] and easily spread. Public health emergencies have become the global challenges for the whole international community. The response to these emergencies is not only the responsibility of health department, but also demand the joint efforts from other departments such as communication department, transportation department, border control department, *etc.* to perform different tasks. Thus, effective communication and coordination among multiple agencies is a crucial issue.

Emergency Operations Center (EOC) has been widely used in public health emergency management for better multi-agency collaboration in the past decades. The essential nature of EOC is that it greatly improves the multi-agency coordination by having the heads of the various involved agencies together to share information and participate in decision-making processes [2]. So far, many countries and regions such as the United States and the European Union (EU) as well as international organizations such as World Health Origination, have established public health EOCs either independently in the health department or as a part of the overall command system in the government.

Chinese National Health and Family Planning Commission (CNHFPC) (used to be Ministry of Health) set up the National

*Corresponding author: Shi-Xue Li, Department of Public Health, Shandong University, Jinan, Shandong Province 250012, China.
Tel: +86 0531 88382127, +86 13810797464
Fax: +86 0531 88382553
E-mails: yjxumin@163.com, shixueli@sdu.edu.cn
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Health Emergency Response Command Center (NHERCC) after SARS in 2003, and since then it has played an important role in responding to emergencies such as Wenchuan earthquake and pandemic influenza H1N1. A lot of efforts have been made to use the center more effectively and frequently both in routine time and upon emergency, including carrying out the risk assessment and conducting exercises periodically. However, there are still a lot of gaps to be addressed before the center becomes a good working center. This paper is to study and summarize the good practice of the operations of public health EOCs in selected countries and regions, and thereby to make constructive suggestions to improve the performance of the NHERCC in CNHFPC.

2. Materials and methods

A comprehensive literature search that formed the basis for this review on the public health EOCs in the United States, the EU, the United Kingdom and Australia was conducted. The countries and regions were selected mainly based on the availability of the relevant literature, together with their development levels of the EOC. There were well-developed national EOCs that were not included in the study due to the limit of the language.

For the literature review, relevant articles on the journals, dissertations, published books, and grey documents that were related to EOC of the selected countries were retrieved. The online database Pubmed, Cochrane library, NHS evidence and the general Google search instrument as well as the library database of University of Oxford were used to identify studies and reviews published in English from 1994 up to July 2014.

Search terms included public health, (disaster or outbreak or disease outbreak or risk or emergency or event) and ('EOC' or 'emergency operations centre/center' or 'command and control operations centre/center' or 'strategic health operations centre/center' or 'command centre/center' or 'situation room' or 'crisis management centre/center' or 'emergency co-ordination centre/center') along with the name of the respective country or region.

In addition, official websites of the Ministry of Health of the respective country or region were searched. Personal communication with experts helped to identify additional published literature. The reference lists of retrieved articles, abstracts, books and presentations of international workshops served as additional sources of information.

The main question to be answered by this review was 'How are the EOCs built and operated in the health department in the United States, the EU, the United Kingdom and Australia'? The topic was generally broad. To be more practical and focused, the information of EOCs related to the following aspects was collected and categorized:

1) What are the functions of the EOCs?
2) What is the organizational structure of the EOCs?
3) How are the human resources working in the EOCs?
4) What is the information management in the EOCs?

3. Results

Public health EOCs developed very fast in the past decades after SARS. Quite a number of EOCs of health authorities were set up or strengthened in the first decade of the 21st century. The EOC of the US Center for Disease Control and Prevention

(USCDC) was set up in 2001 and began to provide a centralized and physical location to manage CDC's response to domestically and internationally large-scale public health incident from 2003 [3]. The EOC of the European Center for Disease Prevention and Control (ECDC) has become operational since June 2006 [4].

In this study, one national or regional public health EOC was selected in each of the identified countries and region. The key information of the four aspects from the selected EOCs including functions, organizational structure, human resources, and information management, are summarized in Table 1.

3.1. EOC functions

The functions of EOCs are widely discussed in the emergency management discipline. Ron Perry listed the key functions of an EOC comprising: 'coordinating overall response; making policy decision; allocating personnel; gathering information; dispersing information to the public; and hosting visitors, especially VIPs' [2]. According to National Incident Management System of the United States, the core functions of an EOC include: 'coordination; communications; resource allocation and tracking; and information collection, analysis, and dissemination' [5]. There are other versions of EOC function lists, however, 'the importance of coordination, communication, management and information gathering and interpretation are the consistent themes' [6].

All selected EOCs have the function of coordinating and commanding the emergencies response activities to public health threats or planned events in their countries or regions, and abroad, which include information management, personnel deployment and resource allocation [7,8]. In addition to the basic EOC functions, public health EOCs play an important role in closely monitoring the situation, and providing a platform for the health professionals to analyze the collected information and make risk assessment based on that. To maintain the situational awareness is highlighted by all the selected EOCs, especially by Emergency Operations Center of European Center for Disease Prevention and Control (ECDC-EOC). As a supranational center, ECDC-EOC provides support for ECDC threat detection, risk assessment, investigation and risk communication activities for emerging public health threats in the EU member states and internationally. During routine time, daily risk assessment and epidemiological briefings are held in the EOC as its main functions. Besides responding to the real emergencies or events, Emergency Operations Center of US Center for Disease Control and Prevention (USCDC-EOC)and ECDC-EOC are actively involved in conducting exercises to evaluate their ability to respond rapidly and effectively to potential public health emergencies as well as make adjustment accordingly [5,9]. USCDC-EOC also emphasizes the efficiency or timeliness of personnel and resource allocation and can manage to transport them to anywhere in the world within hours after notification.

3.2. Organizational structures of the EOCs

The organizational structure is a very important aspect of EOC development and operation, which determines how the EOC is consisted of and how it works. All the selected EOCs have standardized and flexible organizational structure, and among them Incident Command System (ICS) is widely applied. Established as a standardized emergency response operating

Table 1
Summary of the five aspects of the selected EOCs.

Country/Region	The United States	EU	The United Kingdom	Australia
EOC Name	USCDC-EOC	ECDC-EOC	Emergency Co-ordination Center of UK Department of Health	AuDoHA-NIR
Functions	- Monitor and coordinate emergency response activities to public health threats and planned events in the US and abroad - Conduct exercises to evaluate its ability to respond public health emergencies	- Support the response to emerging public health threats in the EU MS and internationally - Daily risk assessment - Participate public health crisis simulation exercise	- Maintain situational awareness - Support command and coordination upon public health emergencies - Advise on policy - Information management and communication	- Maintain situational awareness - Information management - Coordinate the deployment of personnel and suppliers - Implement health aspects of disaster plans
Organizational structure	Incident Command System	Simple structure including screening, technology, logistic/outbreak	Standardized structure including incident director and deputy, function specific team	Incident Coordination System
Human resource	- Managed by Division of Emergency Operations, CDC's Office of Public Health Preparedness and Response - Surge staff upon emergencies - Trainings provided to surge staff	- Managed by The Epidemic Intelligence and Response Section in the Surveillance and Response Support Unit of ECDC	- Managed by Public Health England (used to be Health Protection Agency) of Department of Health - Trainings to staff with command role	- Managed by Office of Health Protection of Department of Health and Aging
Information management	- Under framework of National Incident Management System S - Watch 'All hazard' globally - Dedicated staff for information analysis and communication	- Develop and use tools for risk tracking, assessment and measure coordination - Agreement on terminology and procedures with EU MS	- Not available	- Clear framework for information gathering, collation, interpretation and dissemination

system used around the US according to the guidance from the Department of the Homeland Security and the directives from the White House [10], ICS is adopted in the USCDC-EOC as well. ICS provides a flexible core mechanism for coordinated and collaborative incident management. It is normally structured to facilitate activities in five major functional areas: command, operations, planning, logistics and finance/administration [5]. ICS is built using the top-down approach with responsibilities and performance initially lying on the Incident Commander who is responsible for overall management of the incident. Besides Incident Commander, there are other positions for command staff which typically include a public information officer, a safety officer and a liaison officer. If needs rises, four functional sections (operations, planning, logistics and finance/administration) can be established. Each function has its own branches, with a set of fundamental supporting agencies [11].

ECDC-EOC has a comparatively simple organizational structure with the functions of screening, EOC technology and logistic/emergency. Other public health functions such as communication, technical support and administration support are under the overall structure of emergency response rather than the EOC structure [9].

Emergency Co-ordination Center of UK Department of Health has its standardized and flexible structure including incident director and deputy, and function specific teams. The incident director is responsible for the general command and control in order to ensure the strategy implementation and grasp the rhythm of response action, delivering coordinated advice and support for the "front line" staff and government. Function specific teams, including international team, forecasting team, specialist teams from Health Protection Agency specialist service, communication team and logistics and resource team, are composed of different teams depending on the nature of the incident [7].

The organizational structure of National Incident Room of Australian Department of Health and Aging (AuDoHA-NIR) is the Incident Coordination System which is based on Australian Inter-service Incident Coordination System. Under the DoHA coordinator, there is an NIR coordinator which leads the activities of three managers including a planning manager, a logistic manager and an operations manager. The planning manager is responsible for the management and coordination of the activities of surveillance unit, situation unit, communication unit, information unit and medical advisory. The logistic manager leads and coordinates the activities of preparedness unit, corporation support unit, secretariat unit and liaison office unit. The operations manager takes the charge of stockpile unit, medical transport, border unit and donation unit [12].

Although the organizational structures vary among the selected public health EOCs, generally speaking, they are all standardized, scalable and flexible. There is an incident commander at the top level of the structure to be responsible for the overall command and coordination. The commander is usually supported by command staff or managers to lead or coordinate the activities of teams or sections with specific functions. Among different organizational structures, ICS is a well-documented and widely used management system in public health settings. It defines the operating characteristics, interactive management components and structure of incident management and emergency response organizations engaged throughout the life cycle of an incident [13].

3.3. Human resources of the EOCs

Although, it is difficult to quantify the number of staff needed for an EOC, given its variance in terms of jurisdiction, type, scale and duration of emergency, it is easy to understand that for a facility like EOC the enough qualified staffing is one of the most critical issues. All the selected EOCs are operated in normal circumstance by a designated emergency response unit or department (Table 1) and have increasingly available staff to work in EOCs during emergencies to boost their overall capability.

Taking USCDC-EOC as an example, it is routinely managed by the Division of Emergency Operations (DEO) in the CDC's Office of Public Health Preparedness and Response. When activated for a response, it can accommodate more than 200 personnel working 8-h shifts to handle situations ranging from local events to worldwide incidents [14]. Except for the staff working in the DEO, many staff and responders working in EOC adjust their normal work schedule to accommodate part-time engagement in the center during the emergency. Appropriate training is provided to the part-time staff to make sure they are qualified for their assignments during emergency response and are familiar with various guidance documents including the National Response Framework, ICS, and CDC Emergency Operations Center functions [15]. The other three selected EOCs are staffed in the similar way.

The first rule of staffing an EOC is that no person should be assigned roles and responsibilities that are alien to them. To achieve this, all personnel in an EOC should be assigned the tasks similar to their normal working ones, accept their roles in an EOC, undertake their tasks and fulfill the related trainings [16]. It is obviously that all the selected EOCs are managed by department or unit responsible for emergency management and appropriate trainings are provided to the EOC staff.

3.4. Information management of the EOCs

Information is the lifeblood of an EOC. As a coordination and communication center, the volume of information available and used in an EOC can be enormous [6]. Information management is an essential component of functional EOC operation, which includes information collection, analysis or assessment, and dissemination.

USCDC-EOC and AuDoHA-NIR have information management framework and principles. The USCDC-EOC manages the information under the framework and principles of National Incident Management System [5,13]. It monitors the 'all hazards' globally. The key information collected includes incident notification, situation awareness/update, analytical data, baseline data and geospatial information. AuDoHA-NIR follows the information management framework of the national emergency manual. Information gathering, collation, interpretation, reaction to information and information dissemination are the common aspects of its information management.

USCDC-EOC has dedicated staff for information management. The Subject Matter Experts provide information and data analysis, public information officer is responsible for interfacing with the public, media and other agencies with incident-related information requirement, and the Joint Information Center reviews information for publication, and coordinates the risk communication upon the emergency [17].

ECDC-EOC develops and uses specific tools for information management, such as Threat Tracking Tool to monitor threat assessment, the Early Warning and Response System for coordination of measures, and Epidemic Intelligence Information System as a risk assessment platform. It has close connection to other EU rapid alert systems. In order to be interoperable, ECDC-EOC has agreement on terminology and procedures with EU member states for better communication and information sharing [9].

Among the selected EOCs, USCDC-EOC attaches great importance to information sharing and risk communication by having designated staff and facility to be responsible for public information; ECDC-EOC is a regional center and focuses much on the risk assessment of public health emergencies with the support from the relevant threat detection and assessment tools.

3.5. Limitations

This paper tries to understand and summarize the EOC operations in the four selected national or regional EOCs and learn the best practice for the improvement of the NHERCC in CNHFPC. Although many efforts have been made to get the relevant literature and information of the topic, the retrieved information resource is still not enough to thoroughly understand the overall structure and performance of the selected EOCs.

4. Discussion

EOCs are used in a variety of emergencies or events, including natural disasters, disease outbreaks, bioterrorism and mass gatherings, etc. Public health EOCs are physical or virtual centers responsible for the strategic management of public health emergencies [6]. As the command and coordination center, the selected public health EOCs define the functions, organizational structure, information management framework and have dedicated staff. The EOCs play an important role in efficient communication and information sharing, fast personnel assignment and supply transportation, etc. in responding to public health emergencies in the past. The EOCs are also widely used to conduct exercise and risk assessment during routine time to keep itself functioning and in continuous improvement.

Since the establishment in 2003 after SARS, the NHERCC has been used in responding to emergencies such as natural disasters, disease outbreaks and events, e.g. the Olympic Games. It improves the emergency management by providing support for risk detection and assessment, information sharing and better communication between the on-site and the off-site staff. However, there are still a lot of drawbacks such as the shortage of human resource, instable organizational structure, *etc*. The following aspects are the implications that can be learnt from the good practice of the selected EOCs for the center's further improvement.

4.1. Include the public health specific functions in the function list of the NHERCC

An EOC should have a clear picture of the functions in order to play a proper role in emergency preparedness and response. As a public health EOC, the core functions of the center include coordination, command, communication, information management,

personnel and resource allocation and tracking. In addition to the general and broad description of the functions, it is important to consider the specific functions based on the characteristics of public health discipline. USCDC-EOC and ECDC-EOC have good experience in this case. Both EOCs have comprehensive surveillance network to closely watch the situations, bring health professionals to make risk assessment routinely, have designated officer or a group of specialists to be responsible for risk communication and carry out exercise and evaluation or adjustment afterwards for further improvement.

The NHERCC could set a list of its functions by learning from the practice of USCDC-EOC and ECDC-EOC, as well as taking consideration of its own needs and situation. First of all, the public health emergencies are usually not as predictable as the meteorological disasters such as typhoon, which occur in a certain local area in most cases. Therefore, rather than being involved in the response activities on the scene of incidents, as a national EOC for a country with vast territory, the NHERCC should focus on detecting the risks timely, continuously monitoring and assessing the situations. Secondly, because the public health emergency with national significance happens at low frequency, exercises should be carried out periodically to test the operation plans and procedures in order to assist the responders and relevant agencies in understanding their roles, tasks and responsibilities upon emergencies, help the staff familiar with the relevant documents and make improvement based on the lessons learnt from the exercises. Thirdly, as the public health emergencies usually concern the public and make people feel anxious, it is very important for the NHERCC to appropriately carry out risk communication activities to timely and accurately inform the public of the latest situation.

4.2. Standardize the organizational structure based on the lessons learnt for the 'team-mode' and the common practice of ICS

The organizational structure is an essential component for a functioning public health EOC. It is important for the standardized operation of the EOC as well as uniformed training of the EOC staff and responders. Among the selected EOCs, ICS is the most widely used organizational structure. ICS demonstrates several characteristics. First of all, it is clear top-down command and control with all the commanding positions arranged hierarchically. Secondly, it can achieve multiple organizational goals as each function area can have its own goal under the basic system objectives and plans established by the top of the hierarchy. Thirdly, it has multiple protocols due to the dynamic emergency situations and the complexity of the structures [11].

The organizational structure of the NHERCC has not been standardized and fixed so far. Being activated upon emergencies with national significance, it is mostly responding in the 'team-mode', where different working teams are set up to address specific issues according to the nature of the threat. The structure should be standardized and fixed based on the lessons learnt from the 'team-mode' and the common practice of ICS. The mode of ICS could be considered as a top-down, scalable and flexible structure with multi-goals and protocols, which is quite fit for the national level EOC confronting complicated situations in many circumstances. The 'team-mode' structure should be studied carefully to identify the most commonly involved teams and surge teams for public health emergencies. All the elements involved in the response should be included in the structure with

their clear roles and responsibilities. The structure should have both the strategic command function as well as the tactic operations function.

4.3. Enhance the human resource capacity by identifying and training both dedicated and surge staff

The number of staff needed for an EOC may vary by many factors such as jurisdiction, the workload and the resource available. However, a public health EOC usually have a certain number of full-time staff from an unit or department with the responsibility of emergency management and they are responsible for the routine operations of the EOC, while a scalable number of part-time staff who usually work on certain public health or medical subject and shift to work in the EOC upon the emergencies related to their subjects. All the selected EOCs are staffed in such a way.

For the NHERCC, the lacking for appropriate number of dedicated staff is the key hinder for its development. Dedicated staff for the core function of the center should be appointed or employed, including operations, information management, planning, logistics, and communication. All the dedicated staff should have clear roles and responsibilities and be provided with standardized training to obtain the knowledge and skills to fulfill their tasks.

During the emergency more staff will be needed to maintain the operation of the center, therefore the surge staff for all functions of center need to be identified and trained in advance of the public health emergencies. Exercises should be carried out to simulate the scenario of the emergency and help the surge staff to be familiar with their tasks during the public health emergency. Such training should be provided repeatedly as the work shift is frequent and the knowledge of public health emergency response updates rapidly.

4.4. Strengthen information management by developing tools for risk detection and assessment as well as enhancing the capacity of risk communication

During the course of an incident, information is vital to assist the incident commander and support agencies and organizations in making decisions. All the selected EOCs attach great importance to information management by identifying the information sources, developing the threat tracking and risk assessment tools, having dedicated staff and resources for information management.

In the NHERCC, there are existing information sources such as surveillance systems, mass media, hotlines and official notifications. However, except the web-based surveillance system, other information is collected and analyzed manually, which is time-consuming. The practice of ECDC-EOC can be learnt to develop the tools to retrieve information from the existing surveillance systems or sources for risk detection and assessment.

Communication is an essential function of EOC. NHERCC has not had dedicated staff and strategic plan for risk communication so far. This function should be strengthened based on the existing communication channels. The practice of USCDC-EOC can be learnt by inviting risk communication specialists to participate in EOC planning and operations. For the interoperability and better communication among different agencies and jurisdictions, the standard terminology and procedures should be developed and agreed by the relevant elements in the response.

Except the four aspects mentioned above, there are other issues to be considered in order to enhance overall operations of NHERCC, such as reasonable layout, well-functioning equipment and comprehensive operations plans. And the last but not the least is that each EOC has its own specific situations, therefore, the best practice leant from other EOCs must be adapted accordingly for its own situations and lessons learnt from its own practice.

Conflict of interest statement

We declare that we have no conflict of interest.

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