Asia-Pacific
Economic Cooperation

A Guide to Public Health Emergency Response Capacity Building

APEC Health Working Group

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Preface

Many new epidemics such as SARS, avian flu and influenza A (H1N1), and natural disasters such as the earthquake in Sichuan province of China, the great earthquake in Japan 2011, as well as the tsunami in Indonesia 2004 have brought great economic losses to many countries around the world, especially APEC economies, and also exert serious social impact on them.

APEC has been paying special attention to issues related to economy, such as human security, disaster control and cultural cooperation etc., and it has made some achievements in building public health emergency response system. Nevertheless, APEC economies still need to make more efforts in improving public health response, sharing response experience and carrying out regional cooperation. Today, when public health risks occur frequently and affect and threaten the health of our global population, it becomes especially important to strengthen the comprehensive capacity of the APEC economies to respond to public health emergencies and jointly prevent the emergencies that will possibly happen.

Given the above reason, Shanghai Municipal Centre for Disease Control and Prevention applied for the APEC Fund for "technical training program on public health emergency response capacity building"(S HWG 06 11A). The School of Public Health in Fudan University was entrusted by both APEC and Shanghai CDC to write the Guide to Public Health Emergency Response Capacity Building, which is an important part of the program, aiming to give a basic idea about the framework and the main content of public health emergency response system. During the process of writing this Guide, public health experts of Fudan University received full support and help from the Emergency Management Office of the Ministry of Health, the Health Emergency Response Centre of China CDC, the Health Emergency Management office of Shanghai Health Bureau, and Shanghai CDC.

As a systematic and complicated process, public health emergency response capacity building involves not only hardware environment building but also human resources building. Therefore, not only the improvement at the system and institute level but also individual capacity improvement should be taken into consideration. APEC members can improve their own emergency response system according to the capacity assessment of their existing system.

Due to tight schedule and capacity of the editor, mistakes and defects are unavoidable in this *Guide*, so criticisms and suggestions are warmly welcome.

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Abbreviations

APEC	Asia-Pacific Economic Cooperation
APSED	Asia-Pacific Strategy for Emerging Diseases
CAR	State Capability Assessment for Readiness
CDC	Center for Disease Control and Prevention
DHHS	Department of Health and Human Services
DHS	Department of Homeland Security
ELISA	Enzyme Linked Immunosorbent Assay
ERRP	Emergency Rapid Response Plan
GIS	Geographic Information System
GPS	Global Positioning System
HCAR	Hospital Capability Assessment for Readiness
HRSA	Health Resources and Services Administration
IFA	Indirect Fluorescent Antibody Test
IHR	International Health Regulation
MMRS	Metropolitan Medical Response System
PCR	Polymerase Chain Reaction
PPE	Personal Protective Equipment
RS	Remote Sensing and Telemetry
SARS	Severe Acuter Respiratory Syndrome
SCBA	Self Contained Breathing Apparatus
UNDP	United Nations Development Programme
WHO	World Health Organization

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Introduction

In recent years, with the increasingly frequent flow of population, expansion of international trade as well as the changes of social and natural environment, public health emergencies have become the focus of attention around the globe. A range of emergencies such as "mad cow disease", "anthrax event", "SARS" and "avian flu" which have continuously occurred and threaten people's life, health and security make people more and more aware of the important impact of public health emergencies on social stability and economic development. According to the global situation, the occurrences of public health emergencies are almost unavoidable. At present, the world has entered into a period with frequent occurrences of public health emergencies. Monitoring data show that since the 1970s, at least one new infectious disease has been discovered each year at an unprecedented speed. A research indicates that the newly discovered infectious diseases have increased by 4 folds over the past 50 years and that about 40 such diseases were unknown a generation ago. In 2005, the newly amended *International Health Regulation* (IHR) stressed that all member states should strengthen the building of their monitoring and early warning system and control the occurrence of public health emergencies by using global resources.

Asia-Pacific Economic Cooperation (APEC for short) is an important forum for economic cooperation in Asia-Pacific region. After twenty years of development, APEC, which was a regional economic forum and consultation agency at the very beginning of its establishment, now has become an important forum for economic cooperation and an intergovernmental organization for economic cooperation at the highest level within Asia-Pacific region. It has played a central role in promoting regional trade and investment liberalization and strengthening economic and technological cooperation among its members. The spirit of APEC family is: "to create stable and prosperous future for people in the region, to establish a big family of APEC, to deepen the opening and partnership spirit of the big family, to pay contribution to the world economy and support an open international trade system".

In recent years, APEC has also been involved into other issues related to economy, for example, human security (including anti-terrorism, health and energy), anti-corruption, disaster control and cultural cooperation etc. Therefore, today, when public health emergencies occur frequently and affect and threaten the health of our

global population, it becomes particularly important to strengthen the comprehensive capacity of the APEC economies to respond to public health emergencies within the region and jointly prevent the emergencies that will possibly happen.

Since 2003 when the Severe Acute Respiratory Syndrome (SARS) occurred, the global public health emergency response system has been developed rapidly, especially in China where remarkable achievements have been made in the development of the system. This article, after sorting out and analyzing the technical documents, guides, regulations as well as summaries currently published by international organizations, puts forward the core contents (core capacity) of public health emergency response capacity building of APEC by summarizing the practice and experience of APEC economies like China, so as to provide reference for APEC member states to improve their own emergency response capacity.

1 Public Health Emergency

1.1 Basic concept

Currently there isn't a standard and universal definition of public health emergency in the world. In the core capacity goal realization assessment manual mentioned by IHR (2005), which is newly published by the World Health Organization (WHO), "event" is defined as: "the case in which diseases occur or will possibly occur, including infectious disease, zoonosis, food safety, chemical event and nuclear radiation crisis, etc." Public Health Risk refers to possible events which are harmful to the health of crowd and the IHR specially emphasizes that Public Health Risk may cause worldwide spread of disease or bring about serious dangers to the international community. Urgent Events means that the spread of a disease or the potential disease caused by an event is unusual or unexpected and has a serious impact on public health and has a high risk of causing infection and spread. Public Health Emergency of International Concern refers to the unusual and sudden events which may cause spread and infection among countries or need joint international efforts in prevention and control. According to the proposals of IHR, in deciding whether an event is a public health emergency of international concern, we should take into consideration the degree of danger that the event has brought to people's health, the risk of international spread of the disease and the interruption of international transportation.

Regulation on the Urgent Handling of Public Health Emergencies of the People's Republic of China points out that the Public Health Emergency refers to "the serious infectious disease that suddenly happens and causes or may cause severe losses to the health of the public, sudden, unknown diseases acquired by groups of people, events of serious food or occupational poisoning, and other events endangering public health". The Regulation also classifies public health emergencies into four grades according to their nature, degree of danger and coverage, namely, the particularly serious (Grade 1), serious (Grade 2), relatively serious (Grade 3) and ordinary (Grade 4).

1.2 Characteristics of public health emergency

Public health emergency bears such characteristics of being unexpected,

involving groups of people and requiring a comprehensive solution. Since it has a wide coverage and causes great losses, it often leads to social panics. Meanwhile, it often results from illegal behaviors, operations against rules and lack of the sense of responsibilities. At present, it has got some new characteristics, for example, it happens in a large scale, causes great losses, exerts extensive influence, causes greater concern, has complicated reasons and involves the continuous occurrence of new infectious diseases.

Public health emergency is directly related to people's health, economic development and social stability and has become the focus of attention in the society. Therefore, to improve the capacity of preventing and controlling public health emergency has been taken as an important indicator of a country or government's achievements and social progress.

2 Public Health Emergency Response System

Because of the uncertainty of public health emergency, surveillance is needed before the event, which means that the early identification and timely information release is the key to effective emergency control. Thus, the establishment of an effective public health emergency response system (referred to as emergency response system hereinafter) becomes to key to improving the whole public health system. Emergency response system refers to a system which can, in case of public health emergency, provide necessary personnel, material and energy and take rapid actions within a short time so as to reduce the danger of the emergency to minimum. It serves as an important support for a country to respond quickly, make decisions correctly and take actions immediately in time of emergency so as to reduce the impact of the event on people's health, economic construction, social stability and national security to minimum.

An effective emergency response system should include: a big professional health institution, well-trained health technical personnel, smooth and accurate disease surveillance and report system, modern laboratory, electronic information system that can facilitate quick communication with other departments, adequate stockpiles (medicine and vaccines, for example) and effective methods to prevent the spread of disease (isolation, for example), all of which are essential to emergency control. According to the WHO's suggestion, a comprehensive alert and response

system should involve various parts such as surveillance, response and assessment after the event (See Diagram 1).
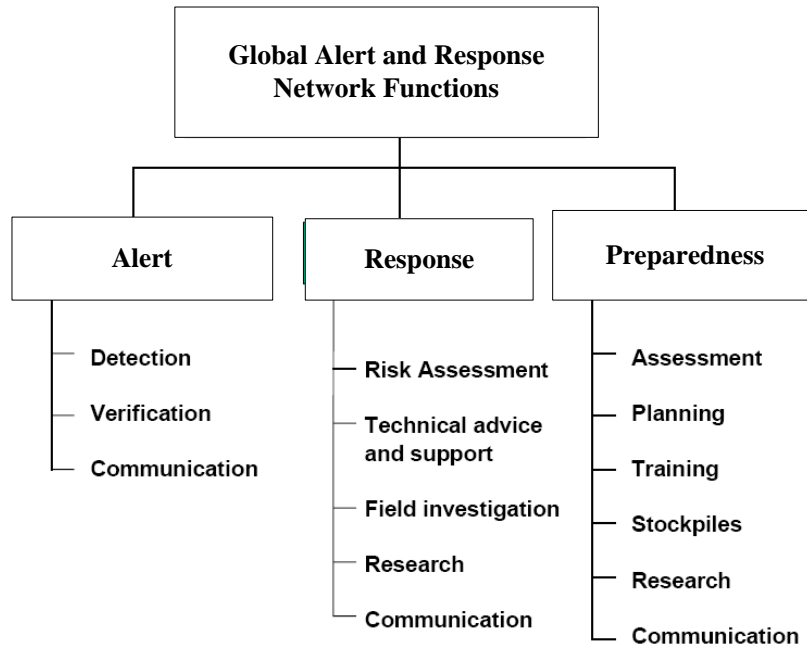
Diagram 1 Framework of Global Alert and Response Network

(Sources: WHO. A framework for global outbreak alert and response. WHO/CDS/CSR/2000.2)

2.1 Framework of the Emergency Response System

2.1.1 Alert system

Alert is a new method to guide human behavior so as to prevent various dangers to environment and people's health and a direction for a country in working out its health policy and health quality standards. It is a method which not only takes into consideration the limitation of scientific basis but also can guarantee people's health at a level. It is also a new method to facilitate and readjust prevention behaviors when there is a lack of causal relations and adequate evidence of dose-response relationship, or a new method to take actions before people's health is threatened. Deep down, it is a method which, after taking into consideration the inadequacy of materials and uncertainty of dangers, still insists in issuing alert where it's necessary to take actions. Alert includes alert analysis and alert monitoring. Alert analysis refers to management activities that monitor, identify, diagnose and assess various symptoms of an emergency and give timely warning. Alert monitoring refers to management activities to correct, prevent and control undesired tendency of the symptom according to the

result of alert analysis. Being the key to controlling and reducing the number or degree of the danger of an emergency and a theoretical support for addressing the dangers from the roots, Monitoring and alert can be conducted by establishing an enabling political, economic, social, legal and management environment under the framework of alert and emergency preparedness so as to ensure the preparedness of emergency, the coordination of the preparedness and the effective use of existing resources to the maximum degree. At the same time, to safeguard monitoring and alert, a series of workable emergency plans with clear definition, standard description, and well-defined target should be worked out to handle emergencies and achieve the goal of protecting people's lives and property as well as the environment.

Alert system consists of the following subsystems:

(1) Information system: formed by data from different sources, an established information system can integrate materials from various systems. These systems have many similarities and differences. Some of them use the existing data, some collect new data, some use the traditional data, and others use non-traditional data sources. By integrating these systems, the information system put more groups of people under surveillance.

(2) Information collection, analysis, feedback and alert system: this system should actively collect and get the information related to target event and report the information timely. The information analysis is aimed to examine the quality of information materials, understand the development trend of the target event dynamically through analysis and make the prediction. Meanwhile, a channel to feedback the information must be created to enable all the working units and individuals who should be formed of the public health surveillance information to acquire the information timely so as to respond quickly to epidemic situation and decide focus of their effort and direction of research.

(3) Surveillance alert system: by long-term and continuous collection of information, the surveillance system gets the regular fluctuation range of relevant indicators. The information collected is analyzed and compared with the baseline information and when it is above the prescribed warning line or threshold, it will be reported to the relevant department. This system is designed to identify the possibility and degree of seriousness of the danger that the event will bring about and issue alerts of different degrees to the relevant departments according to the grades of different warning degrees so as to take quick, timely and proper measures of prevention and

control.

2.1.2 Emergency Response System

The Emergency response system is an integration of the following six subsystems:

(1) Emergency Command Centre: command and decision-making institution with the highest authority, including decision-making of leadership, command and coordination, surveillance and supervision as well as implementation and operation system.

(2) Public Health Information System: including report and surveillance system of infectious diseases, surveillance and alert system of symptoms, communication system of clinical and prevention information, expert information database as well as biological, chemical and nuclear threat database.

(3) Health-care Network for Disease control and prevention: cornerstone of the response system, including disease prevention and treatment network, laboratory diagnosis network, personnel training base, as well as teams of professionals in the fields of field epidemiological investigation, health supervision and law enforcement, health education, risk communication and public relations.

(4) Medical treatment network: a major force to respond to public health emergency, including emergency medical treatment outside hospitals, medical treatment network and poisoning treatment centre.

(5) Stockpile system for emergency products like medical machinery and equipment, etc.

(6) Emergency risk surveillance and assessment system.

2.1.3 Support System

A powerful support system is needed in the construction and operation of the whole system, including:

(1) Policy and Legal Support: the construction and operation of alert system involve various sectors, and need relevant policy and legal support which is the lifeline that ensures the effective operation of the whole emergency response system.

(2) Emergency planning system: a complete and scientific plan can not only guide and standardize public health emergency response and handling but also further improve the institutions of the response system.

(3) Hardware construction and technical support: the comprehensive use of computer technology, network technology, communication technology, geographic

information system and remote sensing technology is needed to establish and improve the alert system, thus the relevant software and technical platform are also needed to give support.

(4) Personnel Allocation and Training: stable and professional human resources deployment is very necessary and at the same time personnel training and talent team development should be given equal attention. On the one hand, technical personnel with high educational level and excellent competence should be introduced, and on the other hand, various trainings should be offered to the existing personnel so as to improve their competence.

(5) A necessary material stockpile system should be provided to ensure the allocation of materials under emergency situation.

(6) Assessment System: an important part of the whole emergency response system. To build up a scientific and effective public health emergency response system, an appropriate assessment system is needed because assessment at a regular time can discover problems, improve the system and upgrade the effectiveness of the system in a timely manner.

2.2 Public Health Emergency Response Systems of Major APEC State Members

At present, APEC consists of 21 member states and 3 observer organizations. Here we take the U.S. and China as examples and introduce the basic frameworks and functions of their emergency response systems.

2.2.1 the U.S.

The public health emergency response system of the U.S. includes the following three subsystems in a top-down manner: (the Federal) Center for Disease Control and Prevention (CDC), (the State) Health Resources and Services Administration (HRSA) and the local Metropolitan Medical Response System (MMRS). Besides these three systems, the United States Department of Defense, the U.S. Department of Health & Human Services, the Federal Bureau of Investigation, the Environmental Protection Agency and the U.S. Department of Energy have also participated in the construction and improvement of the emergency response system, which guarantees the powerful commending function of the system. The system is mainly characterized by its well-established framework, clearly-defined functions as well as its focus on the construction of alert system.

CDC-(the Federal) Center for Disease Control and Prevention	HRSA - (the State) Health Resources and Services Administration
• **disease surveillance**	• medicine provision
• epidemic control	• implementation of treatment
• large-scale epidemic prevention	• communication system
	• Quarantine and

MMRS—(local) Metropolitan Medical Response System

• medicine stock and distribution
• early warning and report
• emergency response and management
• medical care administration

Diagram 2 Three-Level Public Health Emergency Response System of the U.S.

As the core of the whole emergency response system and center of coordination, CDC has the following functions: working out a national disease control and prevention strategy, carrying out public health surveillance and alert, respond to emergencies, integrate resources and provide trainings to managers and employees in the field of public health. HRSA conducts its management in different regions of the country. The country is divided into 10 regions, and various States within a region are linked so as to jointly develop the capability of the region to respond to public health emergency and provide all the citizens of the region with health care services by improving the emergency response capacity of hospitals, emergency department and other health care cooperation department. As an operational system responding to public health emergency at the local level, MMRS guarantees effective response to public health risk in the region within the first 48 hours after the breakout so that the region can control the risk and situation on its own before the emergency response resources are mobilized nationwide through the cooperation and interaction between the "first-site response personnel" of local law enforcement department, fire fighting department, natural disaster treatment department, hospitals, public health institutions and other institutions

Based on the lessons drawn from the anthrax event which caused the panic and fear of biological attack, the CDC and department of Health and Human Services

(DHHS) have further strengthened the public health emergency response system since 2001 by improving the emergency rapid report mechanism, disease surveillance and control capacity and the rapid response team construction.

After the "911 Event", in order to prevent various emergencies, the U.S. established the Department of Homeland Security (DHS) and worked out Emergency Rapid Response Plan (ERRP) under the guideline of "the Department playing the leading role with support from various sectors, multi-level coordination and rapid response". The Plan explicitly defines the functions and roles of DHHS and CDC in time of emergency, and its rapid response mechanism is a component of the Federal emergency rapid response system.

Moreover, the U.S. has also established emergency prevention and response bureau with the major functions of guiding and supporting the country to respond to various disasters, protect facilities and reduce death and casualties and property losses. Apart from the Federal response institutions at the first level, all the States of the U.S. and local governments under the jurisdiction of the States have relevant emergency management offices which are at the second and third level of the emergency management system respectively. The management agencies at each level have an operation department with a special power within a special period, namely, the operation and allocation center for emergency response.

2.2.2 China

Since 2003, governments at various levels in China have quickened their steps in the public health system construction and realized that the establishment of a sensitive, efficient and rapid emergency response mechanism is essential to rebuilding a public health system. Both Chinese central government and local governments at various levels pay great attention to emergency response capacity building and increased their input in public health. The network construction in CDC at the central, prefecture and county levels has been completed and finance departments at all levels have also put a lot of money in medical salvage system. The promulgation of the *Regulation on the Urgent Handling of Public Health Emergencies* (referred to as Regulation hereinafter), the revision of the *Law of the PRC on the Prevention and Treatment of Infectious Diseases* and the enactment of the *National Contingency Plan for Public Health Emergencies* mark that Chinese emergency response has been integrated into the standard and legal track.

In June 2003, the Ministry of Health issued the *Notification of the Ministry of Health on Problems Concerning the Construction of National Public Health Information System* which clearly defines the target and focus of the construction of the national public health information system of which the construction of network direct report system involves the construction of basic network of the national public health information system and the construction of epidemic and public health emergency surveillance system. In January 1, 2004 the legal network surveillance and report system for notifiable infectious diseases began to be introduced on a trial basis across the country and was officially put into use on a nationwide scale in April 1. This system consists of network systems at five levels for disease surveillance report from township level to the national level and network platforms at three levels from prefecture to national level, thus realizing the real-time report of 37 notifiable infectious diseases. It is required that the individual cases of infectious disease discovered by medical and health institutions should be reported to database of the China CDC so that the data can be reported and updated in time. The database information is managed at various levels and the CDCs at all levels and their corresponding health administrations at the same level are responsible for the information report and feedback. (See Diagram 3).
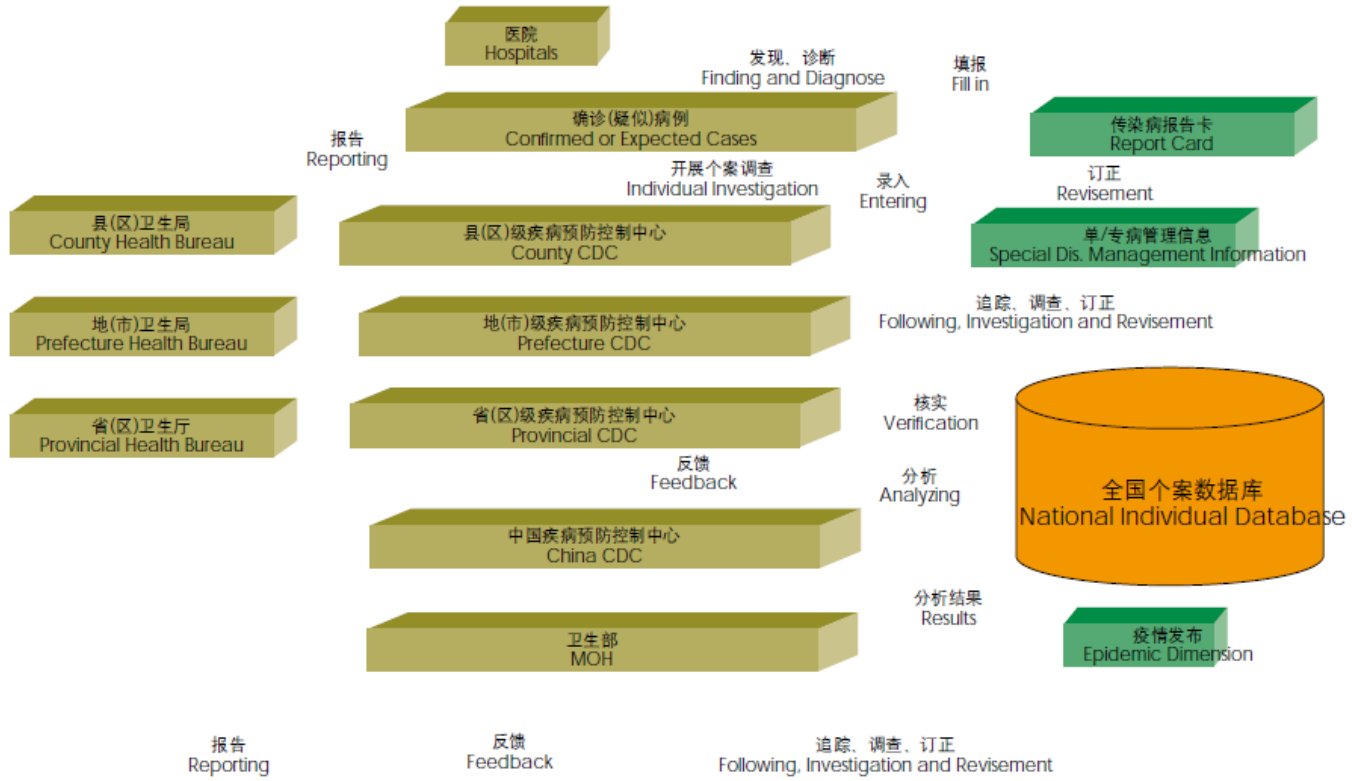
Diagram 3　Information report procedure for notifiable infectious disease in China

The application of the network direct report system has made the infectious disease to be reported in a timelier manner and improved the quality and completeness of the reported data, thus further strengthening its early warning capacity. Since March 2005, China has further integrated its report and surveillance system for special diseases and improved surveillance information on the basis of the original disease report information system. It has also, through the construction of information network platform, further strengthened the capacity and function of the surveillance system, which has laid a solid foundation for early warning. Based on this, China has improved the surveillance of public health emergencies (See Diagram 1), alert and report system, and established the basic response principles with hierarchical management and response. Medical institutions at various levels, disease prevention and control institutions, health supervision institutions and quarantine institutions at exit-entry ports are responsible for carrying out the daily surveillance of public health emergencies.(See Diagram 4 and 5)
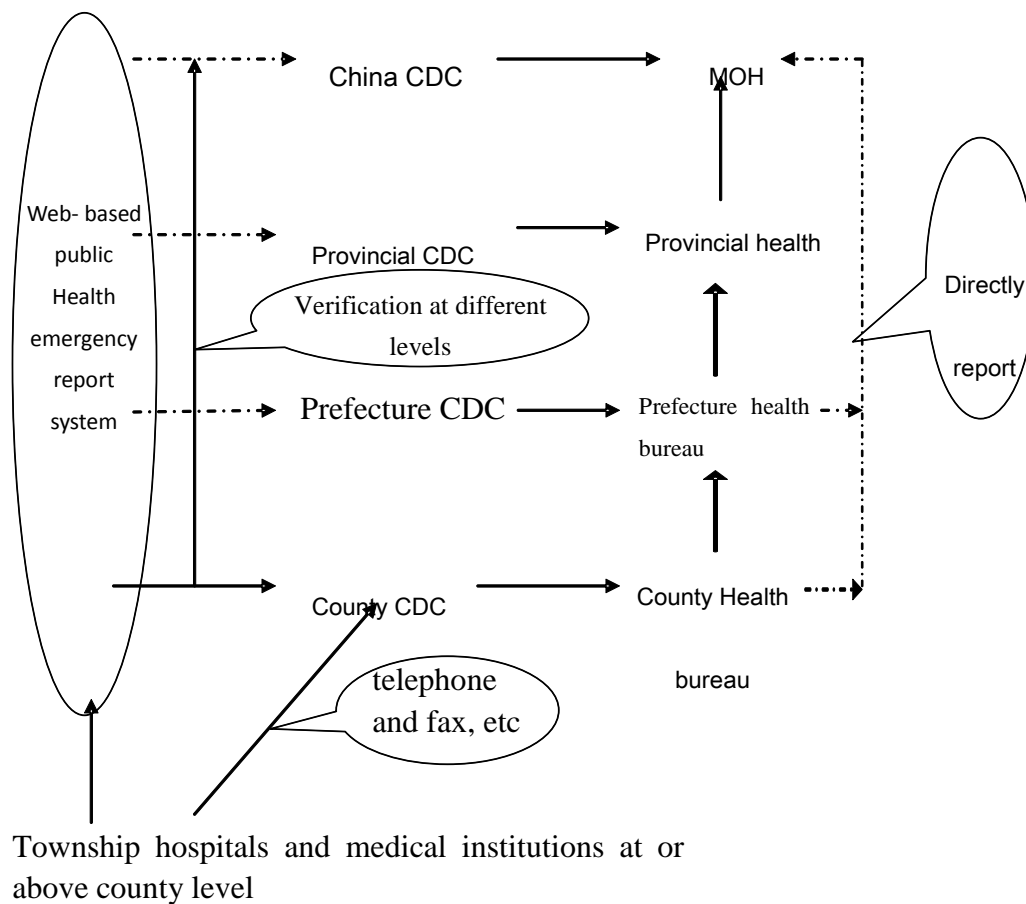
Diagram 4 Sketch-Map for Public Health Emergency Report System in China

(Source: A Handbook of Health Emergency Response)

Table 1 Public Health Emergency Surveillance System in China

Item	Content of Surveillance	Method of Surveillance	Institutions and Individuals in charge of Surveillance
Notifiable infectious diseases	Notifiable infectious diseases	The health administrations under the State Council establish network direct report system for infectious diseases. The system is extended from the existing national, provincial, prefecture and country level to township level and at the same time, from disease control institutions to medical institutions at various levels.	Medical institutions of different kinds and at various levels; the report institutions should be the institutions and individuals authorized by the health administrations.
Health surveillance	Surveillance on occupational health (for example, occupational diseases, workplace), radiation health (for example, radioactive source), food health (for example, food and food-borne diseases), environmental health (for example, water-source pollution, environment of public places), social factors and behavioral factors, etc.	The health administrations under the State Council set up sentinel sites for surveillance across the country in a scientific and rational manner according to the demand of surveillance in various professional fields and the surveillance units must conduct surveillance according to the surveillance plans prescribed by the State.	Medical institutions and disease control and prevention institutions authorized by health administrations
Disease and symptom surveillance	Mainly focus on the surveillance on some serious infectious diseases, diseases of unknown reasons as well as diseases that will	Establish surveillance sentinel sites in designated general hospitals of big and medium-sized cities	Medical institutions of surveillance sentinel sites designated by the health

	possibly cause outbreak and wide spread and relevant symptoms.		administrations
Laboratory surveillance	Pathogen of serious infectious diseases, vectors spreading diseases, drug-resistance of bacterial strain and poisonous and toxic materials in the environment, etc.	Establish laboratory surveillance networks in disease control and prevention institutions and designated medical institutions above the prefecture level to carry out relevant surveillance and report the result to disease and prevention institutions at a higher level in time.	Disease control and prevention institutions and relevant medical institutions above the prefecture level
Frontier health quarantine surveillance	Overseas infectious disease, vectors spreading diseases, epidemic-infected animals and polluted foods, etc.	Establish surveillance sites in entry and exit ports and connect the surveillance information with the national disease surveillance information network	Technical institutions designated by the General Administration of Quality Supervision, Inspection and Quarantine of the PRC.
Report phone number at the national level	A unified telephone number for report is set by the State, serving as a channel for information collection linked to the national health information network.	Report	the public

National command centre for public health emergency response

Technical support

| National agency | MOH Command Centre | Relevant department of the State Council | Particularly Serious |

Provincial Command Centre

| Provincial level | Provincial health administration | Relevant department of the Provincial People's Government | Serious |

Prefecture People's Government (or corresponding institution)

| Prefecture level | Prefecture health administration | Relevant department of the Prefecture People's Government | Relative serious |

County People's Government (or corresponding institution)

| County level agency | County Health administration | Relevant department of the County People's Government | General |

→ Leader or professional guidance   ◄┄┄► Cooperation
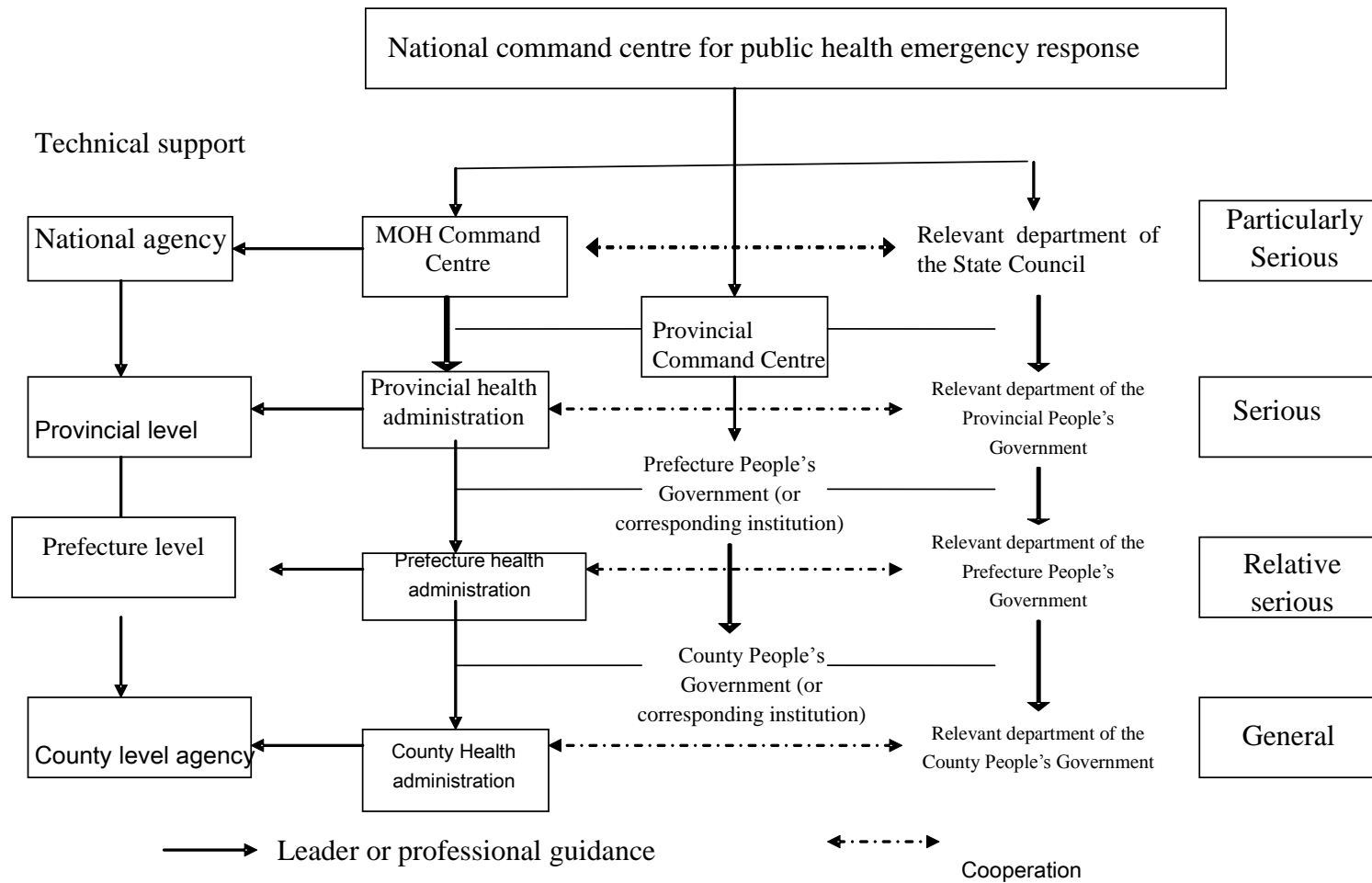
Diagram 5 Frameworks for Public Health Emergency Response System in China

(From *A Handbook of Health Emergency Response*)

As an emergency commanding agency, the Ministry of Health, under the leadership of the State Council, is responsible for organizing and coordinating the public health emergency response efforts across the nation and proposing to the State Council to establish the national command centre for public health emergency response according to the demand. Health administrations under the local governments at various levels, under the leadership of the government at the relevant level, are responsible for organizing and coordinating the emergency response efforts within the areas under their jurisdiction, and proposing to the government to establish the command centre for public health emergency response according to their demand. A health emergency response office (Command Centre for Public Health Emergency Response) should be established by the health administrations under the State Council, responsible for the daily management of public health emergency response.

The medical and health institutions are under the command and arrangement of health administrations and take emergency response actions after the occurrence of a public health emergency. They are mainly responsible for the on-site rescue, transportation, diagnosis and treatment of patients as well as infection control within hospitals, sample collection and cooperation in epidemiological investigation into the patients. The disease control and prevention institutions are responsible for reporting public health emergencies, field epidemiological investigation and treatment, rapid on-site surveillance and laboratory surveillance on the cause of disease, as well as disease and health surveillance. Health supervision institutions are responsible for assisting the local health administrations to conduct health supervision and law enforcement and inspection on food hygiene, environment sanitation and the disease report, medical treatment and rescue, prevention and treatment of infectious disease conducted by the medical and health institutions. Other institutions like exit-entry inspection and quarantine institutions are mainly responsible for health report, temperature monitoring, medical inspection, disease surveillance, epidemic report, the control of patients, disinfection treatment, epidemiological investigation and public education at the exit-entry ports when a public health emergency occurs.

By comparing the public health emergency response systems of China and the U.S., we can find that:

First, both Chinese and U.S. governments take the effective response to public health emergencies and maintenance of social public security as one of their important roles. And both governments are actively exploring a most effective emergency

response system suitable to their own country so as to upgrade their emergency response capacities through reform and innovation of their response management systems.

Second, both of them have basically realized the integration of health emergency response resources and have changed their previous approach that a single department is responsible for a single disaster to the present one that a more powerful comprehensive department at a higher level is in charge of the response to various public health emergencies.

Third, to develop health emergency prevention and response capacity of the whole society has become an important task for the government. Given that it's difficult to predict when and where a public health emergency may happen on many occasions, all sectors of the society should be mobilized to respond to emergencies instead of only relying on the government, and it's also important to enable the public to have a strong capacity to respond.

The supply of emergency response resources should be put in place so that there is a good preparedness for emergencies. The improvement of response capacity rely on the safeguard of response resources including high quality human resources, advanced emergency and rescue equipment and highly reliable emergency response technologies which are indispensible.

Fifth, attention should be paid to emergency response research and talent trainings, as well as the improvement of relevant laws so as to "respond to emergencies according to the law".

3 Public Health Emergency Response Capacity

3.1 Capacity and Capacity Building

According to the suggestion of the United Nations Development Programme (UNDP), capacity is the ability of individuals and organizations or units to perform functions effectively, efficiently or sustainably. Capacity at a broad sense can be divided into such three levels as system (or environment and society), organization (or institution) and individual levels, and there're basic requirements and core functions at each level. Capacity building is a process to discover problems, improve systems and upgrade capacity through assessment.

Individual level: emphasizes the improvement and consolidation of an

individual's knowledge and skills. The process of capacity building is also a process of acquiring and adopting new knowledge and improving the skills of an individual.

Institute level: emphasizes the improvement of the existing institutions and organizational framework. According to UNDP, the best way to improve capacity at the institute level is to optimize the internal structure of the existing system and institution and improve the existing policies, system structure and management effect as well as preparedness and response capacity by taking effective measures.

System (social) Level: refers to developing and improving public management capacity so as to improve its corresponding capacity and accountability system. The building of comprehensive capacity of the society should focus on improving the interactivity of public management so that it can gain experience from previous actions and receive feedback and other related information from people and society.

3.2 Public Health Emergency Response Capacity and Capacity Building
3.2.1 Core Capacities

As a comprehensive capacity of responding to public health emergencies, public health emergency response capacity is the combination of elements possessed by an institution which enable it to fulfill the task of responding to public health emergencies. The content of emergency response capacity depends on the functions and demands of the response system. Currently, various international organizations and countries have put forward different basic frameworks and components of emergency response capacity in accordance with their own functions, the characteristics of public health emergencies within the region, and the purpose of the response systems.

According to the newly revised IHR in 2005, all member states should use their domestic health system and resources to complete the building of 8 core capacities, including the State legislation, policy and financing capacities and coordination capacity as well as the communication, surveillance, emergency response, risk communication, human resources and laboratory capacities of the relevant departments of the State. Moreover, the IHR also proposed specific core capacity building according to the functions and characteristics of a country's sea ports, airports and land ports, involving the capacities that should be possessed under normal conditions and the ones in time of emergencies (see Table 2). In 2005, the World Health Organization Western Pacific Regional Office worked out the

Asia-Pacific Strategy for Emerging Diseases (APSED) which proposed that priority should be given to capacity building in such fields as surveillance and response, laboratory, zoonosis, infection control and risk exchange etc., aiming to upgrade the capacity of a country in infectious disease prevention and control. In 2010, the plan for capacity building during the second period from 2011 to 2015 was put forward on the basis of APSED, extending its coverage from previous prevention and control of emerging diseases to public health emergencies and adding three priority areas of capacity building, namely, public health emergency response and preparedness (at the state level) and regional preparedness, alert and response, as well as supervision and assessment, to the previous fields of capacity building. (See Table 2)

State/Local public health preparedness and response capacity inventory is an assessment tool developed by the CDC of the U.S., specially aiming to assess the public health preparedness and implementation of response programs for biological terrors. Taking the local public health institutions as its targets, it focuses on the assessment of six capacities, including public health emergency plans and preparedness, surveillance and epidemiological capacity, laboratory capacity, alert network/communication and information technology, risk communication and information release, as well as education and training. Public Health Performance Assessment – Emergency Preparedness is a tool developed by CDC of the U.S. together with other public health departments, mainly focusing on assessment of preparedness for biological, chemical and nuclear radiation emergencies. It combines the disaster assessment inventory issued by FBI and the risk, capacity and demand assessment inventory issued by the U.S. Court and it consists of two parts. The first part consists of 20 comprehensive capacity assessment indicators, while the assessment in the second part focuses on the 10 basic functions of public health. This questionnaire is jointly filled out by all the local departments responsible for public health emergencies (including public health institutions, hospitals, emergency department and fire department, etc.). Apart from this, there are other assessment questionnaires such as the State Capability Assessment for Readiness (CAR) and Hospital Capability Assessment for Readiness (HCAR), as well as the emergency response capacity components in the guide to commonly used capacity assessment or capacity building developed by the U.S. (see Table 3).

Table 2 Relevant Contents of Core Capacity Building within Emergency Response System Issued by WHO

Documents	IHR	APSED(2005)	APSED(2010)
Organizations of issuance	WHO	WHO Western Pacific Regional Office	West Pacific Region Office of WHO
Core capacities	**At the state level**： (1) State legislation, policy and financing capacities (2) Coordination capacity and communication capacity of the coordination units of the State (3) Surveillance capacity (4) Response capacity (5) Emergency preparedness capacity (6) Risk communication capacity (7) Human resources capacity (8) Laboratory capacity **Core Capacities of seaports, airports and land ports:** (1) Possessed at any time: assessment and medical diagnosis and treatment, personnel and equipment; equipment and personnel transporting patients; trained personnel examining transportation tools, safeguard of safety environment, and trained personnel and plan for infectious disease (2) Targeted at emergencies: public health emergency plan, adoption of suggested measures to conduct deinsectization and sterilization on luggage and goods.	(1) Surveillance and response (2) Laboratory (3) Zoonosis (4) Infection control (5) Risk communication	(1) Surveillance, risk assessment and response (2) Laboratory (3) Zoonosis (4) Infection prevention and control (5) Risk communication (6) public health emergency preparedness (7) Regional preparedness, alert and response (8) Supervision and assessment
Implementation Period	2005-2012	2006-2010	2011-2015

Table 3 Major Items of Capacity Assessment Inventory Commonly Used in the U.S. (Components of Emergency Response Capacity)

No.	Assessment items	Assessment tools*				
		CAR	State	Performance	ECA	HCAR
1	Laws and regulations	√		√	√	
2	Risk identification and assessment	√				√
3	Risk alleviation	√				
4	Resources management	√				√
5	Emergency plan	√	√			√
6	Command, control and coordination	√				√
7	Information communication and alert	√				√
8	Implementation steps	√				√
9	Logistics and facilities	√				√
10	Training and exercise	√	√			√
11	Assessment and improvement	√				√
12	Crisis communication, public education and information	√	√			
13	Finance and Management	√				
14	Surveillance and epidemiological capacity		√	√	√	
15	Laboratory capacity		√			
16	Health education			√	√	
17	Social mobilization			√	√	
18	Development plan			√	√	
19	Health services			√	√	
20	Public health team			√	√	
21	Assessment of accessibility and quality of public services			√	√	
22	Innovative research			√	√	
23	Leadership					√

* CAR：State capability assessment for readiness

State：State/Local public health preparedness and response capacity inventory

Performance：Public Health Performance Assessment – Emergency Preparedness

ECA：The Council of State and Territorial Epidemiologists (CSTE) Epidemiology

Capacity Assessment (ECA)

HCAR：Hospital capability assessment for readiness

3.2.2 Emergency Response Capacity Building

According to IHR and APSED, capacity building should be carried out at various levels such as individual, institute and system levels. At present, the commonly used capacity building models in the world are:

(1) Potter's Model

Potter's model puts stress on reform and improvement of the existing system by making good use of resources so as to upgrade the capacity of the system and optimize its performance.
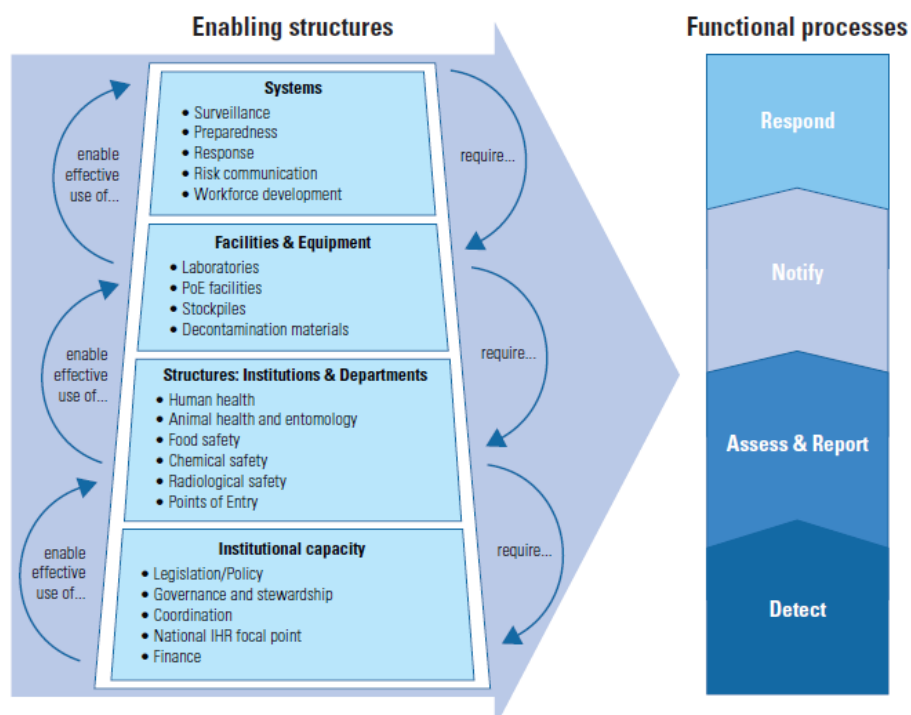
Diagram 6 Framework of Potter's model on improvement of core capacity building suggested by IHR

(Source：WHO. Checklist and Indicators for Monitoring Progress in the Development of IHR Core Capacities in States Parties. WHO/HSE/IHR/2010.1.Rev.1)

(2) Ripple's Model

Ripple's model stresses that capacity building is a gradual process covering the occurrence and development of a public health emergency, hence various aspects should be taken into consideration such as inputs, outputs, outcomes and impacts and

the individual, institutional and system capacities should be strengthened.

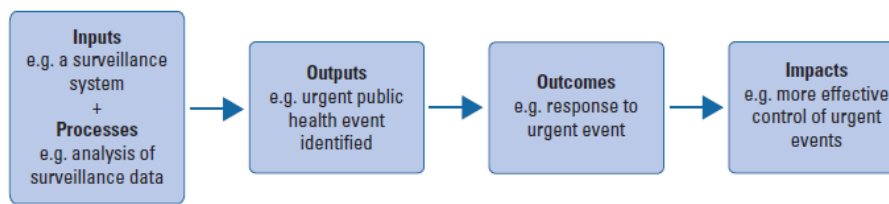**Diagram 7 Framework of Ripple's Model suggested by IHR on improvement of capacity building**

(Source：WHO. Checklist and Indicators for Monitoring Progress in the Development

of IHR Core Capacities in States Parties. WHO/HSE/IHR/2010.1.Rev.1)

(3) Haddon's Theory and Crisis Management Model

According to the crisis management experts such as Birch and Guth, crisis can be regarded as the following three cycles: pre-crisis phase, crisis phase and post-crisis phase. Therefore, the corresponding response strategy for public health emergencies should also involve pre-event, crisis phase and consequence phase. Being originally used in intervention and prevention of traffic injuries, Haddon's Model adopts the idea of polyetiological theory in modern epidemiology to explain the reasons for occurrence of injuries and it also uses the three-grade prevention strategy to control the occurrence of injuries. According to the Haddon's Model, pre-event strategy should include: risk assessment, risk information communication and first-grade prevention strategy; the intervention activities during the crisis phase should include: risk information communication and transmission, establishment of multi-department cooperation mechanism, and medical intervention (such as post-exposure prevention and treatment, consultancy and persuasion on psychological injuries caused by crisis as well as separation and blockade of the community, etc.); and measures during the consequence phase should include: treatment of biological and psychological injuries and complication caused by the crisis, continuous effort in risk information communication, surveillance and recovery efforts after the "disaster"(see Diagram 8). This article will explain the specific contents of capacity building by centering on demand and requirement for capacity of various functional departments of the emergency response system during the whole process of crisis development.
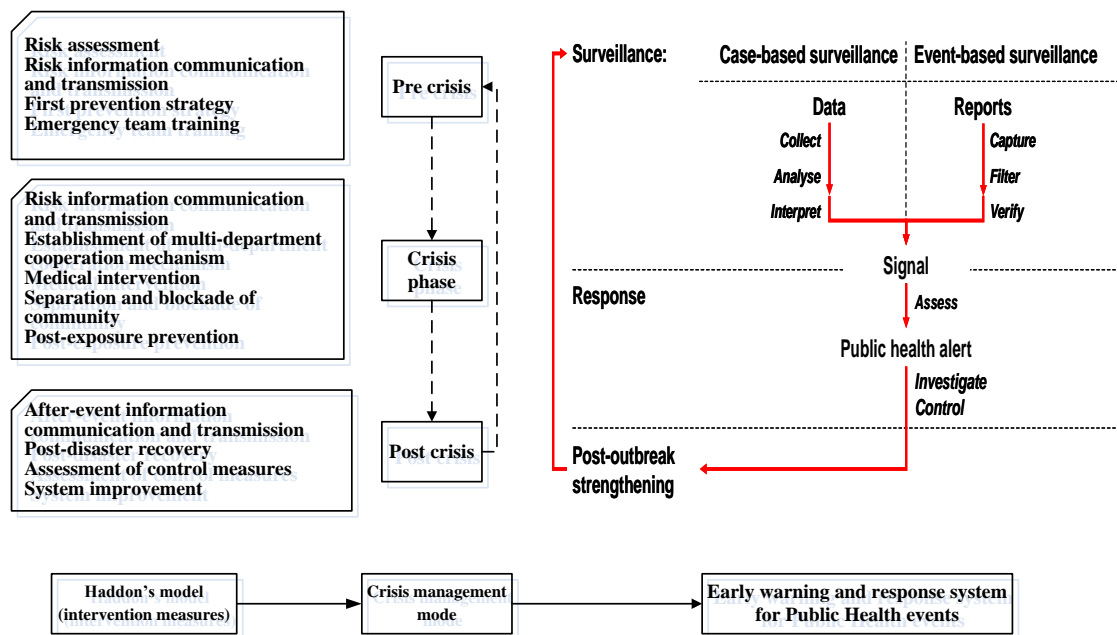
Diagram 8 Haddon's theory, crisis management model and public health emergency response system

3.2.3 Method of Capacity Builing

While capacity building is the core in the construction of an emergency response system, capacity assessment serves as the means of capacity building because it can provide baseline information for system construction, help to understand demand and identify the disconnection between the core system and assistant systems so as to provide information for decision-making.

(1) Basic requirements for capacity assessment

The key problem to the assessment of emergency response system is to examine the completeness and compatibility of the major emergency response factors that governments at all levels should have in responding to public health emergencies, including human resources, organizations, institutions, means and resources etc. and to examine the comprehensive capacity of governments to reduce the losses brought about by the event to minimum. According to the guiding scheme on assessment suggested by WHO, capacity assessment should cover all the links of an emergency surveillance and alert system such as the whole framework of institutions, organization system, process and the final output of the system and assessment should be carried out to relevant parts at various levels of core system and support system.

(2) Major contents of capacity building

The emergency response system has a wide coverage and rich content, and it is generally assessed from the following 6 perspectives.

1) Suitability: means whether the programs, policies, emergency plan of the emergency response system are suitable to the social, economic, cultural and health development of the locality and to the existing health policies; whether the goals and measures, and allocation of health resources are feasible in terms of economic and technical support as well as support of public opinions; and based on this, the assessment is conducted to the plans, policies, activities, measures and the relevant structures and their functions to see whether they are reasonable.

2) Adequacy: means whether the programs, policies and plans of the system that are worked out and implemented have clearly defined the key responsibilities and measures and attach adequate importance to them, and ensure adequate allocation of health resources.

3) Progress: refers to the progress of implementing the programs and plans of the system, that is to say, to examine the implementation of the plans and the supply and use of health resources so as to gain experiences and find out deficiencies, raise questions that should gain attention, give feedbacks to the decisions-makers in time and readjust the plans and measures when necessary to endure that the plan can be implemented smoothly.

4) Efficiency: refers to the ratio between the output of relevant work quantities and qualities and the input of health resources (including human resources, materials and money). The purpose of efficiency assessment is to improve work efficiency and management level.

5) Effect: refers to the effects that have been gained or the actual attainment of goals during the implementation process or completion period. The purpose of effect assessment is to make scientific judgment on the implementation.

6) Impact: refers to the impact of the implementation of plan on social, economic and health development and the people's health, or the sustainability of the effects.

4 APEC Capacity Building Framework for Public Health Emergency Response

4.1 Objectives

The objectives are to improve the emergency control and prevention measures of APEC members, strengthen the joint prevention and control capacity of the world (Asia-Pacific region), and reduce the impact of public health emergencies on people's health, national economy and social security.

The specific targets are as follows:

(1) To provide guidance to the member states or areas within the region to improve the mechanism, institutional and legal construction of their emergency response systems;

(2) To reduce public health risks within the region;

(3) To strengthen the capacity of identifying public health emergencies at an early age;

(4) To strengthen the capacity of rapid readiness and preparedness for public health emergencies;

(5) To improve the stockpile capacity for public health emergencies;

(6) To strengthen the capacity of cooperation in the region and the world at large.

4.2 Principles and Core Contents

According to the definitions of capacity building given by IHR, APSED and the existing commonly used capacity assessment tools, this Guide elaborates on the core contents of capacity building from the following 10 aspects, aiming at achieving the building of core capacities required by IHR and APSED.

(1) Policies, laws and regulations

To integrate emergency management into the legal system will help to create a legal support environment for emergency response measures by ensuring the legitimacy and effectiveness of these measures so as to control and prevent public health emergencies effectively and at the same time reduce the cost of crisis to minimum. Therefore, to work out the legislation strategy for public health emergencies, gradually implement the emergency legislation plan and bring the emergency response under the rule of law will be very important in both theory and

practice to the improvement of health quality of the whole society and people's health.

(2) Surveillance

Surveillance refers to the continuous and systematic collection, analysis and explanation of data, and the close integration and release of these dispersed data to the people who need them so that they can take actions and reduce the incidence of the disease and death rate. By long-term and continuous collection of information, the surveillance system gets the regular fluctuation range of relevant indicators. The information collected is analyzed and compared with the baseline information and when it is above the prescribed warning line or threshold, it will be reported to the relevant departments. It is designed to identify the possibility and degree of seriousness of the danger that the event will bring about and issue alerts of different degrees to the relevant departments according to the grades of different warning degrees so as to take quick, timely and proper measures of prevention and control.

As a comprehensive project, surveillance is closely related to the local economic conditions, professional quality of disease control personnel and laboratory capacity, etc. A well-established surveillance system can achieve the goal of identifying public health emergencies at an early period through risk assessment and it should be assisted by a rapid early warning system to achieve sensitive and rapid alert and response. Governments of all member states should guarantee the establishment and improvement of the surveillance system by laws, regulations or administrative means and make clear the structure and functions of its subsystems.

(3) Response

The emergency command, risk communication and rapid response mechanism is the key to handling and controlling emergencies. So, all the member states or areas should establish a steady rapid response team with the cooperation of various departments, which is ready to give response in 24 hours of each day.

(4) Emergency Preparedness

A public health emergency is always complicated and changeable, and it's difficult to predict when and where it will happen and what kind of emergency it will be. Moreover, once it occurs, it will spread rapidly and cause great casualties and economic losses. Therefore, full preparation is the basis for emergency response efforts. Health departments at all levels and relevant institutions should make a great effort to work out and improve their emergency plans, make a full preparation in human resources and materials and carry out relevant training and exercise by

following the principle of "prevention first " and "being always on alert".

(5) Risk communication

Risk communication serves as a bridge to help the public keep rational in face of an emergency, and it is one of the most important ways of implementing risk management. The U.S. National Academy of Sciences defined risk communication as "an interactive process of exchange of information and opinion among individuals, groups and institutions", and it involves multi-dimensional natures of the risk and the relevant information and it not only directly transfer the risk-related information, but also includes expression of the attention, opinion and relevant response to the risk event, or the publication of the laws and regulations of a country or institution in risk management. Therefore, whether the relevant government departments can effectively transfer the information to the public and help them establish rational perception of risk and give proper psychological and behavioral responses has become the key to the establishment of the alert system. The U.S. Department of Health and Human Services defined government risk communication as that the government department publishes correct, timely and necessary information on the event which will possibly occur or has occurred and affected public security, to the public, media and stake-holders with the aim to inform them the potential risks and the measures to avoid risks and help them make favorable choices when they are faced with losses and injuries.

Since Crisis evolvement covers such phrases as pre-event, starting phase, crisis phase, solution phase and assessment phase, the government should provide different information for the public in different phases, trying to predict and satisfy the information demands of the public, the media and the stakeholders in different phases.

(1) Human resources

Since emergency response talent team is the mainstay of an emergency response system, team construction is the key to upgrading the level of emergency response and should cover the relevant departments at all levels of the whole emergency response system.

Construction of human resources is in fact the improvement of the staff's knowledge structure and upgrading of an individual's capacity. Member states and areas within the region should, in accordance with the special conditions of emergency response in their own country or area, develop human resources for emergency response and establish their emergency response talent teams with high

quality, optimized structure, appropriate scale, reasonable distribution as well as both full-time and part-time staff so as to provide effective support for the response effort.

(2) Laboratory

Biological events take a large proportion in public health emergencies and microbiological labs play an important role in emergency response by providing scientific basis for identification of pathogens, field investigation and adoption of effective measures of administrative control.

In accordance with the emergency surveillance, the need of emergency control and prevention and the serious situation in biological and chemical safety, a laboratory response network system should be established with the support of public health expert institutions, scientific research institutions both at home and abroad and military institutions so as to carry out lab tests in emergency disposal.

(1) Supervision and assessment capacity

Supervision means following the track of activities adopted by the system, including the whole process of material collection and transmission, report, analysis, feedback and emergency response, so as to ensure that the system can strictly implement the plan, complete the tasks prescribed by the plan effectively and ensure the relevant input and output.

Assessment means the comprehensive assessment on the various systems (including information system, advisory system, command system, implementation system, safeguards system, support system and surveillance system, etc.) that have participated in emergency response and control, the development process and final result of the event. It is carried out after the emergency is brought under control and it includes the collection of opinions on the result of response, establishment of assessment criteria, selection of assessment methods, implementation of rewards and punishment and the utilization of assessment results.

The supervision and assessment of different events should be done by expert teams in different professions and at different levels.

(2) Regional cooperation

The globalization of public health emergencies such as infectious diseases calls for international cooperation in the field of health. Since the capacity building for public health emergency response is a long-term and difficult task, continuous efforts and close cooperation of international community are needed to further promote international cooperation in control and prevention of emerging infectious diseases

and strengthen the technological cooperation and assistance in control and prevention between various economies.

(3) Scientific research capacity

Scientific research on emergency response is a powerful support for the improvement of emergency response effort, so the building of research capacity should be focused on such areas as surveillance, early warning and rapid response capacities.

5 The APEC's guides for building public health emergency capacity

5.1 Construction of policies, laws and regulations

Being the legal guarantee for the governments to handle the emergent public health risks, the legal system for public health emergencies emphasizes the governments' ability to make rapid and effective responses to the latent or already happened public health emergencies. It increases the government's consciousness of their responsibility and strengthens their power for unified command. A complete legal system will ensure the establishment and improvement of the surveillance system over public health emergencies, promote the information communication among different nations, regions, departments and medical institutions, and help to regulate who is responsible for reporting, what to report, how to report and when. Employing legal means in public heath will help to investigate the legal liability of government and relevant departments, thus promoting the emergency preparedness for and response to public health risks.

The laws and regulations should support different types of emergency treatments, treatment procedures and the technical prevention and control measures. When making the independent legal system for public heath, the following three factors need to be considered.

(1) Are there enough laws and regulations about public health? Is there a hierarchical structure or close connection among the law and regulations?

(2) Is there inconsistency among the different types of laws and regulations about public health?

(3) Does the legal system for public health meet the requirements of social development?

5.2 Surveillance

In order to ensure the rapid and appropriate response to an effective treatment of public health emergencies, the public health surveillance system should lay stress on information system, risk assessment and early warning ability.

5.2.1 Information system

As the symbol of social informatization, information system construction is the fundamental work in modern society. The advantage of the network in speed, space and two-way communication decides its promptness, extensiveness and novelty in information communication. Establishing public health information networks, accelerating the development of information infrastructure and improving the information analysis, prediction and research are essential to the rapid and effective responses to public health emergencies. The comprehensive network information platform should include information system, data analysis system, data storage management system, early warning and information communication system, and emergency response and treatment system.

As the means to implement the emergency plan, the emergency information system, also known as emergency information platform, is based on the advanced information technologies and systems, such as the Global Positioning System (GPS), the Remote Sensing and Telemetry (RS) and the teleconference system, thus realizing the multi-network integration of the emergency information resources. It needs to do the risk assessment, surveillance and control, prediction and early warning, coordination, integrated emergency response, and overall evaluation. The emergency information system of public health risks is composed of information retrieval subsystem, intelligent emergency subsystem and decision-making and command subsystem, among which intelligent emergency subsystem includes database, model base, plan base and decision-making base. The database contains fundamental geographic information and public security data; the model base includes such models as the information identification and extraction, the process and consequences of the events, crowd evacuation and warning grading; the plan base contains plans for the possible emergencies and risks; the decision-making base is the intelligent man-machine system supporting the decision-making activities. Collecting and analyzing all the information endangering the surveillance network, the emergency information system will estimate what poses the threat, and the scale and degree of the harm. When the essential data are ready, the system will promptly send the

warning to the parties concerned. The widely-distributed surveillance points in the system will update the information timely.

The basic framework of network information platform includes the network supporting platform, the application supporting platform and the application software, among which, the network supporting platform includes server, storage system, network equipments and communication links, the application supporting platform operating system, database, network security system, workflow engine, data exchange engine and middleware, the application software the customization subsystem supporting the above functions. The network information platform usually has the following functions:

(1) Information collection

Because of the suddenness of the emergencies, the sensibility of the system can only be improved through the multi channel information collection and the comparison of the integrated information from independent but complementary data sources. If some unconventional specific signals simultaneously appear in several surveillance systems, the emergency is highly possible.

A good information system will be formed by integrating data from various sources: some utilize the existing data, some collect new data, some make use of traditional database, some draw data from unconventional data sources. The integration can put more groups under surveillance. The data sources may be:

1) Case-based surveillance: Survey the morbidity and mortality of the target disease;

2) Event-base surveillance: Survey the events related to human and animal diseases, food, water, and environment pollution, like the sales surveillance of drugs and medical items, the absence surveillance of primary and secondary school students, the animals and medium surveillance, the environment surveillance, the climate surveillance, the hydrology surveillance, the social help hotline surveillance;

3) Information from non-professional sources: Related information about the target event from relevant departments, mass media, general public, international organizations and non-government organizations, and research institutions.

When collecting information about public health emergencies, it is required to: 1) continuously and systematically collect, analyze and explain the relevant public health information, including the emergency itself, and then issue the warning about the public health emergency to make the decision-makers and first responders well

informed; 2) systematically collect, analyze and explain the health-threatening information, other negative influence and the effect of intervention during the emergency, and then issue the analysis results and the explanation; 3) continue to systematically collect the related information after the emergency to assess the intervening measures and adjust the polices and strategies on public health, thus offering a better service.

(2) Data analysis

The key point of routine surveillance information analysis is how to identify the outbreak of possible public health emergencies. In addition to the analysis and statistical description of routine data, an integrated analysis of the automatic surveillance data is essential. In the construction of health emergency system, a variety of analytical model defining should be provided to ensure the timely and appropriate analysis of statistical reports, charts and geographic information system.

Public opinion is another important source of emergency information. The analysis of public opinions refers to the process of processing and analyzing the public opinions about the emergencies, and then drawing the conclusion. As to the impact of public opinions, the concerns over public interests and the impact on the reputation of public sectors, the following factors needs to be considered when analyzing public opinions: the event; public opinions and feelings; which state the masses are, perceiving and opinions expressing or acting; the degree of systematization and the presence or absence of plans for the movement; caution against political interpretation and the analysis of obvious interest appeal; if there is great impact on the existing social system; what is the target of the movement, some departments or the existing system. The analysts of public opinions should be "non-participating observers", not "non-observing participants". They need to remain neutral but also be very observant.

(3) The information system of emergency response

There are three kinds of users of the information system of public health emergency response: the government (usually the temporary or permanent emergency response centers), the public and functional departments. When collecting information on the spot, the staff members from different departments should report the information to the superior departments to make them well informed of the changes of the emergency. Meanwhile, with the rigorous logical calculus and numerical analysis provided by the emergency response centers and also the analysis and assessment by

the government leaders and experts, the government can promptly announce wise decisions on emergency response.

5.2.2 Risk assessment and early warning ability

Risk assessment refers to the quantitative evaluation of the impact on and damage to people's life and property of the emergency in the pre-event and crisis phase, but not in the consequence phase. After calculating and identifying the occurrence probability and potential consequence of the risk, the outcome of the risk assessment can help to decide the risk level, which threats needs controlling and how (Fig. 9). As one of the key links in risk management, risk assessment is usually applied in guiding risk response. According to the course of the event, risk assessment can be classified into pre-event assessment, in-event assessment and post-event assessment.

The risk assessment of public health emergencies could help to guard against the threat to the public health and prevent the emergencies. In the emergency management of public health risks, by analyzing the cause, process and consequences of the event, the risk assessment can effectively collect and integrate the related information from all quarters of the society. Then, the public health emergencies can be promptly responded and effectively controlled, thus reducing the damage and optimizing the decision-making. In addition, the risk assessment of public health emergencies means the emergency management changes its focus from mainly on event management to on both event and risk management, which will improve both the emergency management and the emergency response capability.
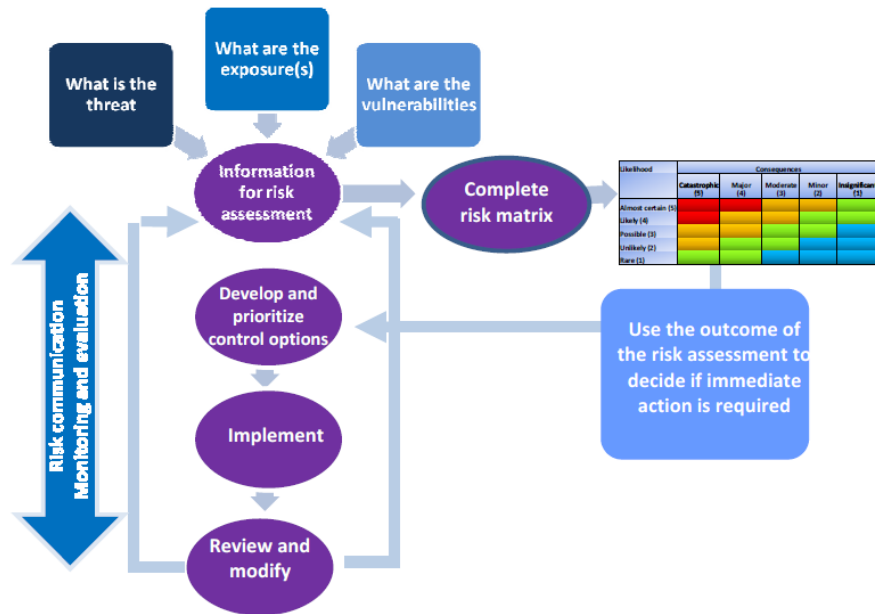
Diagram 9 Basic procedure of risk assessment and assessment model

(Sources：WHO. Outbreak Communication: Best practices for communicating with

the public during an outbreak:

http://www.who.int/csr/resources/publications/WHO_CDS_2005_32web.pdf)

(1) The basic requirements and procedure of risk assessment

Risk assessment requires the forecast, identification, analysis and evaluation of the possible risks. With the information provided, the risks can be effectively controlled, thus providing the best safety guarantee at the lowest cost. Doing risk assessment involves the following six steps:

1) Plan and preparation: to decide the scope, target, aim and principle of the risk assessment.

2) Risk analysis: to identify the sources of risk, to analyze the risk tolerance and control ability, and to find the potential risks and the causes, which will lay the foundation for the assessment of risk probability and risk consequences.

3) Risk probability assessment: to decide the likelihood of occurrence of the public health risks by the analysis of the risk sources, the risk tolerance and the control ability.

4) Risk consequence assessment: to decide the level of risk consequences, this is very crucial to the emergency response. The comprehensiveness, accuracy and objectiveness of risk consequence assessment decide the accuracy of risk grading.

5) Risk grading: to grade the risks on the basis of risk probability and risk

consequence assessment, and then to decide the index system and the priority of risk management, including which risks to control and which to accept.

6) Measures for risk control: based on the results of risk analysis, to study the best management plans and put forward the measures to minimize the harm of the risks.

(2) The means of risk assessment

The common means of risk assessment for public health emergencies include risk loss listing, field survey, flow chart, cause-and-effect diagram, fault tree analysis, scenarios analysis, brainstorming, Delphi Method, etc.

1) Risk loss listing: to work out the losses and list all possible sources of risks.

2) Field survey: to survey the possible losses and issue a report.

3) Flow chart: to draw a flow chart of the risk subject according to the process of production and management and the logic of daily routines, and to survey the key link and weak link in the chart to find the potential risks.

4) Cause-and-effect diagram (also fishbone diagram): to place the risk event at the main bone of the risk analysis and classify the causes into different types and subtypes, forming a fishbone like diagram.

5) Fault tree analysis: to find out the cause of the event through logic reasoning, starting from the event itself.

6) Scenarios analysis: to analyze the risks and consequences when the factors and conditions causing the risk change. This method is used to identify the key factors and their impact. A scenario is the graphic description of the future state of an event or organization. The scenario analysis can describe the future state as well as the future changing process of the event.

When the risk factors and the risks cannot be evaluated quantitatively, the risk matrix can be applied to qualitatively analyze the factors and risks. When drawing the risk matrix, the risk assessment team can list, compare and analyze all the possible damages (Fig. 10). In addition, the risk matrix can be employed to analyze the situations before and after the implementation of the regulatory measures。
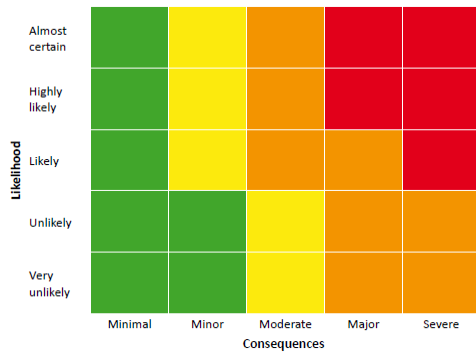
Diagram 10-a Risk Matrix (with boundary)
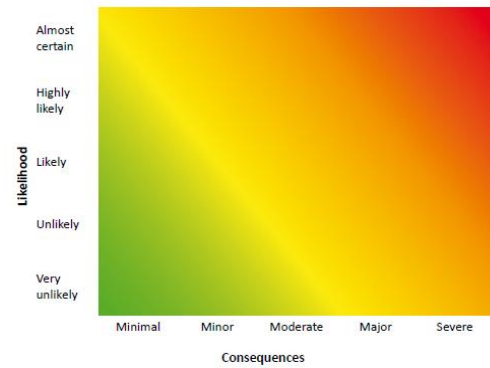
Diagram 10-b Risk Matrix (without boundary)

(3) Early warning management

Based on the comprehensive evaluation of the collected information and factors, a warning will be issued in advance to the endangered area and the early warning actions will be carried out accordingly to prevent its occurrence. The early warning index and threshold will be defined on the basis of the name, type, scope, impact and epidemic features of the public health emergency.

5.3 Response

Prompt and effective response is the key to minimize the damage and impact of public health risks. Measures should be taken to improve the response ability on such aspects as the directive and decision-making system, emergency response, response team, protective and processing equipments.

5.3.1 The directive and decision-making system

As the highest authority and decision-making body, the directive and decision-making system will make the decisions, coordinate the activities and monitor the responses to public health emergencies. It is the nerve centre of the emergency response system.

(1) The construction requirements

Practicality, reliability, economical efficiency and advancement are the fundamental principles for the construction of the directive and decision-making system for the emergency response. The requirements are as follows: 1) to adhere to a unified organization and leadership; 2) to construct the system based on the principle of overall layout, gradual implementation, advanced practicality, and suitability for

both peacetime and wartime; 3) to adhere to the openness and standardization and make the best of modern technology. In the software and hardware configuration the "open" and standardized products and techniques should be considered first; 4) to guarantee the safety. The construction of the system must meet the safety requirements to ensure the reliability and safety of the system; 5) to keep track of, get feedback about, update and improve the system to meet the requirements of the productive practice; 6) to perform the construction, training and operation with the purpose of public health emergency response to make the system in work.

(2) The staff in the directive and decision-making system

The system construction involves medical hygiene and information management, so the staff in the directive and decision-making system should consist of leaders and experts from health administrative institutions, medical care institutions, disease control institutions, health supervision institutions, medical research institutions and information management organizations.

(3) The requirements of the system

The basic operating requirements of the directive and decision-making system are: 1) to be able to promptly start the emergency response with an organized operation, timely personnel and material distribution and effective emergency response; 2) to dynamically evaluate, with the feedback, the developing trend of the event and modify the response measures accordingly to minimize the damage and impact; 3) to release the precise data and information in time to help the experts and directive personnel make the right decisions; 4) once the decisions being made, to implement them without any delay and supervise the implementation to put the emergencies under control as soon as possible.

(4) The operating mode of the system

1) The duty system: The 24-hour duty system should be implemented in the response center of public health emergencies, no matter on guard or by phone. Persons should be specially assigned to register and handle the collected information about the events. The job logging includes duty records, fault records and operative plan.

2) Making decisions: During the emergency response, the decisions will be made, the scheme discussed, the nature of the event judged, and measures worked out on the basis of analyzing information about the public health risk and emergency response resources and understanding the "three-dimension" distribution (time, region and

population) of the event and the distribution of the response resources.

3) Directing and managing: The response center will communicate with the spot by means of video conference, telephone, digital documents and text messages, and carry out the operating plan and emergency response plan. The funds, goods and materials, response teams and experts in the area will be allocated, and the instructions of health administrative institutions will be received and issued simultaneously.

4) Response modification: In the process of public health emergency, the response level will be modified in accordance with the plan or administrative instructions.

5) Evaluating: The standard evaluation mechanism and objective evaluation index will be established to evaluate and summarize the response efforts, thus improving the response ability to public health emergencies.
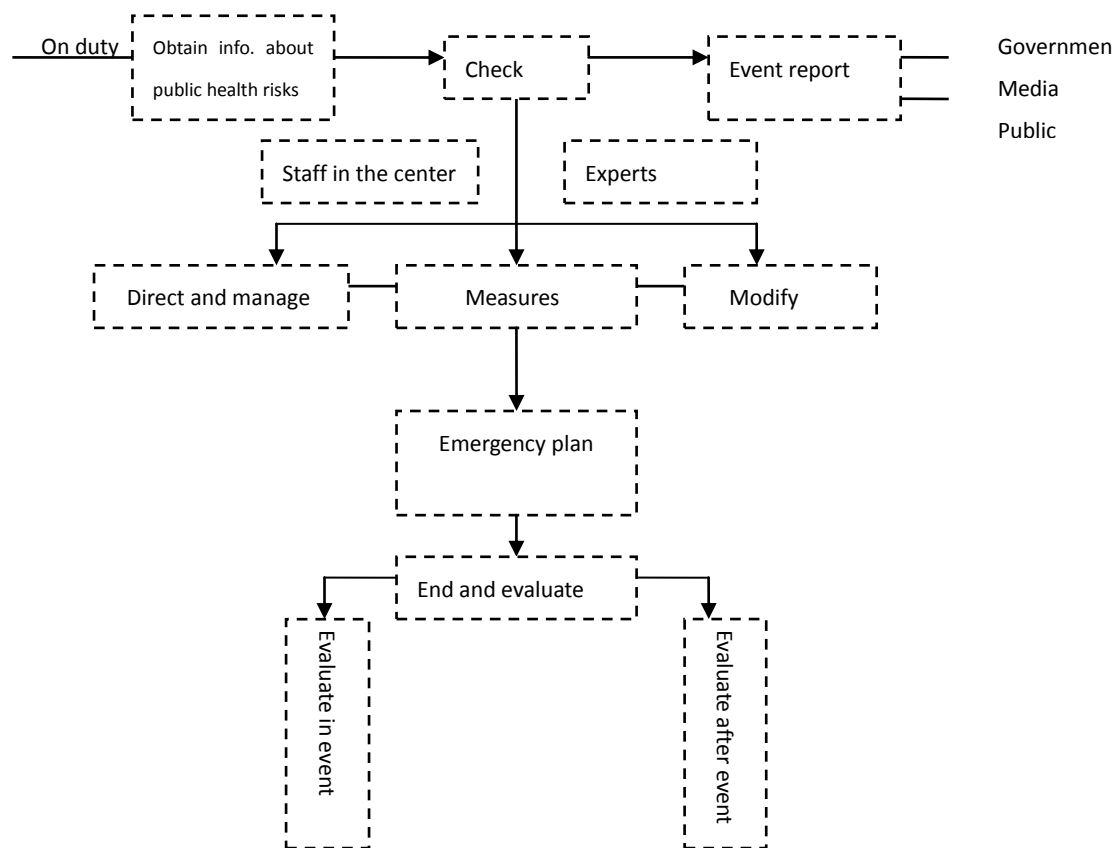

Diagram 11 The operating mode in the directive and decision-making system of emergency response in China

(5) The hardware configuration, information communication and fundamental

duties of the system

Through the information platform, the directive and decision-making system can effectively link up the network system from the top down and interconnect the information to be well informed of public health emergencies and response resources. Based on the health information system, the directive and decision-making information system will adopt such advanced information processing technology and modern management means as the B/S (browser and server) structure, WebGIS, database technology, and SMS interactive platform. The system should also include hardware facilities like the response command center and computer center, as shown in Table 4.

Table 4 the hardware configuration of the directive and decision-making system

Site	Name	Hardware configuration
Command center	Conference system	microphones, audio equipments, projectors, video conference terminals, big screens, televisions, consoles, computers
	Duty system	telephones, fax machines, printers, photocopiers, computers
	Lighting system	tricolor lighting
	Video display system	display screens
Computer center	Computer center	computers, private servers, exchange boards, video conference equipments
	Power system	nonstop power supply(UPS power)。
	Fire alarm system	automatic alarm, manual fire alarm controllers, automatic extinguishers
	Air conditioning and outdoor air system	fresh air system, smoke extraction/exhaust system (constant temperature and humidity precision air conditioning system)
	Light-current	power distribution system for networks, telephones,

	system	UPS system (servers, network equipments and monitoring equipments)
	Premises distributed system	data lines, voice lines, audio and video lines, control lines, etc.

5.3.2 The emergency response

When the public health emergency happens, the appropriate response should be called forth immediately according to the principle of graded response. The developing trend of the event will be predicted based on the nature and features of different events. If the situation and impact continue to get worse, the level of early warning and response should be increased; if the situation and impact is not spreading, the early warning can be cancelled and the level of response lowered. The survey, treatment, rescue and verification should be carried out simultaneously to effectively control the public health emergencies.

Meanwhile, other areas should be well prepared for the emergency response. As soon as receiving the monitors about the emergency, the response team should be organized and goods and materials ready. Under the instruction of the higher administrative departments, the support for the suffering area should be prepared and also measures adopted to prevent the risk from spreading to this area.

5.3.3 Emergency disposal and medical rescue

The emergency disposal for public health risks includes:

(1) To organize and coordinate the relevant departments to take part in public health emergency disposal.

(2) To assemble the personnel, goods and materials, transportations and other facilities for the emergency disposal. The regulations should be strictly observed when involving the management of dangerous chemicals and transportation safety to avoid accidents.

(3) Medical rescue: The timely and effective medical rescue is crucial to prompt treatment of the sick and wounded and to the control of the public health risks. To meet the international trend, a professional Disaster Medical Assistance Team (DMAT) needs to be set up among medical rescue teams to ensure the urgent medical treatment and timely treatment of the sick and injured. When the emergency occurs, the

directive and decision-making system will assemble the medical resources and assign the DMAT in the nearest area to perform the rescue operation in the first time. Arriving in the disaster area, DMAT, during the treatment of the sick and injured, will form such a medical rescue chain as "front medical clinic → urgent medical assistance team and mobile medical clinic →local hospital →rear hospital(teaching hospital)" as soon as possible and establish an integrated medical rescue network for emergency disposal.

(4) To designate the area to be controlled: The appointed administrative departments need to designate the area of the epidemic disease and the area to be controlled, and to enforce the blockade on the basis of the level and type of the emergency and also the essential requirements of the national emergency response.

(5) To adopt regulatory measures: The market, assemblies, theater performances and other gathering activities should be limited or banned. The contaminated public drinking water, food and other goods should be sealed up. The houses, transportations and other facilities might be requisitioned temporarily.

(6) To manage the migrant population: The preventive work will be carried out for the migrant population. Patients of infectious diseases and suspected patients will be isolated, observed and treated, and the close contacts will have medical observation assembled or at home.

(7) To exercise health quarantine on transportation: The temporary health quarantine stations will be set up on traffic sites and entry/exit ports by the railway, transportation, civil aviation and quality control authorities to inspect and quarantine the vehicles, passengers, goods and animals. The patients, suspected patients and close contacts will be temporarily isolated, checked and transferred to the institute appointed by the local health authorities.

(8) To issue the information: When the public health emergency occurs, the information should be issued timely, accurately and objectively to guide the public opinions and achieve the desired social effect.

(9) To carry out the mass prevention and mass treatment: The mass publicity and education of the public health emergency will be carried out to raise the public awareness and prevent the event.

(10) To maintain social stability: The supply of goods will be guaranteed and the prices restrained to prevent panic purchase. Such law violating and public security disturbing deeds as rumor mongering, biding up prices, hoarding and fake goods

making and selling must be severely punished.

The poisoning emergency and nuclear and radiation accidents will be taken as examples to illustrate the emergency disposal.

Example 1: The poisoning emergency

When the poisoning emergency occurs, the on-the-spot directive center for the poisoning response should be set up immediately to organize the experts to draw up the medical disposal plan and to carry out the health emergency response. The basic requirements of the on-the-spot disposal are:

(1) Contact avoidance: The health departments, with the help of public security departments, work safety administrative departments and environment protection departments, will search and rescue the victims, blockade the endangered area and seal up the related materials to prevent future contact.

(2) Medical rescue zone setting: The disaster area with the poison diffusion tendency is usually divided into hot zone (within the red line), warm zone (between the red and yellow lines) and cold zone (between the green and yellow lines). The area for medical rescue is set in the cold zone and can be further divided into such functional divisions as decontamination area, triage area, observation area, rescue area, transferring area, commanding area and morgue area.

(3) Samples collection and rapid poison detection: The field survey staff should collect samples as soon as they are informed of the outbreak of event and the situation of the disaster area. In sampling, special attention should be paid to the representativeness of the samples and the appropriateness of sampling devices and storage containers. The sample size should be big enough for duplicate testing. When conditions permit, the field survey staff must begin poison testing as soon as possible to guide the on-the-spot disposal.

(4) On-the-spot decontamination: The on-the-spot decontamination area will be set up between the warm and cold zones to decontaminate the severely injured and contaminated clothes and valuables.

(5) On-the-spot triage and medical rescue: The on-the-spot triage area will be set up near the decontamination area in the cold zone. The medical rescue team is responsible for the triage of the exposed people. By the principle of triage and the features of poisons, the patients and exposed people will be grouped into four kinds: the top priority, the second priority, the deferred and the non-treating, which are

indicated by red, yellow, green and black colors respectively. The red sign stands for the critically ill patients and must be given top priority. The yellow sign stands for the intensive care patients and will receive a second priority. The green sign means the mild cases and the exposed people and can be treated later. The black sign means the dead people and need not to be treated. Those with the red sign must be sent to the rescue area immediately to get emergency treatment, those with the yellow and green sign to the observation area to have medical treatment, those with the black sign to the morgue area.

(6) Transportation of patients: Patients will be received and treated by the appointed medical institutions. In transportation, the medical worker must closely observe the poisoned patients to ensure the continued treatment and provide emergency treatment if necessary. The medical workers and institutions responsible for the transportation will hand over the patients to the appointed medical institutions and report to the health administrative departments about the transportation.

(7) Treatment of patients: The health administrative departments organize to draw up the diagnosis and treatment plans of the poisoning emergency and guide the response work. The responsible medical institutions should accept, treat and observe the patients properly and report the relevant information to the health administrative departments. If necessary, a second decontamination will be performed.

(8) Protection of the rescue workers: The rescue workers on the spot need to know the functions and limitations of the protective equipments and select the appropriate protective equipment in accordance with the poison and its impact. No entry will be permitted without proper protection.

(9) Public health protection and education: The measures for public health protection will be proposed on the basis of the features of the poisoning emergency and the requirements of health protection. The public will be educated on the self-aid, mutual aid and other health protection knowledge.

(10) Psychological assistance: During the poisoning emergency, the professionals should be organized to do the psychological counseling and crisis intervention.

Example 2: Nuclear and radiation accidents

The emergency response to nuclear and radiation accidents should give priority to the site. The response to the severe radiation accidents should be organized and implemented by the state health departments or the health emergency departments.

Here is the disposal plan:

(1) Grouping the injured: Group the injured according to the injury, radioactive contamination and radiation exposure.

(2) Rescue of the injured: Provide the emergent treatment to the severely injured. Deliver those with non-radiation injury and minor radiation injury to the medical institutions appointed by the local health authorities. Those with moderate or more severe radiation injury will be delivered to the medical institutions appointed by the higher health authorities or the nuclear and radiation injury center. The injured should be evacuated immediately to avoid further radiation.

(3) Treatment of the contaminated victims: Conduct radioactive contamination tests on the possible and already contaminated victims. Decontaminate the contaminated victims to prevent the diffusion.

(4) Estimate of the exposure dose: Collect the biological samples and goods to estimate the radiation dose of those exposed to the overdosed radiation.

(5) Public protection: Release the radiation protection drugs and guide the use. Instruct the public to have the personal protection and prevent the psychological effect. Measures to protect the public health should be put forward as required.

(6) Radioactivity monitoring of drinking water and food: Take part in the radioactivity monitoring of drinking water and food, and give advice on whether the drinking water and food is safe.

(7) Protection of the emergency workers: The emergency workers should be well protected to reduce the radiation exposure dose as much as possible.

5.3.4 The emergency team

A skilled health emergency team with quick response ability is the important guarantee for the effective emergency response. Generally speaking, the state health emergency team consists of health emergency administrative staff, medical professionals and technicians, who are usually required of the senior academic title, 5-year or above working experience and emergency work experience. According to the different types of the public health emergencies, the state health emergency team can be further divided into four kinds: urgent medical rescue group, sudden acute infectious disease prevention and control group, poisoning emergency group and nuclear and radiation emergency group. With the preliminary judgment of the scale and impact of the public health risks, the emergency groups should decide the professions and number of the emergency staff. The composition of these groups is as

follows:

(1) The urgent medical rescue group: Consist of medical professionals specialized in internal medicine, surgery, emergency treatment, intensive care, anesthesiology, epidemiology, health emergency management, etc.

(2) The sudden acute infectious disease prevention and control group: Consist of professionals in lemology, epidemiology, pathogenic microorganism, clinical medicine, health emergency management, medical care, etc.

(3) The poisoning emergency group: Consist of professionals in food hygiene, occupational hygiene, environmental hygiene, school hygiene, clinical medicine, health emergency management, medical care, etc.

(4) The nuclear and radiation emergency group: Consist of professionals in radioactive medicine, radiation protection, radiation detection, clinical medicine, health emergency management, medical care, etc.

5.3.5 Emergency equipment

There are four objectives of emergency response to public health risks: to treat the injured, to protect the affected people (including clothing workers), to find out the causes as soon as possible, to control the event and eliminate the follow-up impact. To achieve these, the following eight kinds of emergency equipments should be provided: treatment, transportation, protection, sampling, identifying and testing, consequence elimination, organization and command, and self-safeguard.

(1) Organization and command equipments: Include command vehicles, communication tools and office supplies. The command vehicles for emergency response are required to have good cross-country and communication performance.

(2) Treatment equipments: Include equipments for emergency treatment, surgery, diagnosis, testing and disinfection. Similar to the equipments used in the conventional medical institutions, the equipments might be somewhat different because of the type of the emergency and the treatment needs, such as first-aid cases, respirators and surgical instrument sets.

(3) Transportation equipments: Rapid transportation is the key to effective response to public health emergencies, so the appropriate transportation means are significant to better treatment of the injured. The transportation can be done by land, sea and air, involving stretchers, vehicles, vessels and helicopters.

(4) Protective equipments: Include protective equipments for medical staff like

biological protective clothing and masks, and equipments for transportation and isolation like negative pressure ambulances, isolated compartments for the transportation of patients with infectious disease, isolated intensive care units.

(5) Sampling and storage equipments: The on-the-spot samples are the most important evidence to investigate the causes of the emergency. The sampling must be timely, accurate, contamination-free and invariant. The necessary equipments include dedicated sampling tools, storage containers and transportation means.

(6) Identifying and testing equipments: The common equipments include biological testing equipments, reagents, chemical toxicant testing boxes, gas detectors.

(7) On-the-spot disposal equipments: One of the characteristics of the public health events is the mass outbreak. Consequence elimination equipments can limit the scope and degree of the impact, preventing further damage, for example, field disinfection equipments for infectious diseases, decontamination equipments and pollutant disposal equipments.

(8) Self-safeguard equipments (logistic supply): For example, tents, generators, compressed biscuits and self heating food, which are demanded in various public health emergencies.

5.3.6 Emergency response and prevention after the crisis

The end of public health emergency does not mean the finish of emergency management, but the beginning of a new stage, that is, the reconstruction stage.

From the medical point of view, the purpose of reconstruction is to ensure the local health system in good operation and to establish a comprehensive prevention and control measures. From the social point of view, two issues need to be addressed in the reconstruction stage: First, eliminate the consequences of the public health emergency and quickly recover social production; second, by investigating and reflecting on the roots of the event, propose the suggestions for improving the technology, management, organization and operation and conduct the necessary organizational reform to strengthen the emergency prevention and preparedness. Therefore, improving the reconstruction ability is extremely important. The reconstruction after the public health emergency includes short-term and long-term reconstruction.

(1) Short-term reconstruction: In short-term reconstruction period, measures should be taken to settle down the affected people, to prevent and control the diseases,

to eliminate the environmental contamination, to evaluate the recent damage caused by the event, to reduce the negative influence of the emergency on the public and society, to recover the normal life and production, and to promote the recovery and development in all walks of life.

(2) Long-term reconstruction: After the public health emergency, an objective evaluation should be made of every aspects of the event, including the analysis of the causes, the consequence evaluation, evaluation of response measures and state capability for readiness. Thus, further improve the evaluation mechanism and carefully review the deficiencies in the system. Improve the government's emergency management ability and realize the transformation of resources and capacity management from "wartime" mode to "peacetime" mode.

5.4 Emergency Preparedness
5.4.1 The Emergency Planning System

The Emergency Planning System is an institutional document formulated beforehand to cope with public health emergencies, which aims at giving a clear-cut division of the principal parts who shoulder the responsibility as well as the operational mechanism in the emergency management procedure that includes four phases: pre-event phase, event outbreak phrase, crisis phase and consequence phase. The Emergency Planning System is made to regulate the emergency handling procedures, to make clear about the responsibilities of related sections, units and the staff. Once the event happens, the Planning System will be launched in time and the rescue work will be carried out correctly, orderly and efficiently, thus controlling the event in the minimum scope and reducing the damage.

(1) The positioning of the Planning System

Whether the Planning System can work well, efficiently and practically is closely related with the positioning of the System. To certain degree, the positioning of the system decides its quality, decides whether it can be carried out effectively. The positioning of the Planning System mainly involves the following five aspects: firstly, it not only involves the categories of the public health events but also concerns the scope of the application of the System, the emergency response function, and the degree of the response; secondly, it involves both its relationship with other departments and the local government; thirdly, it involves both its relationship with the System superior to it and the System inferior to it; fourthly, it involves its

relationships with laws and regulations as well as policies; fifthly, it involves the set-up of the institutional system and the working mechanism. It is vital to grasp the relationships mentioned above in working out the System.

(2)The constitution of the Planning System

A complete emergency planning system generally includes the overall planning system, dedicated planning system, department planning system, large-scale activity planning system and important events planning system. The overall emergency planning system is a comprehensive planning system and guiding document laid out by the state to deal with major emergencies; the dedicated planning system is a part of the overall planning system, it aims to deal with certain kinds of major emergencies and involves more than one departments (units); the department planning system is formulated by certain department to deal with certain kind of public health emergency or to fulfill its responsibility in the emergencies according to the overall planning system and the dedicated planning system.
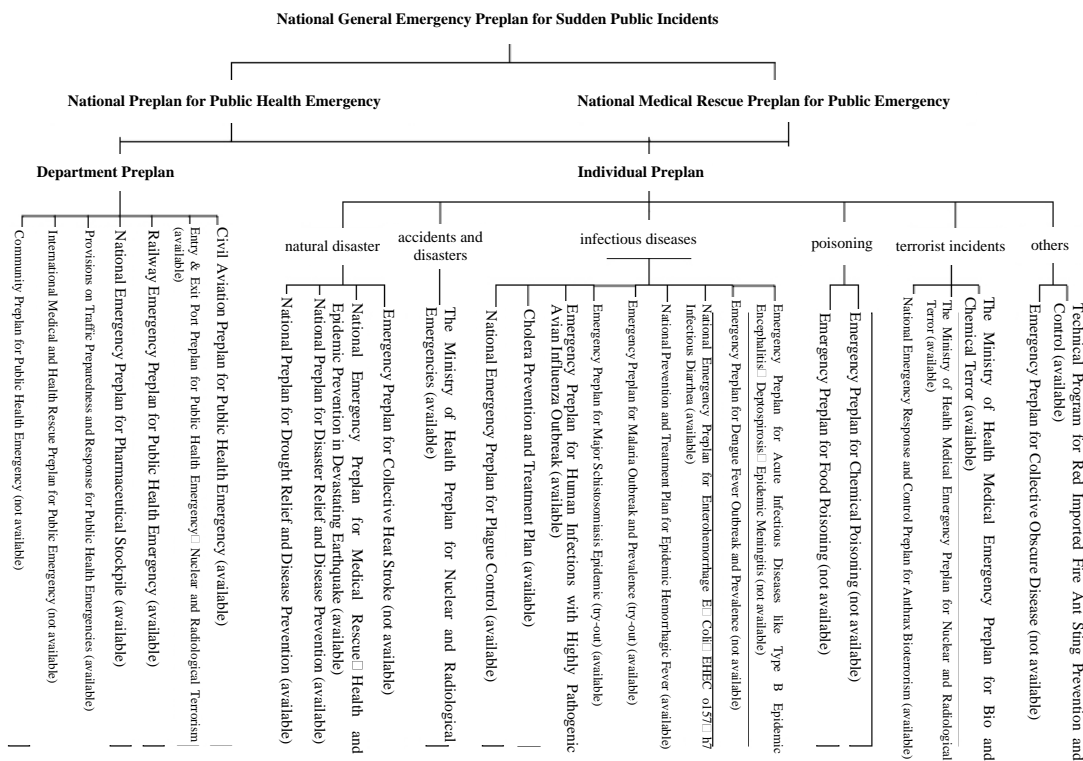

Diagram 12 China's planning system for public emergencies

(3) The basic requirements of the Planning System

The Planning system mainly includes the following key elements: 1) the scope,

the category and the classification of the public health emergencies, including the purpose of the System, the working principle, the laws and regulations it bases on and the scope of its application; 2) the composition of the emergency leading institution, the responsibility and the power of the related departments, including the responsibilities of the emergency institutions at different levels and the framework of the organization system; 3) the forecast and early warning of public health emergencies, including the forecast and early warning system, the classification of the early warning, the early warning actions and the early warning supporting system; 4) the public health emergency information reports, including the collecting, analysis, reporting, notification release and press release system; 5) the handling of public health emergency, including earlier handling, responses at different levels, commanding and coordinating, first aid on the spot and the finish of the work; 6) the public health emergency safeguard measures, including human resources, financial resources, medical supply, goods and materials, transportation, communications, personnel protection, social security, emergency technology and emergency facilities and equipments; 7) the recovery and reconstruction after the emergency, including aftermath disposal, investigation and evaluation, along with reconstructing infrastructures; 8) the supervision and management of the Planning System, including the drill of the Planning, training and education, responsibility as well as the rewards and penalties, the updating of the Planning, etc.. 9) Professional team building and training for emergencies.

The international practice for the layout of the emergency planning is to use chapters, sections, paragraphs and subparagraphs. Generally, there are three levels of headlines in a plan; some plans adopt four levels of headlines. Chapter is the first level headline, section is the second level headline, paragraph is the third level and subparagraph is the fourth level. Each headline is marked by Arabic numerals as ordinals. Such a layout and structure will be able to convey the content t of the plans better. The compiling requirements of the Planning: 1) It is necessary to constitute substantial enhancement of the awareness of the importance of compiling the Planning System. The compiling of the Planning is the prerequisite and ground for emergency work. The compiling of the Planning System shall take priority in the emergency management of governments at different levels and the structure of the system should go like this: "lateral extension to the side and longitudinal extension to the bottom", that is to say, the System should be complete and should not leave out

anything in connecting with the emergency work. 2) The leading and organizing of the compiling work should be strengthened. The compiling work should be taken as an urgent task in fully performing government functions and be important in the agenda. Necessary conditions should be provided to make sure the smooth progress of the compiling. 3) The compiling work should be practical and results-oriented. The Planning is formed to work well and effectively in case of emergency. Therefore, each department should take a pragmatic look at its own conditions, adopting a realistic, adaptable, innovative approach to the compiling work, bravely exploring good methods and avoiding blind copy. 4) It is important to investigate and evaluate hazard sources and make a targeted, feasible Plan. Each department should find out the regularities of the events concerned in recent years by investigating hazard sources. Thorough analysis should be made in order to find out the reasons of the events and the key parts, an overall evaluation of the hazard sources should also be made and lessons should be drawn from that. 5) The building, training and drill of professional public health emergency team should be promoted. The drill of the Planning is one of the best ways to train the team. 6) The Planning management should be strengthened. When the compiling work is finished, dynamic management shall be carried out, that is, the actual situation should be informed in time so that appropriate adjustments and revisions will be made accordingly, in this way, the Planning will be better targeted, more feasible and adaptable.

5.4.2 Emergency fund and emergency resources

Emergency reserve refers to the materials which ensure the supplies for public health emergencies, mainly including three forms: goods, funds and productive forces. Goods is the materials stored directly for disaster relief, focusing on different kinds of goods, drugs with special detoxification effects, personal protective equipments (PPE) and specific diagnosis reagents. Goods can be utilized in the first time, but it only suits for emergencies that demand fewer materials, therefore, this method is not only not able to ensure the supplies in the whole process of emergency relief, but also tie up space and circulating fund and increase management costs. Fund reserve is divided into enterprise storage by agreements and storage by coordinating, centering on antibiotics, vaccines, antiseptics, the former refers to the storage agreements signed between governments and enterprises that demand the enterprises preserve emergency materials for the government, the latter means that governments and agreement enterprises coordinate with each other and adjust the categories and amounts of their

own emergency storage respectively, they also share the real-time information of their storage through information platform. Productive forces reserve refers to the systematic planning and investment of the research and development as well as the production of some of the emergency materials. In this way, mass production can be carried out in short time so as to meet the large scale of demands in case of emergencies. According to their different features, it is suggested that fund and productive forces reserve should be made the best use of, meanwhile, productive forces reserve should take up most of the proportion and proper amounts of materials should be kept, too.

The material reserve is operated under the principle of dependency administration, complete categories, quality safeguarding and dynamic storage. Material reserve can be divided into the following categories: 1) the disinfectants required by epidemiological survey, rapid monitoring and test equipments, apparatus and related reagents; 2) the equipments and materials used for collecting, preserving and transporting samples; 3) special vehicles used for on spot inspection and test, such as water monitoring car, air monitoring car, toxic and dangerous chemicals/ nuclear radiation inspection and test car, emergency monitoring car, etc. ; 4) the quarantine, disinfection, personal health protection articles and facilities for patients with infectious disease; 5) medical supplies, vaccines, antibodies, diagnostic reagents and medical appliances demanded by medical aids and on-site disposal.

Founding well distributed national public health emergency material warehouse is the key part of the emergency material reserve allocating system. According to the principle of dependency administration, corresponding public health emergency material warehouses are built in each administrative area. Each country should appoint related functional departments to be in charge of the production, storage, allocation and transportation of emergency materials, thus ensuring normal supplies. It must be noted that timely supplements and renewals are necessary when emergency storing materials are transferred or past their best before date

5.4.3 Protective Equipment

Personal Protective Equipment(PPE) refers to the dresses, gloves, safety goggles and respirators worn by public health emergency workers in order to protect them from the damage of chemical, biological and radioactive hazards, this kind of equipment is used to protect workers from the hazardous materials on the spot. The PPE is mainly classified into the following types:

(1)Protective Clothing

Protective clothing ranges from positive pressure, gas-tight, permeation resistant clothing which enjoys the best protection function to ordinary particle tight protective clothing, different types of protecting clothing have different properties and apply to different situations. In terms of patterns, protective clothing is divided into coveralls and split clothing. The protecting function of some kinds of protective clothing may decrease after washing and sterilizing because the materials used are different. Therefore, some kinds are disposable; some kinds are confined to certain times of usage. It can be selected by asking professional institutions for consultation or by the test data provided by the manufacturer.

(2) Personal protective equipment for eye and face

Personal protective equipment for eye and face should be able to protect workers from the flash and dash of high-speed particles. Safety goggles can separate small amounts of spray from workers. If it is necessary to protect eye mucous from pathogenic micro- organisms, full face mask would be the best choice in respiratory protection.

(3) Protecting gloves and boots

Like protecting clothing, different types of protecting gloves and boots apply to different kinds of chemicals. Furthermore, whether high temperatures, sharp objects, wires and electric powers exist on the spot are factors that should also be taken into consideration, and the gloves and boots should enjoy good anti-wear properties, too.

(4) Respirator

Respiratory protection is divided into two types: self-contained (airline respirator) and filter-type (air purifying respirator). Self-contained respirator separates the respiratory organs of the users from hazardous air, clean air outside the working environment is brought by air sources carried by the respirator (e.g. Self Contained Breathing Apparatus , SCBA or airway tube (long tube air-feed type). Both Level A and Level B protecting use self contained breathing apparatus (SCBA).

The common filtering respirators are dust mask and gas mask, which can be classified as disposable (simple, half type), replaceable half mask and full face mask. Replaceable half mask and full face mask use replaceable components, and the masks are classified as anti-dust (particles) type, anti-gas or anti-vapor type and comprehensive protecting type preventing both dust and gas.

Dust filter has different levels according to their efficiencies, each type of canister and filter box applies to certain kind of gas or vapor, some may prevent only one kind of gas, some may have comprehensive protection, some may have smoke filter layers or particle filters (detachable or non-detachable). The filtering respirator is used for Level C protection. Considering the types of the hazards on the spot, it is suggested that filter components with the combination of anti-dust and anti-gas will be best. Respirators should be selected under the guidance of GB/T18664-2002 the Selection，Use and Maintenance of Respiratory Protective Equipment. The selection of the respirator should also match the types and concentrations of the hazards on the spot.

Personal protective equipment can be further divided into four grades. See table below:

Table5 Common personal protective equipment for different protection grades

Protection grade	protection objects	protective equipment
A	1) Contact with gas, liquids that can be absorbed by skins; 2) Chemicals that can cause cancer and has high toxic nature; 3) The conditions that high concentration liquids are most likely to splash, infiltrate and contact with people and vapors are most likely to expose; 4) Contact with unknown chemicals and the hazards reach to an immediately dangerous to life or health concentration(IDLH)(see GB/T18664-2002), chemicals that can be absorbed by skins; 5) Oxygen - deficient environment.	1) Respiratory protection: full face mask self-contained breathing apparatus(SCBA); 2) Protective clothing: completely closed, gas-tight, chemical protective clothing which prevents acids and bases, it can also prevent liquid and gas infiltration ; 3) Protective gloves and boots: anti-chemicals; 4) Head protection: safety helmet
B	1) Gaseous, toxic chemicals, their categories are clear and they cannot be absorbed by skins; 2) Reach to an immediately dangerous to life or health concentration (IDLH); 3) Oxygen – deficient.	1) Respiratory protection: self-contained breathing apparatus(SCBA); 2) Protective clothing: chemical protective clothing with a hood, non-gas tight, anti-chemical liquid infiltration; 3) Protective gloves and boots: anti-chemicals; 4) Head protection: safety helmet.
C	1) Gaseous, toxic chemicals that cannot be absorbed by skins, their categories and concentrations are clear; 2) Not reach to an immediately dangerous to life or health concentration(IDLH);	1) Respiratory protection: air filtering respiratory protection articles (positive pressure or negative pressure system), filtering components adapt to specific objects that should be prevented, the

	3) Not lack of oxygen.	protection grade is corresponding to the concentration of the hazards; 2) Protective clothing: preventing particles and small 3) amounts of sprays; 4) Protective gloves and boots: anti-chemicals;
D	Non-volatile, solid or liquid substance that is less infectious.	1) Respiratory protection: no need for protecting; 2) Protective clothing: corresponding to the substance people contact; 3) Protective gloves and boots (or shoe cover).

5.4.4 Expert pool

The expert pool for public health events should include experts from national medical and health care institutions, research institutions, universities and colleges and related departments. According to the actual conditions, expert pool could be further divided into different groups, such as emergency management group, sudden acute infectious disease group, poisoning disposal group, nuclear and radiation accidents group, emergency medical aid group, emergency supply group and psychological relief group.

Members of China Health Emergency Expert Pool should qualify themselves in the following aspects: 1) They should have good professional ethics, be upright, law-abiding and are willing to join the pool; 2) They should have senior or advanced professional titles, professionals with intermediate grade titles may also be recruited if they have high professional competence, great theoretical attainments and rich emergency experiences; 3) They should have solid foundations for the theories in their research areas and rich experiences, meanwhile, they should also be well known both at home and abroad in their own fields; 4) They should dedicate and devote to their work, actively participate in the activities organized by the expert database system.5) Generally they should be under 65 years old and be healthy.

The major responsibilities of the expert pool are: 1) identifying the grade of public health emergency and giving advice on the corresponding measures taken to deal with the events; 2) giving suggestions and guidance on public health emergency preparedness; 3) joining the work of revising, formulating public health emergency planning and technical programs;4) giving opinions and suggestions for emergency prevention and disposal, providing technological guidance as well; 5) identifying the end of public health emergency response and evaluating the performance of the response. In China, members of the Ministry of Health (MOH) Emergency Expert Pool mainly undertake the following works:

1) Each expert group summits to the MOH its work summary of the current year and makes working plan for the next year at the end of each year. The working plan shall be fulfilled after the approval of the MOH.

2) Members of the expert pool should hold at least one plenary meeting each year, informing the MOH of what are happening, seeking advice, studying and considering the working plans and important events. According to the requirements of

the MOH, members can also convene interim and advisory meetings, studying and discussing related work and giving their opinions and suggestions.

3) Decisions of the expert pool are made under the principle of democratic discussion and consensus, voting could be adopted when necessary. The votes won't be effective until over half of the participants hold the same opinion.

4) Members of each field could make out rules of activities of their own groups in accordance with this administrative management, clarify the responsibilities, work and working procedures of each member. The activity rules of the professional groups should summit to the Experts Database System and the MOH to register.

5.4.5 Emergency drill

To test and improve the actual combat capability of the emergency rescue system, emergency management centers at different levels should make out corresponding drill plans and carry out regular and interim emergency drills.

(1) The purpose of the drills

Emergency drill is one of the most important activities of the Early Warning System, the drill could not only test whether the Planning has scientificity and feasibility or not, but also identify the defects of the emergency response, meanwhile, it is also an important measure to improve the response and rescue capability of the emergency rescue system and to cultivate the capability in cooperation.

(2) The forms of the drill

The drills can be tabletop exercise or simulation exercise. Each form is divided into three kinds: individual exercise, complex exercise and comprehensive exercise. Individual exercise is performed to develop and practice some basic operations or techniques which are used to accomplish specific tasks, such as communication, notification, reporting procedure; whether the personnel, equipments, materials and apparatus are in place; epidemiology survey and emergency disposal, the emergency evacuation of chemical poisoning population, etc. Complex exercise combines more than one emergency task which is closely related with each other, one of the major purposes is to communicate and strengthen the cooperation and coordination among emergency rescue organizations. Complex exercise may involve various emergency rescue organizations, such as the cooperation among disease prevention and control departments, medical aid department and fire departments. Comprehensive exercise is performed by all or most of the organizations within the system that undertake emergency rescue work, it aims to verify the capabilities of the emergency rescue

organizations to execute the tasks, to test their coordinating capabilities, to see whether they can allocate and utilize emergency resources and forces efficiently and completely.

(3) The implementation and report of the exercise

Emergency drill is an effective way to find problems and better the plans. Only when plans are exercised repeatedly can they be implemented smoothly when launched. The whole process of the emergency drill should be carried out in accordance with the plans and no links should be omitted. The endurance of the performers and subjects of the exercise should be taken into full consideration when the plans are made out, perfect design and careful organizations are necessary to avoid or reduce public panic and social pressure. It is particularly important to avoid repeated accidents caused by human errors which may lead to loss of lives and properties. The exercise team may include evaluating group, expert group, monitoring reporting and data analysis personnel, emergency disposal group, field epidemiology survey group, professional control team, related laboratory staff, medical aid staff, etc.. Before the exercise, the allocation of emergency materials, personal protective equipment should also be taken full consideration.

During the process of exercise, the command institution, rescue team and the public should participate in the work in an all round way and work together to verify and complete the joint coordination mechanism. Feedback and revision of the plans are necessary after each exercise or the launch of public health emergency planning. The exercise is not able to make people understand and master the plans but also to verify whether the plans are reasonable, scientific and complete, it is useful for the further revision and improvement of the plans. It is suggested that simulate drills be carried out each year to improve the comprehensive emergency capabilities of medical staff.

When the exercise is finished, the results should be summarized and evaluated, the problems and defects should be settled in time, they could also ask the higher level emergency institution for help when necessary.

5.5 Risk communication

It is also called "risk information exchange", emphasizing on the exchange of risk information and materials among people related with risks and stake holders.

5.5.1 Basic requirements

The information of risk communicating includes: (1) the narration of the basic situation of the events, focusing on the potential risk of the events and the possible tendency of the events; (2) the response capacity of the government, such as the current corresponding measures and the results; (3) individual prevention guidance, including the publicity and education of related knowledge and personal prevention measures. Experts from American CDC think that the information of risk communication should have the following characteristics: simple, prompt, accurate, reliable, unanimous and consistent.

5.5.2 The basic principles

WHO sums up experiences from the risk communication of the outbreak of SARS, issued WHO guide to risk communication of the outbreak of infectious disease in 2005, put forward 5 principles in responding to the outbreak of infectious disease and other emergencies, that is, trust, prompt disclosure of information, transparent, concerns about public and planning.

5.5.3 The target of risk communication and the demands

(1) When government communication events occur, public health administrative departments should actively communicate and coordinate with local governments, kick off emergency planning if necessary and carry out emergency management work. The communication includes the resources and capabilities of the response and solution time, command abilities in coping with the events, response strategy, the right moment for controlling the situation, implementing rescue programs, fulfilling duties, economic and trading issues, etc. Public health administrative departments should know the whole situation, the governments, the laws and regulations before communicating with governments.

(2) Internal communications

When emergencies occurred, internal information exchange and communication mechanism should be established to connect local public health administrative departments, the corresponding emergency medical institutions, disease prevention and control institutions, related emergency departments in the region where emergency occur, higher level public health administrative departments. When emergency occurs, internal information spreading should be given priority over others.

(3) Communications among departments

Public health emergency risk communication involves various sectors, such as governments, public health administrative departments, business departments devoted to certain fields, etc. They should work under the leading of the government, shoulder their own responsibilities and make concerted efforts in emergency risk communication, for example, different departments should jointly hold press conference and release information together, and thus best controlling effects could be achieved.

(4) Media communication

With the publicity and education of the mass media, the public is more likely to know what is right or wrong, consequently, governments could gain understanding and support from the public. The media is in a special position; it is the link between governments and the public. It could not only guide the public opinion and satisfy the public demands for information but also influence governments. When public health emergency occurs, governments must attach importance to interviews carried out by medias, make full use of the media's guiding and publicizing function, in this way, there will be a smooth interaction between governments and the media and the public's right to know the truth is guaranteed.

The communication with the media mainly covers the following aspects:1) the time, venue, influenced areas, affected population; 2) the cause of the public health emergency; 3) the history of the accidents, the current situation and the tendency of the accidents; 4) the victims' clinical manifestations, the treatments and the prognosis; 5) the public' prevention measures.

To sum up, when public health emergency occurs, governments should arrange interviews by the media in time, disseminate authoritative, objective and impartial information of the events. At the same time, government should supervise the contents of the press releases, prevent the spread of erroneous and one-sided information, and guard against the media which may take the opportunities to build hypes.

(5) Public communication

The methods and strategies adopted to communicate with the public should be based on the comprehensive consideration of the nature and grade of the emergency as well as the scope and degree of the events. Generally speaking, the targeted audiences should include: the public live within the area where emergency occurs, the public live in the neighboring areas, people involved in the events and the families of

the staff participate into the handling of the events, medical staff who don't directly participate into the handling of the events and the general public concerning about the development of the events. Before communicating with the public, it should be clear that the demands of the public include many aspects such as information, recognition and trust. Only in this way, can necessary and well-directed information be provided, and good result is achieved. The common way of communication between governments and the public is through the media, the next one is direct communication.

5.5.4 Information dissemination mechanism

An important index to the handling of the public health emergency is whether the information dissemination is effective and in order, because organizing information dissemination, news report and guiding public opinions are important parts in handling emergencies.

Advocacy and Public Information Working Group should be established among the institutions coping with public health emergency. When major public health emergency occur, information office dedicating to information dissemination and communicating with the media should be set up, spokesman should be appointed to release information. The spokesman is responsible for information collecting, handling and disseminating, considering the interview application of reporters, arranging interviews and management of reporters. The spokesman must fully involve in the decision making of events, have a full picture of the development of the events, make good preparation for information dissemination; hence, information dissemination will go smoothly and guide the public opinions in a right direction.

When public health emergency occurs, the following principles shall be followed:

(1) Different communicating strategies should be used to influence different targeted audiences;

(2) The first time release, that is, information should be released as soon as possible (including " there is still no reliable information" or "there isn't any definite information"),   information dissemination should not be delayed or cancelled;

(3) Information should be disseminated without interruption, let the public, the media know the latest news immediately;

(4) Using clear and concise language to spread core information to the public and the media;

(5) Determining the name list of the experts who could accept interviews carried out by the media. Interviews of the authoritative experts are a good way to disseminate accurate and objective information of the events in time, and to obtain the trust and support of the public;

(6) Keeping appropriate public panic, excessive fear could lead to scares and disturb social orders, conversely, the public may fear nothing, then the control of the events may be influenced and the situation may deteriorate more rapidly.

(7) Making good use of informal information dissemination methods, media briefings on a small scale may be used to ease the anxieties of the public quickly.

Certain disciplines and principles should be adhered to in disseminating public health emergency information, that is, it should be accurate, prompt, impartial, helpful in settling the accidents and giving right guidance, etc. Furthermore, unified standards for information dissemination should be set up, the specific standards, grades, time limits, channels, scopes and technical analysis, policy explanation of the early warning and risk alarm of different types of emergencies should be published, the content should be authoritative, the system should be complete and the standards and orders should be clarified.

5.6 Human resources

The principle of building human resources is to control the total number and adjust the structure, the structure of the existing health technicians should be improved, and the key point is that the proportion of professional and technical personnel as well as health technicians with senior professional titles is small in the emergency team.

Human resources building should cover each level of the emergency system. It can be enhanced from the following aspects:

(1) Optimizing the structure of the personnel: attach importance to the age, academic qualifications, professional titles and specialties of the emergency team, according to the constitution of the existing personnel and the demands for emergency workers of the country and the region, emergency professionals with high degree and high level should be introduced actively, professionals in urgent need should be introduce, too. The structure of the existing emergency personnel shall be optimized without interruption. In the field of disease prevention and control, workers in the related fields such as epidemiology, health statistics, disease prevention and control,

health policies, laboratory test should be taken into consideration; in the field of medical rescue, workers in the related clinical fields such as medicine, surgery, orthopedics, burns surgery, emergency treatment laboratory test should also be taken into consideration.

(2) Improving the abilities of the personnel: on-the-job training is the most effective means to improve the abilities of the personnel. In training public health emergency professionals, professional knowledge and abilities should aim at certain fields, including disease surveillance, disease prevention and control, public health emergency disposal, emergency rescue, epidemiological survey, data statistics and analysis, laboratory test, clinical diagnosis and personal protection. Experiments, practices and simulation training should be emphasized to improve the staff's abilities in recognizing the risk, adapting to the environment, executing the task and coordinating with each other, it is also important to better their psychological quality. Besides, great attention should also be paid to talent cultivation, the resources strength of research institutions and colleges should be made full use, international exchange and cooperation should be enhanced.

(3) Setting up an effective incentive and guarantee mechanism of emergency talents. Corresponding incentive institutions and measures should be adopted to guarantee the working and living conditions of emergency talents so as to mobilize them.

(4) Establishing emergency talents exchange mechanism, improving the efficiency of exploiting and using talents. Joint emergency mechanism and coordinating mechanism allocating talents between different regions and departments could be founded to realize unified target, unified command and unified dispatch, thus the efficiency and function of the existing emergency could be fully employed.

(5) Establishing long term expert pool exploiting and operating mechanism. The consultation and advice of the think tank should be brought into full play, members of the expert pool are more professional and authoritative in studying the occurrence mechanism, developing mechanism and disseminating mechanism of the emergency. With the participation and guidance of the experts, governments will be able to take more effective and right-directed measures in coping with emergencies.

5.7 Laboratory

5.7.1 Basic instruments and equipments investment

Great importance should be attached to the investment, update, inspection and verification of the laboratory instruments and equipments, including the basic experiment equipments such as incubator, drying oven, high pressure steam sterilizer , microscope, bio-safety cabinet (BSC) and advanced equipments such as polymerase chain reaction (PCR), full automatic biochemical analyzer for bacteria, etc.. This guarantees the high quality of the experimental performance. Bedsides, laboratories should also be equipped with facilities that have the function of dust control, human pollution prevention, laboratory animal's pollution prevention and the prevention of the pollution from experimental materials themselves. Laboratories should also have sufficient sources of light and proper room temperatures. Laboratory instruments and equipments inspection and verification system should be set up. There should be regular or interim inspection and verification of the instruments and equipments, keeping them in good function, avoid troubles in case of emergency.

5.7.2 Sampling and quick detection

The prompt, accurate and complete sampling is the prerequisite for correct experimental diagnosis, qualified sample collecting is essential to the correct test results. The sampling time is closely related with the confirmation rate of the events, the quicker the sample is collected, the higher the detection rate of the pathogen, otherwise, the suspected food, the vomit, the excreta would have been disposed and the patients would have taken large amount of medicine, all these could influence the detection of the Infectious agents. At the same time, all samples related with the events must be collected with special focus and purpose and based on the epidemiological data of the patients. The number of the samples must meet the needs of test repeated tests. For example, when digestive diseases break out, the samples should be collected are: the patients' drink and food, vomit, excreta, double portion of blood as well as the kitchen things, the tableware and the feces of the people involved; for respiratory diseases, the samples needed are: pharynx swab sample, gargle, phlegm, air conditioner cooling water and aerosol that may contain bacteria or virus.

The key to control public health emergency is timely and effective response. Quick test techniques and effective test methods could ensure the timely and effective control of the emergency. For example, flu could be detected within 24 hours if the method of Rocking Bed Absorption Method Micro Scale Cell Plate Short Term

Culture Fluorescent Antibody Test is adopted; PCR technology or nest-PCR are suitable for detecting brucelliasis; SARS detection can use the following methods: virus isolation, Indirect Fluorescent Antibody Test (IFA) Enzyme Linked Immunosorbent Assay (ELISA) and PCR; cholera detection should use the method of agar culture.

5.7.3 Biological safety

Laboratory biological safety is the guarantee of the experiments, there should be strict biological safety management rules and regulations as well as biological safety operation manual.   The biological safety principle of preventing proliferation should be strictly adhered to, it should be assured that the samples are preserved and transported properly and are prevented from pollution, it is also necessary for the operators to do well in personal protection. Good laboratory building structure and layout, correct microorganisms operating technology by the test operators, employing instruments and equipments that could reduce biological risk, personal protective equipments meeting the requirements are guarantees of biological safety.

5.7.4 Capacity building of laboratory staff

Professional training for laboratory staff should be enhanced, it includes the professional theory and knowledge, operating skills, the following fields should be covered: laboratory biological safety knowledge, infectious disease, epidemic, food hygiene, and clinical diagnosis. Professional team build should be taken as a long term task. Various channels like training, continuing education and academic exchange should be used to improve the professional competence of the test staff. Professional information should be updated, it should be assured that the professional team is ready to assemble at the first call and be capable of fighting and winning.

5.7.5 Network Labs

Many countries established public health emergency network labs, such as America, Canada, Britain, Australia, Russia, Japan, ~~South~~ Korea, etc. WHO also set up worldwide single disease laboratories network, such as HIV and flu virus. The members of the network labs should include disease prevention and control institutions, colleges and universities, research institutions, related labs of medical institutions and the armies. The principle of building the labs should be voluntary participation, sharing resources, cooperating and mutual benefit, sharing weal and woe.

In coping with public health emergencies caused by biological factors, the

network labs are divided into three levels: national labs, reference labs and sentinel labs. Sentinel labs include hospital laboratory, clinical laboratory and commercial diagnostic laboratory, they are committed to the task of early detection of biological pathogenic factors, providing services like routine diagnosis, pathogen investigation and transfer treatment, and they also decide whether it is necessary to send samples to reference labs and national labs for further test. Reference labs include public health laboratory at provincial and municipal level, military laboratory, international institutions laboratory, veterinary laboratory, agriculture laboratory, food laboratory and water quality laboratory, they provide services for pathogen investigation, sample transfer and test.
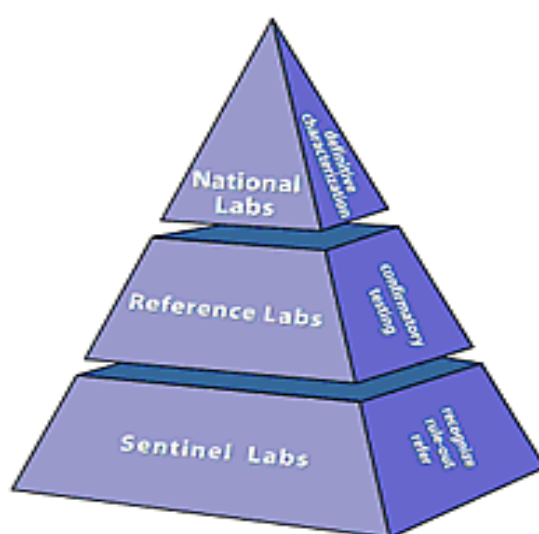

Diagram13 Laboratory Response Network for Public Health Emergency Caused by Biological Factors

(From CDC of America website)

National labs, including CDC and military medical institution labs are required to work in the characterization analysis of specific strain, biological assay, selective agent activation analysis and highly infectious biological factors disposal. In handling accidents caused by chemical factors, the lab response network is divided into three levels: Level-1, Level-2, and Level-3. Level-3 labs cooperate with hospitals, collecting, preserving and transporting clinical samples; Level-2 labs are responsible for testing the exposure of toxic chemicals, such as analyzing cyanide, nerve agent, toxic metals, etc; Level-1 labs are able to shoulder the test tasks under ultra limit conditions, they could not only detect and inspect toxic chemicals of Level-2, but also detect and inspect the exposure of other chemicals, such as mustard agent, never agent

and other toxic industrial chemicals. With special high flux analysis ability, Level-1 labs are able to deal with large scale exposure emergencies, analyze large number of patients' samples need to be tested.

Diagram 14 Laboratory Response Network for Public Health Emergency Caused by Chemical Factors

(From CDC of America website)

The establishment of laboratory response network could realize information connecting, resources sharing, mutual support, mutual cooperating and coordinating, improve the labs' capability to monitor, test major infectious disease, mass obscure disease and poisoning, it could also enhance the labs' scientific research ability.

5.8 Supervision and Assessment Capacity
5.8.1 The purpose

Supervision and evaluation system is a part of the whole public health emergency system, by supervising the whole public health emergency system, it could follow the implantation of the plans, thus recognize and solve corresponding problems in time and improve the public health emergency system. Based on supervision, evaluation could further enhance the sense of responsibility and make sure that the public health emergency system meets its target. Comprehensive evaluation should be carried out according to the changes of the outputs, results and effects of the whole system.

5.8.2 The contents of the supervision and assessment

Supervising and assessing the process and result of emergency management should center upon every sector of emergency disposal, including establishing

emergency system, the reports of the events, epidemiology survey, medical rescue disposal on the spot, sample collecting and test, organizing the research of emergency prevention and treatment.

Supervision is a normalizing work, a constant and regular activity, a routine work of the whole public health emergency, collecting the related work of the system. Evaluation is an interim activity, aiming to collecting related materials by special investigation and special research. Emergency management evaluation mainly includes crisis phase evaluation, consequence phase impacts evaluation and emergency management evaluation. Crisis phase evaluation should include: (1) evaluating the type and nature of the event; (2) evaluating the affected areas and the severity of the accident; (3) evaluating the controlling effects of the emergency measures that have been taken; (4) evaluating the tendency of the events; (5) giving advice on whether it is necessary to kick off emergency planning. Consequence phase impacts evaluation include summing up the event, on-the-spot investigation and disposal, patient treatment, the effects of the measures taken, the problems and experiences and advices in the process of emergency disposal.

5.8.3 Supervision and assessment index

According to the recommendation of WHO, the different parts within the public health emergency system could be supervised and evaluated frequently, directly or indirectly by indexes. While supervision and evaluation indexes are determined, it is necessary to consider the effectiveness of the materials, the feasibility and cost effects of material collecting, the agility and stability of the indexes.

There are many ways to set up and classify evaluation index, it could be divided into supervision and evaluation index. Supervision index is often used to supervise and manage the implementation of the activities in a dynamic way, and find the changes of the supervision in time. Evaluation index decides whether the goal is achieved by process evaluation, result evaluation and effect evaluation, it can also be described as investment index, process index, output index, result index and effectiveness index.

Investment index: it is the resources and guarantee of the operation of the whole system, include human resources, money, standard and institution, communication, surveillance system, computer and other resources logically required.

Process index: it monitors and follows the implementation of the action plan that affects the core function of the system, such as training, supervision, institution and

instrument development, the implementation of emergency measures when emergency occurs and material collecting.

Output index: it mainly refers to the measurement of the intermediate results produced by the action, including analysis report of the surveillance result, feedback, the number/proportion of health professionals who receive training/education, the number of times of the supervision implemented and planned as well as their ratio.

Result index: it evaluates the quality of the system and the achievement of the goal, including the effectiveness of the system, the integrity of the report, the ratio between the monitoring information used for health decision and the number of emergencies.

Effectiveness index: it evaluates the achievements of the global goals of the system, including case fatality rate change caused by potential infectious disease, mortality change, hygiene behavior changes in the operation of the program, health behavior change of the target population, etc. It covers the following aspects: secondary attack rate, attack rate, case fatality rate, the number of food poisoning cases, drinking water disinfection coverage, the qualified rate of food, preventive medicine taking rate, emergency immune and emergency immune vaccination rate.

5.9 Regional cooperation

Public health emergency regional cooperation should cover the following aspects:

(1) Establishing APEC prevention and control cooperation mechanism and institution. APEC member economies should carry out extensive cooperation, make full use of their own advantages, draw up prevention and control measures; from a long term point of view, a joint prevention and control of public health emergency mechanism should be discussed and established, it should be scientific, standard, orderly and general preference. Each economy should actively take part in international prevention and control, share prevention and control experiences, promote international public health cooperation institution.

(2) Employing modern means of communication, enhancing technological cooperation and information exchanges between countries, improving the research level of public health emergency prevention and control of each country.

(3) Setting up regional infectious disease special fund, gathering excellent workers, jointly studying, developing and preparing new prevention and control

technology.

(4) Organizing experts with rich experiences from different countries to jointly carry out investigations and studies on epidemiology, etiology, clinical diagnosis and treatment, traditional medicine and alternative medicine, to master the laws of infectious disease spread and strengthen emergency handling capability.

(5) Opening up "green channel" for the study of new and major infectious diseases, realizing lab resources sharing mechanism of different countries.

(6) According to general preference principle, providing technology aid and technology transfer for related countries as the capacity allows, help the recipients to improve its own ability in preventing and controlling public health emergency.

(7) NGOs play more and more important roles in public health emergencies, the cooperative network will be complete if NGOs are incorporated into it.

(8) Making full use of the supports from WHO, the United Nations Food Agriculture Organization, the Joint United Nations Programme on HIV/AIDS, the World Bank, International Vaccine Institute and the World Trade Organization.

5.10 Scientific research capacity

Scientific research on public health emergency is a guarantee for improving health emergency works. It should be set out to improve the scientific research ability in three aspects: surveillance, early warning and response. The specific contents are as follows:

(1) Persuading APEC economies pay more attention to scientific research and invest more in it, organizing a survey on the existing abilities of public health emergency.

(2) Building public health emergency planning and information sharing platform, improving information exchange and scientific research ability.

(3) Setting up national research centers for new infectious disease, studying the occurrence mechanism, screening technology and methods and reagent of new pathogenic microorganism, pathogenic microbe separation and test, gene detection technique of unknown pathogens, etc.

(4) Carrying out the study on forecasting model of epidemic disease prevalence, improving predicting and early warning capacity.

(5) Establishing emergency network labs at different levels.

(6) Exploiting economical effective diagnosis reagents and vaccines;

demonstrating and developing new technologies of quick diagnosis, quick sampling, quick test and quick disposal.

7) Carrying out research on emergency standardization.

8) Enhancing academic exchange between different regions.

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