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Classic Cases in Public Health Emergency

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Prepared by
Shanghai Municipal Center for Disease Control and Prevention
No. 1380, West Zhongshan Road, 200336, Shanghai, China
Telephone: 0086-21-62758710
Fax: 0086-21-62756323
And
Fudan University, School of Public Health
Add: 138 Yixueyuan Road, Shanghai, China
Tel : 0086 21 5423 7334

For
Asia Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

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Preface

A number of new epidemics such as SARS, avian flu and 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 to APEC economies, and also exert serious social impacts 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 experiences 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 reasons, 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 *Classic Cases in Public Health Emergency (Classic Cases* for short). *The Classic Cases* talks about 6 categories of public health emergency, including infectious disease, chemical poisoning, food safety, nuclear radiation, biological terror and biohazard, second disasters after natural disaster. 2 classic cases of each category are selected and elaborated in the process of the events, the causes, and emergency dispoal, the impacts of the events as well as lessons and experiences.

During the process of writing *The Classic Cases*, 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.

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

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Abbreviation

IHR	International Health Regulations
NPS	Nuclear Power Station
METI	Ministry of Economy Trade and Industry
EHEC	Enter Hemorrhagic Escherichia coli
TEPCO	Tokyo Electronic Power Corporation
TMACC	Tokyo Metropolitan Ambulance Control Center
PSA	Probabilistic safety assessment
OILs	Operational Intervention levels
CBS	Columbia Broadcasting System
ICRP	International Commission on Radiological Protection
IAEA	International Atomic Energy Agency
NPS	the National Pharmaceutical Stockpile
NA	Neuraminidase
SPEEDI	System for Prediction of Environmental Emergency Dose Information
EMTs	emergency medical technicians
ARS	Acute Radiation Syndrome
HA	Hemagglutinin
TMFD	Tokyo Metropolitan Fire Department
OCHA	Office for the Coordination of Humanitarian Affairs
UCC	Union Carbide Corporation
ABC	American Broadcasting Company
CDC	Centers for Disease Control and prevetion
USAMRIID	United States Army Medical Research Institute Of Infectious Diseases
AMI	American Media Inc.
NBC	National Broadcasting Company
HIC	Humanitarian Information Center
MEXT	Ministry of Education, Culture, Sports, Science and Technology
HUS	Hemolytic Uremic Syndrome
LRN	Laboratory Response Network for Bioterrorism
WHO	World Health Organization
DHHS	Health and Human Services

ADB	Asian Development Bank
SARS	Severe Acute Respiratory Syndrome
MIC	Methyl Isocyanine
ICMR	Indian Council of Medical Research
EOC	CDC's Emergency Operations Center
NISA	Nuclear and Industrial Safety Agency
UNDAC	United Nations Disaster Assessment and Coordination
EWRS	Early Warning and Response System
STEC	Shiga Toxin-producing Escherichia coli

Chapter 1 Infectious Disease

Section 1 SARS

On 16 November, 2002, the first case of pneumonia with unknown causes occurred in the city of Foshan, Guangdong province, on 5 July, 2003, World Health Organization (WHO) announced that the chain of person to person Severe Acuter Respiratory Syndrome (SARS) transmission has been cut completely. The prevalence of SARS has made severe impacts on global public heath system and imopsed unprecedented challenges to public health response.

I The Course of the event

On 2 Junuary, 2003, Guangdong province, China reported the first case of pneumonia with unknown causes (Atypical pneumonias) patient. Retrospective sampling survey on aggregation cases of pneumonia of unknown causes demonstrated that the first case of illness occurred on 16 November, 2002.[1] On 11 February, 2003, WHO received the first offial report from Guangdong pronvince that there were 305 patients of SARS and 5 died.

At the end of February 2003, a doctor who was in the incubation period of SARS travelled to Hong Kong, China passing the pathogen to local residents and tourists there. These infected people then communicated the disease to other people in Viet Nam, Singapore, Canada, Chinese Taipei and China. In late February, a Shanghai-based Amercian businessman was confirmed to be infected when he arrived at Hanoi, Viet Nam by way of Hong Kong, China later a number of medical workers were infected, too. The patient then came back Hong Kong, China for treatment but died on 14 March. The resident doctor of WHO in Hanoi, Karl Lou Vulbani notified WHO the disease situation of local medical workers first and called the disease SARS. On 12 March 2003, WHO issued a global alert about the outbreak of SARS.[3] On 15 March 2003, American Centers for Disease Control and Prevetion (CDC) issued a health alert to hospitals and clinicians.[4] The Global Outbreak Alert and Response Network (GOARN) established by WHO collaborated with 11 laboratories from 10 countries to find the pathogen that has caused SARS on 17 March 2003.[5] On 16 April 2003, the World Health Organization announced that a new pathogen, a member of

the coronavirus family never before seen in humans, was the cause of Severe Acute Respiratory Syndrome (SARS), and named it SARS virus.[6] On 24 June 2003, WHO lifted the travel advisory on Beijing and removed it from its list of areas with recent local transmission of SARS. On 5 July 2003, WHO removed Chinese Taipei from its list of areas with recent local transmission of SARS. This achievement means that all known chains of person-to-person transmission of the SARS virus have now been broken.[7]

Up to 7 August, 2003, 29 countries were involved with SARS, there were 8422 suspected cases and 916 deaths; among them, 5327 suspected cases and 349 deaths were from mainland China. The global incidence rate was 11%. About 1/3 SARS patients were medical workers.

II The analysis of the event

1. The Causes

The pathogen that caused Severe Acute Respiratory Syndrome (SARS) is a member of the coronavirus family, it is transmitted mainly through short range respiratory droplets, and it could also be transmitted through contact with a patient's respiratory secretions or close contract with patients. This pathogen has a strong infectious force. Studies demonstrated that the increase of the tramsmission followed an exponential curve; each case transmitted the disease to 2.7 susceptible persons on average. People generally are susceptible to SARS and medical workers are high risk groups of SARS. Reports indicated that animals like masked civet also carry coronavirus that is related with SARS, but it is not clear about whether these animals spread virus, whether they are the host of the virus, and in what way they pass the disease to human beings.

2. Superspreading events [8]

China and Hong Kong, China were most severely attacked by SARS. Experts thought that there were at least two "superspreading events" identified in China. The first case occurred in Guangzhou. The Guangzhou incident resulted in transmission in two hospitals with 3 generations of infection and resulted in 82 cases epidemiologically linked to the source case. Transmission in the first hospital occurred before the implementation of infection control measures and a number of health care workers were infected during a difficult intubation. A total 59 health care

workers were infected in this incident. The attack rate was 61.97% (29/47) in the respiratory ward of the second hospital.

The second superspreading incident (patient 'Y') travelled to Guangdong province where she was infected with SARS-CoV. Eleven secondary cases (3 health care workers and 8 family contacts) occurred in the City of Taiyuan and several health workers were also infected when she was transferred to a hospital in Beijing.

There were also two "superspreading events" in Hong Kong, China which caused the SARS outbreak in Amoy Gardens and Metropole Hotel. The former case was a 33 years old man who lived in Shenzhen and often went to Amoy Gardens to visit his younger brother. The patients suffered from chronic renal failure and received treatment in Prince of Wales Hospital. On 14 March 2003, he began to have signs and symptoms of SARS. On March 14 and 19, he visited his younger brother, during that period he used the toilet many times because of diarrhea. Later, his younger brother, his younger sister-in-law and 2 nurses who looked after him in Prince of Wales Hospital were confirmed to be infected by SARS. The outbreak in Toronto, Hong Kong, China,Singapore and Hanoi were all related with Metropole Hotel. Three months after the patient left the hotel, samples were taken from the blanket outside the room he had stayed and the elevator he had taken, and positive samples were found through PCR test.

3. The disposal of and response to the event

(1) Vietam

Vietnam was the first country which announced that they had controlled SARS successfully. [9] The success of Vietnam should attribute to the active and effective early prevention and control as well as international cooperation. That is, found SARS patients as soon as possible, knew their whereabouts and contacts, too; effectively isolated patients in hosipital; protected health care workers who were engaged in SARS properly; inspected suspected patients completely and isolated them; conducted exit quarantine on international travelers; notified other countires and international organizations in time and shared information with them.

(2) Singapore [10]

Confronted with SARS, Singapore government quickly responded to the emergency, establihsng ministerial committee, leading the unified national actions, daily announcing the development of the epidemic and easing the worries of the

residents. In fighting against SARS, Singapore built six defences in three aspects: gateway,hospital and community, thus effectively stopped the spread of the disease. The prime minister of Singapore summaried their experiences as "selfdicipline, cooperation, mutual aid and flexibility". Singapore was the second country which announced that they had controlled SARS successfully.

(3) The United States

In fighting against SARS, the American CDC had taken effective measures in research, collaboration and information release. It imediately launched the Laboratory Response Network, speeding up reseaches of SARS test, etiology and treatments. At the same time, health department organized emergency investigation groups to actively carry out investigation on cases home and abroad, enhanced information exchange with international institutions, strengthened monitoring and inspection on tourists from affected areas at airport or port [11], employed the Infectious Disease Network to inspect and actively supervise patients and infected persons [12]. By way of network, hotline and prevention brochures, CDC also introduced the basic knowledge and prevention measures of the disease to people, released health alert in time, informed those tourists who entered America from SARS attacked areas of the situation, adviced them to monitor their health and to provide lists of their signs and symptoms.

(4) Hong Kong, China

Hong Kong, China was the second attacked areas reported after Guang Dong province, China. Since late April 2003, the newly increased number of SARS cases had been declining. In coping with SARS, Hong Kong, China had taken effective public health measures, actively publicizing public health education to the general public. Meanwhile, Hong Kong, China had made efforts in studying effective treatment of SARS, and had cooperated with mainland China and international organizations like WHO[13]. Because the earliest infected cases mainly occurred in hospitals, Hong Kong Department of Health had made particular efforts in controlling hospitals and the training of health care workers. It established hospital ward director system in public hospital and set up infection control network. [14]。 At the same time, families were not allowed to go to hospitals to visit patients; all patients who went to hospitals should wear masks. On March 27, in accordance with Quarantine and prevention of Disease Ordinance, Hong Kong, China forced residents who had

contact with SARS to go to designated clinics for inspection in 10 consecutive days and demanded them staying at home when possible. Soon after the first case of SARS was confirmed in Hong Kong, China, Hong Kong, China established Steering Committee and expert working group, actively carried out invstigtaion and implementing prevention and control measures, it also actively searched for international cooperation. On May 23, WHO lifted its travel advisory against visiting Hong Kong, China.

(5) Mainland China [15]

China's governments at different levels had taken strict measures in epidemic prevention and control, stopping the prevalence of the disease quite quickly. The measures adopted were: mobilizing social forces; implementing classified guidance principle, giving priority to the prevention and control of key areas and key parts; setting up and enhancing Disease Monitoring of Special Case Report system, adopting comprehensive prevention and treatment measures that mainly based on controlling and managing source of infection, exercising early finding,early reporting,early isolating and early treatment. The following measures were taken to treat patients: individual reception, safe transfer, classified isolation,centralized treatment and enhancing disease prevention.

When the epidemic occurred, Chinese government added SARS to the list of notifiable infectious disease stipulated by Law of the PRC on the Prevention and Treatment of Infectious Diseases; on 12 May 2003, the State Council issued and implemented Regualtions on Preparedness for and Response to Emergent Public Health Hazards (Regulations for short); in accodance with the Regulations, the Ministry of Health issued Measures for the prevention and treatment of infectious atypical pneumonia (Measures for short). The formulation and issue of the Regualtions and Measures completed the SARS Emergency Response Mechanism; they were also efforts made to bring public health emergency response on the legal track.

Since 3 February 2003, Guangdong had founded SARS monitoring system throughout the entire province. From 11 February on, the Ministry of Health demanded that SARS surveillance, prevention and treatment work should be carried out nationwide, it also issued atypical pneumonia clinical diagnosis standard and technical schemes of prevention and treatment. Furthermore, in the course of SARS prevention and control, MOH timely revised the clinical diagnosis standard and

monitored case definition. Surveillance sites were set up at health care institutions at different levels, fever clinics were established at medical institutions. From 26 April on, all provinces, all autonomous regions and municipalities reported individual case to MHO at the fastest speed, implemented daily report system, analyzed national epidemic situation in time. Centers for diseases control and prevention at different levels set up open advisory information telephone, improving the sentivity of the monitoring system.

National Disease Supervision Information Management System was used to realize network transmission, analysis, feedback and management. More attention was paid to supervise rural areas, a village based disease surveillance system combining county, and township and village was established and completed. At the same time, more efforts should also be made to monitor schools, measures such as morning check and temporarily closing schools when necessary shall be taken to prevent disease from breaking out at school.

Transportation quarantine system was established, check-up detention station had been set up at important places such as entry-exit port,airport,railway station,bus station and dock, registrating and checking the health situation of flow people.

Poor patients and farmers could receive free treatment. MOH and national CDC organized forces to make out technical schemes of SARS prevention and treatmen according to the changing situation of the epidemic and the latest scientific research findings; they were also reponsible for the training of teachers at provincial level. Each province trained professionals from health care institutions at different levels separately.

Governments at different levels issued daily the epidemic situation, carried out public heath education, provided health counseling, populariezed knowledge of SARS prevention and control; they also carried on patriotic public health campaign and developed a nationwide fitness program that combined SARS prevention and control.

Aiming at solving the problems of SARS prevention and control, the Ministry of Science and Technology unified and coordinated social forces to make great efforts in tackling hard-nut problems such as etiology,rapid diagnostic products,source of infection,spectrum of infection and vaccines. China attached importance to the cooperation with WHO in epidemic information exchaning,field investigation,tackling hard-nut problems in science and technology. It set up working contact mechanism with the Hong Kong Special Administrative Region and the

Macao Special Administrative Region, strengthening epidemic information exchange and cooperation, strengthening academic exchange with other international organizations,research institutions and colleges,the Hong Kong Special Administrative Region and the Macao Special Administrative Region as well as Chinese Taipei region, organizing international academic discussions.

4. The impacts and harms

(1) Health impacts

During the 233 days of the epidemic prevalence, 32 countries and regions were attacked by SARS, there were 8422 probable case (as "clinical diagnostic case"in China), 916 deaths, tens of thousands people were isolated because of suspected cases or contacts with SARS.

(2) Psychological impacts

As an newly occurred infectious disease, the cause,transmission chain, transmission path of SARS are unknown to people, the prevention,control measures and diagnosis methods were also unknown, therefore, there was panic among the population who were confronted with the unknown and suddenly occurred disease. Particularly, the extensive SARS reports from the media gave more psychological hints and pressure on people. During the prevalence, masks and disinfectants had been once out of stock, social stability was heavily influenced by social panic.

The long time stable life had made people feel that they were far from disasters, however, they were very vulnerable once they were confronted with disasters. At the beginning of the prevalence, isolation had been the most effective ways because of the lack of good prevention and treatment. However, living in a stressful isolation circle for a long period would impose negative impacts on people's physical and psychological health. When the prevalence of SARS mitigated, another psychological problems occurred. Some patients were afraid of being discriminated and alienated, thus having anxiety and fear; some people received great attention when isolated, when they got out of quarantine and were alleviated from the disease, the attention they received became less, then some of them suffered from psychological distortion, they relied too much on doctors and expected more attentions from doctors; some felt they were abandoned by the society and got bored and depressed.

(3) Economic impacts

The prevalence of SARS wasn't economic depression, but it greatly affected economic development. According to the statistics from Asian Development Bank (ADB), the total global economic losses amounted to $ 59 billion and the total economic losses of mainland China was $ 17,9 billion, accounting for 1.3% of China's GDP, the total economic losses of Hong Kong, China was $ 12 billion, accounting for 7.6 % of Hong Kong, China's GDP[16]. Because of SARS, Southeast Asia suffered greatly from economic setback, but the situations varied from country to country. The GDP of Singapore decreased from 3.1% to 2.6% compared with the same period in the history, Thailand from 4.1% to 3.1%, Malaysia from 4.2% to 3.7%. Scholars estimated the cost of SARS operations and divided it into 7 aspects: ① the direct cost of treatment: each patient needs as little as 20,000-30,000 RMB and as much as 300,000 RMB ; ② the direct cost of government, society and individual prevention; ③ economic losses caused by the decrease of economic activity volume due to the outbreak of SARS; ④ the increase of transaction cost resulted from unstable epidemic situation; ⑤ the cost that the quality of life decreased; ⑥ the cost that the image of the country was damaged. Economists estimated that the prevalence of SARS in 2003 led to hundreds of billions of economic losses in RMB.

The direct and indirect impacts of SARS in short term were extensive, the key indusries involved were tourism,transportation,commerce and entertainment, the key fields involved were import and export,consumption and consumer confidence. According to the survey conducted by related departments, over 80% residents changed their travel plans because of SARS, since mid-March, visitor arrivals dropped by 6.5% compared to the same period of last year; in April, civil aviation business decreased by 80%; import and export volume in April was 5.9 percentage points lower than the volume on March. [17]

During the prevalence of SARS, many residents purchased lots of daily necessities in order to restrict travels and prepared against the rise in prices. This had once led to rapid sale of daily necessities and obvious rise in prices, some daily necessities had even been out of stock in some places.

III Lessons learned and experiencies

Before this event happened, China generally adopts temporary and compulsory administrative methods to handle emergencies. Although this kind of practice may achieve instant effects under certain circumstances, it often causes waste of resources, interim bodies may be dismissed when the emergency comes to an end, and the valuable experiences in handling emergencies are not summarized. At the same time, seriously insufficient investment in public health and the policy of "working out one's own salvation" had great influence on China's public health system. The SARS emergency has highlighted the vulnerability and ineffiency of China's public health system in every aspect. [18] On 20 May 2003, Wu Yi, the former vice - premier of the State Council and minister of the Minister of Health, summarized China's experienes in fighting against SARS at the Fifty-sixth World Health Assembly held in Geneva:

1. Give full play to the role WHO plays in global public health affairs, promote international cooperation as well as bilateral cooperation. Any disease, particularly those newly occurred diseases caused by pathogens unknown to human beings, is the common enemy of man. It could be handled well only by international and regional cooperation. During the process of preventing and treating SARS, WHO was able to play more part in information exchange,personnel training,technical support and resources utililizing. Each country could make use of their own advantage, actively exploring the cause of the disease, sharing prevention and treatment experiences as well as research findings, coordinating management measures like entry-exit quarantine with each other, thus could prevent the situation from getting worse and avoid losses in economy and social development resulting from overreacting.

2. Establish and complete global emergency mechanism, improve the capacity of handling major diseases. Each country should establish and complete infectious disease surveillance, prevention, treatment and information notificaiotn network, once abnormal condition happens, each country should report timely in accordance with the agreed norms and channels so that related countries could judge correctly and give right response.

3. Economic and social development should keep pace with each other and promote with each other mutually. Economic development is the basis of social progress, social undertakings development like public health and education are the purpose of economic development, and they are also the responsibilities of the government of each country.

IV Introspection on countermeasures

1. Which should be given priority: disease prevention or treatment?

The outbreak of SARS revealed that China's existing health care system was severely incompatible with disease prevention and control. Insufficient investment, bad management, backward system, all these demonstrate that the hardware is not hard enough and the software is too weak, each one was caught unprepared when SARS attacked. Due to the insufficient compensation mechanism, the health and epidemic institutions of mainland China are vulnerable to the outbreak of SARS. Over the long time, the inadequate investment to health and medical service slowed down the building of epidemic system. Strictly speaking, the building of health and epidemic system should be supported by financial subsidies, however, epidemic institutions even could not afford the staff members when there are budgetary strains. Therefore, epidemic institutions have to raise funds by themselves and provide paid service. Few people are willing to dedicate themselves to epidemic control and health surveillance, health care workers seldom reveive training; mechanisms such as the number of epidemic cases, the degree of the disease, the way of reporting the disease, the way of responding to the disease are not complete, all these factors have serious implications on the capacity of health and epidemic system in handling major epidemics and emergencies.

2. "Scientific prevention and treatment" = "vaccines and medicines"?

When SARS was prevalent, its high infection rate and high case fatality rate had caused panic among the population; the key reason was the lack of effective prevention and treatment medicines, therefore, the public had more expectations on the research and producing of vaccines and medicines. When SARS was prevalent, researchers worked day and night on SARS vaccines and medicines, expected the vaccines could be used for prevention and found specific drugs for clinical use as soon as possible. The corresponding departments also initiated urgent research programs, investing large amounts of money in developing vacinnes and medicines.

However, SARS is a kind of RNA virus, its nucleic acid and protein component kept changing and the change has strong randomness. The production of vaccines has its fixed process, only when animal experiments get enough evidence to prove the potency, safety and effectiveness of the vaccine, can it be possible to carry out phase III study of human body experiment, this process needs at least 3-5 years. Of course,

SARS is a special disease, administrative department could provide green channel for the study and producing of the vaccine, but the procedure of verifying the potency and side-effect of the vaccine can not be omitted for any reason, this is a respect and responsibility for life, it is also a respect and responsibility for science, it is also the medical ethics that should be observed by any medical study that involves human being. Therefore, although developing vaccines is the most effective method and means for man to control SARS, it is also certain that human beings are able to find effective vaccines and medicines to cure SARS, we still have to be more practical when confronted with the severe attacks of SARS. Like other infectious disease, the prevalence of SARS requires three links: source of infection, transmission path and susceptible population, besides, the prevalence of SARS was also attributed to the joint efforts of natural factor and social factor. So long as effective measures were taken to cut off the links, the prevalence of SARS would come to an end. It is true that the effective control of the global SARS outbreak did result from effective measures taken to control infection source and to stop the transmission path. So public health is also a kind of science which is more plain and practical, public health system should play better roles in the prevention and treatment of suddenly occurred disease.

3. Isolation

Isolating infection source was considered as the most effective measure to control SARS. If we are able to effectively isolate patients,suspected patients and those who have close contact with SARS and put them under medical observation, it would be not easy for SARS to spread among the population. WHO suggested that those who have contact with confirmed SARS patients should do as follows: have access to SARS information; actively carry out medical observation for 10 days. Public health workers could visit them or call them daily and record their temperature. If the contacts have sysmptoms, they should go to proper local health institutions for diagnosis.

We said that effective isolation should be well implemented, however, it doesn’n mean blind and unselected isolation. In some places, the range of isolation was just simply expanded in order to stop the spread of the epidemic. Althougth this kind of isolation had effectively prevented the spread of the epidemic; it was really a waste from the perspective of cost effectiveness. Governemtns had to organize large quantities of manpower and material resources to arrange the isolated population, the

close of business imposed negative impacts on economy, etc. Therefore, no matter what kind of prevention and treatment measure was taken, it should be confined within limited scopes and has a proper standard for the range.

4. Masks

During the prevalence of SARS, a series of SARS knowledge was disseminated, more and more people began to pay attention to life details that had been neglected in the past and picked up some good habits such as frequently washing their hands, which had been forgotten for a long time. When SARS broke out, more and more people wore masks. However, it should be noticed that wearing masks also requires certain conditions; it doesn't mean that masks could be worn by anyone at any occasion. We suggested that patients should wear masks whether they are attacked by SARS or by common cold for the sake of ourselves and others.

Section 2 Streptococcus suis Infection

From June to August, 2005, human infection with Streptococcus suis epidemic broke out in Sichuan province, China. This is by far the biggest human infection with Streptococcus suis epidemic reported both at home and abroad. 204 people were infected and 38 died in the prevalence of the epidemic. [19]

I The cours of the events

Since late June 2005, in the city of Ziyang, Sichuan, some peasants who were engaged in pig-breeding, pig sale and pork processing suddenly had the symptoms of high fever, body aches and even shock. Since 16 July, people newly infected with Streptococcus suis increased significantly, the number reached the peak on 22 July and began to decrease from 28 July. From 1 August on, the newly infected cases decreased significantly and no new case occurred after 4 August.

At the same time, live pigs' infection with Streptococcus suis occurred in 149 villages, 88 townships, 21 countries and districts, 8 cities like Ziyang, Neijiang, Chengdu, Mianyang, Zigong, Luzhou, Nanchong and Deyang. 647 live pigs died. The epidemic began to appear on 24 June; the number of sick and dead pigs reached the peak around 20 July, thereafter, the epidemic mitigated greatly.

The major characteristics of this epidemic:

(1) The affected areas concentrated relatively in certain regions

The epidemic mainly broke out in cities like Ziyang, Neijiang, Sichuan province, which are zones of epidemic in history. Between the years 1976 to 1982, live pigs infection with Streptococcus suis occurred in Neijiang, Zigong, Chengdu, Mianyang, Sichuan province, the incidence of the disease was 0.1-0.4%. Among the severely attacked eight cities in this epidemic, Ziyang, Neijiang, Zigong and Chengdu belong to zones of epidemic in history, dead and sick pigs in theses regions accounted for 98.3% of the total numbers.

(2) The outbreak emerged with point distribution

In the prevalence of this epidemic, 14.55% towns and villages of the 37 counties and cities were attacked; on average, there were 1.6 cases in each township or village and 1 case in each village. There were 647 sick or dead pigs altogether, 18.64%

townships and villages of the 21 counties and cities were attacked. Averagely, 7 pigs died in each township or village and 4 pigs died in each affected village.

(3) No direct correlation between the epidemic focuses

Laboratory test and epidemiology indicated that human infections were caused by slaughtering pigs without authorization and processing of dead and sick pigs. Most of the animal epidemic focuses were located in relatively isolated areas, only few focuses were located near major roads. The epidemic focuses are quite widely separated and there were no direct epidemiologic correlation between them, this suggested that the possibility of mutual spreading was not high.

(4) The outbreak was seasonal

The investigation indicated that the most severely attacked areas like Ziyang and Neijang had a temperature that was 2℃ above that of the same period of last year and a humidity 2-5 percentage points higher. This outbreak started on 24 June and reached the peak in July, it was the same time when the same epidemic occurred in Neijiang, Sichuan in 1976. The time and climate features were also similar to the epidemic broke out in Nantong, Jiangxi in 1998. All these suggest that Streptococcus suis epidemic outbreak is seasonal.

(5) The epidemic frequently occurs in rural areas

The investigation indicated that all the outbreaks occurred in rural areas which are remote and poor. The animal infection only broke out in free range farms and most of the sites are dark wet places with poor sanitation and poor ventilation. No case of human-to-human transmission was found. About animal infection, the incidence rate of the same group was low.

II The analysis of the event

1. The causes of the outbreak

The prevalence of the epidemic had something to do with the farming practice and the habits in stockbreeding in local areas. In the affected areas, large numbers of pigs were raised in farmer households separately; farmers have the habits of slaughtering sick pigs and eating them. Pathogens could be transmitted through young pigs allocated to the pigsties. The local farmers did not wear protective gear or gloves in slaughtering sick pigs. Normally 1–2 persons carried out the procedure, which

involved bloodletting though a neck artery, manually inflating the carcasses, scalding the pigskin with ≈80°C water, and splitting and shaving the skin with large knives. Scalding and shaving were often performed together. The farmers then sliced the meat into smaller pieces before cooking for food. The complete process of slaughtering could take more than 1 hour. Epidemiology survey demonstrated that all patients had slaughtered sick or dead pigs or had direct contacts with those pigs. We guess that in slaughtering, washing, splitting and processing sick or dead pigs, infection may have occurred through direct exposure of skin wounds.[20]

Investigation demonstrated that patients with Streptococcus suis not only ate plague pork, some one even lived together with pigs, the drinking water wells in some farmer's house were close to the filthy pigsties and manure pits, some villagers made pigsties and manure pit their toilet , etc.

During the whole process, no evidence of pathogen transmission from human to human was identified. Forbidding illegal slaughtering of live pigs and eradicating transmission routes have been the key parts in coping with the outbreak.

2. The operations and response

When the epidemic broke out, the Ministry of Health and the Ministry of Agriculture made timely arrangement, sent out inspection group and expert group to guide and cooperate with local governments in epidemic preventing and controlling. It was quickly confirmed that the outbreak was caused by Streptococcus suis type 2, and documents were immediately made out and issued, they are: The Clinical Symptoms,Key Points in Diagnosis and Treatment,Prevention and Control Measures of Human Infection with Streptococcus suis; The Diagnosis and Verifying Procedure of Human Infection with Streptococcus suis; Technical Specifications of Streptococcus suis Prevention and Treatment. It should be assured that all prevention and control measures have actual effects. [19]

(1) The search and treatment of patients

The city of Ziyang, Sichuan organized experts to train 179 infectious disease doctors from 171 towns and villages. Daily report and zero report of epidemic situation had been put into practice. The related departments actively searched for suspected cases and sent them to designated hospitals for treatments. Special funds,

about 1 million RMB, allocated by the municipal governments of Ziyang, Neijiang, were used for treatment and subsidies.

(2) Strictly implementing epidemic surveillance and reporting system, improving epidemic early warning and reporting capacity as well as early emergency responding capacity

Technical plans were formulated and revised in time, guiding the prevention and control of the disease in a scientific and standard way. For example, documents such as The Scheme of Epidemiology Survey on Human Infection with Streptococcus suis,Case Reporting Procedure and Epidemic Verification and Diagnosis Process,The Investigation and Monitoring Scheme of Streptococcus suis Type 2 Epidemic were made to regulate norms of monitoring and clinical diagnosis. At the same time, all forces from the society were mobilized, professional institutions and professional personnel were brought into full play in the emergency handling work, and a dragnet epidemic survey was conducted in order to find patients or sick animals and gave them timely treatment.

(3) Relying on science and technology, relying on laws and regulations, preventing pathogens from spreading with resolution

According to the provisions of The Law of the PRC on the Prevention and Treatment of Infectious Diseases , Law of the People's Republic of China on Animal Epidemic Prevention, Regulation on Handling Major Animal Epidemic Emergencies, Plan of National Public Health Emergency Response, the emergency response mechanism was immediately launched; close attention was paid to the key parts of prevention and control so as to block the transmission of the disease. The ministry of Health and the Ministry of Agriculture summed up and popularized the practices of Ziyang in time, the specific prevention and control measures were: "five responsibilities"(the city is responsible for the country,the county is responsible for the township,the town ship is responsible for the village, the village is responsible for the household); "three controls"(blockade and control small areas,inspect and test at the crossroads,perform quarantine before the pigs go to the market); "four prohibitions and one disposal"(no slaughtering,no eating,no selling,no transporting, bio-safety

disposal), all the traces of the pathogen were cut and the epidemic was prevented from spreading.

(4) Carrying out prevention work to the point and guard against the epidemic rebound

On one hand, health care personnel made great efforts in epidemiology survey, did their best to treat and cure the patients, reduced the case fatality, carried out extensive health education, enhanced supervision, guidance and inspection; on the other hand, the prevention and control of animal epidemic were strengthened. The pigs that once lived together with sick or dead pigs were injected with high-sensitive antibiotics; farmers in the affected areas were instructed to put preventive medicine into the pig feed so as to improve the pigs' resistance to the disease; periodic sterilization were made in places like pigsty, livestock trading venues and designated slaughter house in the affected areas, therefore, the hygiene conditions were improved. Immediate efforts were made to develop and produce vaccines; emergency immunization was carried out to protect susceptible herds from being attacked in high risk areas like Ziyang.

(5) Giving more publicity to the knowledge of Streptococcus suis Type 2, notifying related international organizations in time

While Interacting with the media, governments also made great efforts in publicizing the path of contagion, clinical symptom, prevention methods of Streptococcus suis Type 2. They tried to make each household put prevention and control work into practice, make each peasant learn the prevention and control knowledge, thus improving farmers' awareness of raising pigs correctly and preventing disease. At the same time, governments released the epidemic situation timely and notified it to WHO, the Hong Kong Special Administrative Region and the Macao Special Administrative Region. [19]

On 29 July, 2005, the Ministry of Agriculture held the meeting of Streptococcus suis Type 2 prevention and control, directors of the departments of veterinary and experts from related research institutions who came from 11 provinces or cities like Sichuan, Chongqing attended the meeting. Prevention and control work was arranged. Related labs were organized and immediately got to work on the diagnosis and identification. Related research institutions and 2 vaccine production enterprises were

also organized to produce vaccines at once, to make out the procedure of using medicine to prevent the disease and get immunity.

The State Administration for Industry and Commerce delivered notices on 6 August 2005, demanding that industrial and commercial administrations at different levels pay more attention to market inspection. Before the Streptococcus suis Type 2 epidemic was removed, more efforts should be made to supervise the wholesale meat markets, to conduct dynamic supervision on trading activities. Industrial and commercial administrations should take strict measures in market access, complete the institution of asking for bills and receipts, enhance supervision and inspection on the implementation of the system of asking the operators for bills and receipts, prevent meat products without quarantine certificate and qualified documents from the market, establish and complete the management measures of selling meat products with license certificate. The business operators of meat products in the markets should run their business with license and certificate that show the producing places, quarantine certificate and sales commitments. The responsibilities and responsibility tracing of the market owners and the operators in the market in preventing and controlling the spread of Streptococcus suis Type 2 should be clarified. The system of market owner shouldering the responsibility should be enhanced.

General Administration of Quality Supervision, Inspection and Quarantine also issued urgent notice on 4 August, 2005, demanding that inspection and quarantine administrations at different levels further enhance the work of inspection and quarantine, strengthen the inspection and quarantine of importing and exporting animals as well as animal products, pay special attention to the item of Streptococcus inspection and quarantine. Inspection and quarantine administrations were also required to strengthen the inspection and quarantine of entry - exit persons, closely monitor the hygiene conditions of entry - exit persons from highly risk areas. Local governments should work on the monitoring and inspection of Streptococcus suis Type 2 in accordance with the provisions of The Scheme of Streptococcus suis Type 2 Monitoring and Inspection laid out by the General Administration and consider their actual conditions at the same time. The notice also demands that inspection and quarantine administrations at different levels organize special inspection of export enterprises, forbid export enterprises to purchase pigs from pig farms without registration and record to produce meat products and export them. Inspection and quarantine administrations should also instruct enterprises in epidemic prevention and

meat production, making sure that the export products are safe and clean. Quality and technology supervision departments should take strict measures in implementing food quality and safety market access system, carry out supervision and random inspection, guide food producing and processing enterprises to fix their pork purchasing channels and strengthen their verification of the inspection and quarantine certificate, to establish raw material purchasing record system and stock them well. Processing sick or dead pigs for food is forbidden.

3. The impacts

This time all the live pigs' epidemic broke out in rural areas where farmers adopted scattered breeding of pigs and the breeding conditions were poor. However, worrying about the disease, local residents dare not buy and eat pork; in some regions, the pork and live pig price declined and the sales volume decreased, too. Some large scale animal products processing enterprises also suffered from this. A Ziyang based large modern enterprise group mainly purchases live pigs from 198 export Registration pig farms,pig homes with standard breeding and large scale pig farms, the enterprise is strict in the inspection and quarantine before and after the slaughtering of live pigs, however, due to the outbreak of the epidemic, the sales volume of this company decreased sharply by 80% , its products have gone off the shelves in Hong Kong, China, the sales in other regions were also stagnant. [21]

III Lessons learned

When animal husbandry benefits mankind, it also imposes great threats to them because some disease may infect both human beings and animals. The organic and harmonious unify of developing animal husbandry and benefiting mankind is a significant proposition deserving serious consideration.

An indisputable fact is that human destiny and animal destiny are coexistent and co-prosper; we are all in the same boat. The study of medical experts proves that over 70% of the 200 known animal infectious diseases on China could attack mankind.

It is wise to protect animal and maintain their welfare when human beings want to protect themselves. To prevent mankind from the diseases that could attack both mankind and animals, we should promote healthy animal feeding and treat animals friendly. First of all, animal feeding should be scientific, the feeding density should be

reasonable; the environment should be clean, thus reducing the incidence rate. Secondly, livestock-raisers should pay great attention to vaccination and immunoprophylaxi, improve animals' level of immune antibody. When the breeding conditions are improved substantially, disinfection could also be adopted to clean the environment and improve animals own capacity in protecting themselves from disease. Thirdly, antibiotic misuse should be avoided, otherwise pathogen may become antibiotic-resistant and mutate, thus cause the prevalence of new epidemic.

To protect human beings from anthropozoonosis, the key point is avoiding contact with sick, dead livestock or poultry as well as their products. When animal raisers find sick or dead livestock and poultry, they should repot to local veterinarians and ask them to diagnose it, whether bio-safety disposal should be made depends on the situations of the disease. Business dealers should not purchase, slaughter sick,dead livestock or poultry, they should purchase livestock or poultry with inspection and quarantine certificate, consumers should not purchase animal products without inspection and quarantine certificate, they'd better go to standard units like farmers' market or supermarket to buy animal products. If we don't sell, don't slaughter, don't purchase and eat sick,dead livestock or poultry and their products, carry out bio-safety disposal of sick,dead livestock or poultry, we will be able to prevent the transmission path of the disease that could attack both mankind and animals, to avoid human infection and the outbreak of the disease.[22]

Chapter 2 Chemical Poisoning

Section 1 "Methyl Isocyanine (MIC) Release Event" in the Union Carbide India Ltd. (UCIL) in Bhopal

I. Course of the Event

At 11 o'clock in the night of 2 December 1984, the local residents in Bhopal India were in deep sleep. In the underground workshop of MIC storage tanks in the UCIL pesticide factory in Bhopal City, a maintenance worker discovered that the temperature on Tank 3 rose to 38℃ while the temperature of the workshop was only 11℃ and furthermore, the reading in the pressure gauge was also rising fast. He tried to reduce the pressure by hand valve (the automatic valve had been damaged), but in vein. Then he reported this to the section chief immediately and then four workers, wearing gas masks, hurried to Tank 3 and did the repairs with simple tools, but again in vein.

Storage Tank 3 contained 45 tons of MIC, with the boiling point of 39℃～40℃. The continuous rise of temperature and dramatic increase of reading in the pressure gauge meant that the liquid MIC had been vaporized and the enormous pressure generated by this vaporization would force open the valve of the tank and the poisonous gas would be released at any time. Hearing this, 120 workers on night shift of the factory were suddenly shocked. All of them stopped their work and fled home except a worker named Ahmad who still stayed in front of the tank, fighting alone. At the same time, another worker rang the siren to send alarm to the whole city of Bhopal.

At 1:00 a.m. on 3 December, a great noise could be heard from the factory. Since the safety valve failed to work, a great amount of MIC gas was spread to the atmosphere in the morning, staying in the sky of the Bhopal and soon covered an area of 40 km^2. People there were awakened from their sleep, with the syndromes of coughing, respiratory distress and eye irritation. Many of them died during their escape from the disaster, and some died in the first aid room of hospitals. Dead human bodies and animals were seen on the streets of the city within hours[23].

One hour later, the authorities of Bhopal city sent technicians from Bharat Heavy Electric Ltd. to the factory. They sealed Tank 3, but all the 45 tons of poisonous MIC had almost leaked out [24].

On 1:15 a.m., the first victim staggered into Hamidia Hospital and within an hour thousands of victims flooded into all the five hospitals of the City. In Hamidia Hospital, the largest hospital of the City, the beds filled everywhere, and then there were two to a bed. The prior bed tenants were bundled off to their homes unless gravely ill. Then the floors were lined with mats and tents were set up on the grounds. Doctors there hadn't effective therapies except giving wet surgical cotton to soothe the victims' eyes. Most of the poisonous gas hadn't been cleared up until 7 December.

II Analysis on the Event

1. Causes of the Event[26]

(1) Gas Leak

The heat generated by the reaction of MIC with water was much higher than the boiling point of MIC. On the day of accident, a small amount of water went into MIC storage tank through pipes and turned liquid MIC into gas which produced a lot of pressure within the tank and the gas was then leaked into the air through pipes.

(2) Improper site of the factory

The factory was only 2.5 km from the downtown area of Bhopal City. Many Indians settled in the neighboring area of the factory due to the convenient transportation and sufficient water sources here.

(3) Improper MIC disposal

The MIC was stored in 3 tanks, with each having a holding capacity of 15,000 gallons. All the three tanks were filled with MIC and none of them were empty for emergency use. In the U.S. and Japan MIC was used and stored only for a short time or temporarily and there was not such a huge amount of MIC as in Bhopal. Tank 610 stored 6.4 tons of MIC for more than 55 days, accounting for 87% of its holding capacity, which exceeded the limit of 60%. According to the manual of UCIL, alarm should be sent out when the temperature is above 11℃, but the alarming temperature was set at 20℃ in Bhopal.

(4) Malfunction of safety devices and poor maintenance

The vent gas scrubber and flare tower didn't function well; otherwise they could have dealt with small amount of leak. The water spray system was operating, but it could only spray to a height of 12-15m while the height of MIC was 50m. Moreover, there's a lack of training on workers, lack of person in charge, lack of effective public early warning system and the failure of gas leak alarm to warn people at the earliest time since the alarm wasn't different from any other kinds of alarms. Negligence in management and lack of equipment updating was another cause of the disaster. The drought in1977 forced many farmers in India to borrow money from the government and buy cheaper pesticide, which led to the reduction in the profit of the factory. As a result, the factory began to neglect management and stop updating its devices.

(5) Late and misleading warning

Late and misleading warning about the MIC leak increased the human cost of the disaster. The leak was detected at 11:30 PM on December 2; however, the warning signal was started 2 hours later at 1:30 AM on December 3. During these 2 hours, many people were awakened from their sleep because their eyes and throats were severely irritated by the poison gas and soon they died. The actual duration of the MIC leak is estimated to be 45 minutes to 60 minutes. When MIC started spewing in huge quantities, the only useful warning was to ask people not to run but rather lie down on the ground and cover their faces with wet cloths. However, many people failed to take right actions and breathed large amounts of toxic gas after hearing the warning signals. When the disaster was approaching, the UCIL didn't give any warnings to the local residents and didn't even give them the general suggestion-"Don't worry, stay at home and keep your eyes wet" when the deadly gas (including MIC, hydrogen cyanide and other poison gases) leaked out of the storage tank.

2. Event Disposal

Several hours after the accident, the police of Bhopal closed the factory and arrested its manager and some workers being accused of "manslaughter".

(1) Emergency evaluation of workers

All the workers escaped from the plant were told to leave the city, run in the opposite direction and cover their eyes with wet cloth [27].

(2) Emergency medical rescue

Several hours after the gas leak accident, hundreds of victims flooded to Hamidia Hospital, the largest hospital in Bhopal. Although 350 doctors and 1000 nurses in the hospital had already been prepared, there's still a serious shortage of medical personnel to treat so many patients. Given this situation, the hospital had to set up a medical team with 500 students from medical schools. Since all the 750 beds of the hospital were filled with gas-affected patient, some patients had to wait outside the hospital. The Bhopal University hospital was also involved in the rescue work and the 450 doctors there saved thousands of lives on 3-4 December. All the hospitals of the City were crowded with patients[28].

In the aftermath of the event, the Indian Council of Medical Research (ICMR) and other scientific research institutions in Indian worked together on the search for toxicological effect of the poison gas leak and the investigation into survivors. 10 days after the accident, therapies such as detoxification were put forwarded by ICMR and various researches on postmortem examination, bio-chemical and chemical toxicology etc. were also carried out. The Indian government did a lot of rehabilitation and relief work. At the beginning of the accident, it sent many doctors, researchers and chemical experts to Bhopal City so as to carry out examinations on 40% of the city's residents who were most seriously affected. It also built up new hospitals and installed more medical facilities in the city.

3. Impact of the Event

(1) Coverage

It is estimated that 3,800 people died soon after the accident, many of whom came from the slums adjacent to the Union Carbide Corporation (UCC) plant, and 10,000 died in the following days after the accident. In addition, another 15,000 to 20,000 died from the gas-related diseases during 20 years after the accident. According to the report from the Indian Government, more than 500,000 people were exposed to the MIC gas and the accident caused 122 cases of abortion and death, 9 babies born with deformity and 77 babies died soon after their births. Although the dead couldn't feel pain any longer, tens of thousands of people are still living in the pain caused by the gas disaster. All the survivors have respiratory troubles and thus are not able to do heavy physical work; 120,000-150,000 people suffer such chronic

diseases as tuberculosis and cancer, etc; and many others have psychological problems after witnessing the deaths of their beloved in the disaster[29].

(2) Environmental Impact

20 years after the accident, there were still 8,000 tons of poisonous residues in the abandoned chemical plant. The Green Peace estimated that the amount of poisonous materials was nearly 2.5 tons according to relevant data about the raw material storage before the accident. The underground water in Bhopal became inedible as it was polluted by toxic chemical materials including quicksilver. The pollution originates from many years of UCC plant operation, not only from the gas disaster[30].

(3) Social Impact

In March 1985 the Indian Government announced the "Bhopal Gas Leak Disaster Act" as a rapid and just way of claiming for compensations. According to the Act, Government of India should act as the only legal representative for victims of the disaster. All the gas-related cases in the U.S. judicial system were terminated and then transferred to Indian court. After the terminal arbitration by the Indian Supreme Court, the UCC paid US$470million as compensation to the Government of India who then paid the money to the victims. The compensation was based on 3000 deaths and 102,000 permanently disabling injuries. After the final arbitration, the price of UCC stocks increased by US$2 per share. By the end of October 2003, the compensation was distributed to 554,895 injured victims and 15,310 families of the dead who received US$2200 each[23].

III Experience and Lessons[31]

The Bhopal disaster told us that it's very necessary to conduct prediction and early warning against risks near a chemical plant. Meanwhile, it should be noted that not only the original chemicals but also chemical derivatives may affect people and that studies on small accident can provide helpful clues for detecting the possible big disasters in the future.

1. Treat possible accidents seriously in chemical production

It can be seen from the Bhopal accident that serious accidents may occur in chemical production, thus we shouldn't take the frequent minor accidents for granted and pay little attention to them. The production technology and equipment of the plant in Bhopal were quite advanced, with MIC underground refrigerated storage,

nitrogenizaiton, temperature and pressure reporting as well as multi-level “defensive lines” such as vent gas scrubber, flare tower and spray faucet and multiple nitrogen filling devices. But all these devices lost their functions or couldn’t be used on 3 December.

2. Prevent transfer of damages

Transfer of damages is quite common in the world today. The UCC adopted very different attitudes to its U.S.-based plants and that in India. It didn’t give any information to the Indian side and tried to cover up the facts even though there were obviously frequent accidents and risks. The U.S. multinationals also have other plants in Brazil. These plants were ordered by the Brazilian government to stop production after the Bhopal accident and also MIC shipment was not allowed at the seaport dock. Neyes, the then president of Brazil, once said that it is committing a crime to develop industry without environmental protection. Therefore, safety, health and environmental protection should be carefully taken into consideration in introducing new technologies and developing township and village industry.

3. Establish legal system to strengthen supervision

In India, there were no laws and regulations on safety and hygienic production for factories, no supervisions on labor protection and industrial hygiene except standards for 36 chemicals, which was the reason for the big disaster. Within the 7 weeks after Bhopal pesticide accident, at least 7 members of the U.S. Congress put forward proposals on the revision and enlargement of relevant laws and regulations, requiring enhancement of safety management over dangerous chemicals. The Environmental Protection Agency carried out examinations to thousands of underground chemical storage tanks in the country and the OECD (Organization of Economic Cooperation and Development) also issued the applied standards and guidelines.

4. Enhance safety production management

The loose management, long-term idleness of protection equipment or their failure to operate in the accident was one of the reasons for the accident in Bhopal pesticide plant. The lack of safety production equipment, well-established system and strict management had already been the lessons drawn from many accidents.

5. Enhance technical and safety training for employees

The plant and Corporation should be responsible for technical and safety training for its workers. It is the worst practice in operation to transfer their responsibility to workers after the accident without offering trainings and information to workers. Workers and residents in neighboring areas have the right to know what are the possible risks and dangers in the production of the plant and how to act in case of accident. Drills should also be carried out if necessary.

6. Professional training for safety and health personnel

In the areas where disastrous accident may occur, professional rescue agencies should be available and some of them can work together with fire departments. Health and medical personnel should know the clinical manifestation of possible chemical poisoning and methods of rescue and treatment, and they should also be prepared in medical equipment, medicine, and human resources.

Section 2 Gas Well Blowout Accident in Chongqing, China

I. The Course of the Event

At 21:55 on 23 December 2003, slurry overflow was discovered in a gas well named Luojia16H in Chongqing Municipality. The overflow had not been brought under control after various measures were taken by the drilling crew. At 22:04 the blowout was completely out of control and a large amount of natural gas containing hydrogen sulphide was released, causing many deaths and casualties of people, livestock and wild lives. At 15:55 on 24 December, the gas in Luojia 16H was ignited successfully and by then the gas containing hydrogen sulphide had been released continuously for 18 hours. 65 people were discovered and rescued from the scene, of which 8 died. 33,100 people were evacuated except those who moved in the direction of Xuanhan County of Sichuan Province (the number of them couldn't be calculated). With the continuous efforts of search and rescue, the death toll rose up to 70 at midday of 25 December. At 11:00 on 27 December, the well was successfully capped and the blowout accident lasting for about 85 hours was finally brought under control. The total number of people evacuated from the disaster-hit area amounted to 65,632 and by 9 February 2004, the accumulated number of injured persons receiving treatment in outpatient departments was 26,555 persons (times) and 2,142 people were hospitalized[32].

II Analysis on the Event

1. Causes of the Event

(1) Direct Causes

1) The time for mud circulation before pulling out of hole was not sufficient. According to operating rules, the time for mud circulation should be 90 minutes before pulling out of hole, but the actual time spent on mud circulation was only 35 minutes, causing failures in letting out all the well gas and rock cuttings and thus affecting the density and sealing function of mud column.

2) The density and sealing function of mud column was also affected by pulling out of hole without running drilling tools into the well to circulate mud sufficiently after long-term outage maintenance

3) The mud injection was not conducted according to the requirement during the process of pulling out of hole. It is required that the mud injection should be conducted once after lift of 3 drill pipes, but in the actual operation of the accident-related well, 9 mud injections was done after lift of more than 3 drill pipes, of which one was done even after lift of 9 drill pipes. As a result, there wasn't enough mud in the well to fill up the space left by lifting drilling tools and the sealing function of mud column became too weak to overcome the "piston pulling" effect caused by lifting drilling tools.

4) The sign of overflow wasn't detected at an early time. Because of workplace negligence, the gas field logging instrument was not carefully observed and signs such as changes of mud flow were not detected in a timely manner.

5) The back-pressure valve for preventing internal blowout was torn down from the drilling tools, which violated the operating rules. The workers violated relevant operating rules and torn down the back-pressure valve, thus the drill pipes lost its control functions and the blowout got out of control.

6) Ignition of gas was not conducted timely to burn the gas with a high concentration of hydrogen sulphide, causing the release of enormous amount of poisonous hydrogen sulphide which led to many deaths and casualties.

(2) Management deficiencies

1) The safety production responsibility system was not implemented. As a result of loose management on the well field, directions and operations were seriously against the operating rules.

2) The design of the well field was poor and not examined strictly. Priority items such as the residential areas surrounding the gas field were not clearly marked in the project design according to relevant safety standards. Safety assessment and examination were not conducted and there's also a lack of risk analysis and argumentation.

3) The emergency plan for the accident wasn't well- established. The drilling crew failed to work out any "emergency plan" regarding the public, to establish a "joint emergency response system" and ways of contact in emergency situation, to report the accident to the local government promptly, and to inform the public of the direction and distance of evacuation as well as measures to avoid risks, which made the local government very passive in emergency response and disposal.

4) The Gas Company, with high risk operations, didn't give any safety information to the society. The well crew didn't inform the local government of the potential risks of the production operations, the possible accidents and damages, as well as accident-related emergency response measures and plans, nor did they give any education to the public. As a result, both the local government and the public didn't know the possible damages that the accident might bring common sense about emergency protection, and measures to avoid risks. Because of the lack of knowledge about hydrogen sulphide poisoning and how to avoid risks, the damage of the accident was aggravated and some evacuated villagers returned to their homes when seeing no explosions and fire produced by the blowout and soon died from poisoning[5].

2. Emergency Disposal and Response

(1) Emergency mobilization

At 22:30 on 23 December, after the failure in their blowout control efforts, the gas well workers told the neighboring residents to evacuate and reported the accident to the superior department. At 23:00 Chongqing Municipal Government received the accident report and urged the Government of Kaixian County to evacuate the local people as soon as possible. The latter immediately arranged the evacuation at the Gaoqiao Town and at the same time mobilized relevant functional departments of the County to immediately go to the site for rescue. In the afternoon of 24 December, officials in the relevant departments of Chongqing Municipal Government and a professional rescue team rushed to Kaixian County and established a "12·23" rescue headquarters responsible for organizing rescue efforts. The Municipal Government established the rescue headquarters consisting of five subordinating work groups responsible for frontline commanding, traffic control, rear-service ensurance, medical aid and information communication respectively. The rescue effort involved altogether about 12,000 government employees, 1,500 officers and soldiers of army forces, police and firemen at Chongqing, 1,400 medical workers and 2,800 members of militia and reserves. As soon as the members of headquarters arrived at the accident site, they immediately conducted assessment on the accident and situation, defined the nature of the event and countermeasures and collected and analyzed the information about disaster situation and emergency response all time so as to provide reference for the coordination and decision-making of the headquarters.

(2) On-site Disposal

During this accident, all the residents within a radius of 5km of the mouth of the well were evacuated and 15 centralized rescue and concertrated shelters were set up in places more than 5km away from the well. The number of evacuated people reached 65,632. On 25 and 26 December, 20 and 102 search and rescue teams were established respectively to carry out net search and rescue effort within a radius of 5km of the mouth of the well. Thanks to the efforts, over 900 people staying in the hazardous zone were discovered and saved. In order to ensure that the disaster-hit people "have enough food and clothes so as to be free from hunger and cold", the government quickly allocated and transported 45,000 beds, over 85,000 pieces of clothes and 150 tons of rice as disaster relief supplies to the disaster-hit zone. Meanwhile, in order to maintain a good public order after the disaster, 2000 police were sent to the rescue and concertrated shelters. A system of guiding public opinions on emergency was established to bring the leading role of mainstream media into full play in guiding public opinions, which provided strong support of public opinions for the rescue and rehabilitation efforts.

A health emergency response headquarters was set up in the disaster-hit area and it worked out a comprehensive plan including medical rescue, health surveillance, on-site sterilization, health education and hygiene supervision, as well as an implementation plan for various efforts. At the early stage of the blowout, an emergency medical care station was established on the frontline of the disaster-hit area so as to rescue patients. Later, 18 temporary medial rescue stations and 10 circuit medical teams were established as more rescue efforts were needed. The People's Hospital and the Hospital of Chinese Medicine in Kaixian County were mainly responsible for accepting and treating critically ill patients. After the disaster, efforts were focused on the diet health, environmental health, disease surveillance and health education, for example, the regular ventilation in concertrated shelters, preventive sterilization of the environment, innocuous treatment of domestic garbage, daily reporting of disease diagnosis and treatment by the medical stations and close watch on infections diseases. During the event, various channels of education such as television and radio etc. were employed to inform the general public of the real situation of the disaster, the risk prevention, identification and control measures as

well as common sense about health and matters that should be noted by villagers who would return home[33]。.

3. Impacts of the Event

(1) Environmental Impact [34]

The H_2S was quickly spread to the atmosphere after the blowout and H_2S concentration rose to a high level around the gas well and then dropped immediately after the gas ignition, and finally to a level below the national standard 18 hours after the ignition. On 27 December, a random sample survey was conducted on the water quality of more than 10 villages near the gas well. Among the 70 drinking water samples, 11 contained H_2S above the national standards, including 2 pond water samples, 2 well water samples and 7 water samples from the jars of local residents.

(2) Health Impact[33]

The event involved 4 towns and 30 villages near the well mouth and the evacuation of 65,000 people, causing poisoning of an enormous number of people, deaths of 243 villagers and well workers who failed to evacuate, and the death of most of the animals near the well mouth. Moreover, 32,584 persons saw the doctors as being sick or injured, of which 2,139 were hospitalized. Among the 243 people (241villagers and 2 well workers) who died in the disaster, 236 died directly from gas poisoning and 2 died from a car accident in the evacuation, and several died from original diseases aggravated by gas poisoning. By 12:00 on 4 January 2004, the injured and sick people accepting diagnosis and treatment in various hospitals and medical stations totaled 32,584 (persons/times), among which 2,139 were hospitalized. Most of the hospitalized patients showed the symptoms of nervous system such as dizziness and headache, some showed the symptom of eye irritation such as conjunctival hyperemia and chemosis, etc.

III Experience and Lessons

1. Consolidate the “safety first” concept, strengthen safety management and implement responsibility system for safety production

The responsibility system for safety production should be improved to clearly define the tasks and responsibilities of departments at various levels and people on various posts and strictly evaluate their performance. The petroleum and chemical

sectors that may cause social disasters and their subordinating units should inform the local government of the potential risks, possible accidents and damages of their production and operations, as well as the emergency response and protective measures and plans, and submit to the safety production supervision of local government. The local governments must integrate these enterprises into their safety production supervision efforts and safety production responsibility appraisal system in accordance with the principle of "localized management of safety production", get information from these enterprises actively so as to know the dynamic changes in the hidden risk of serious accidents and strengthen supervision and management according to the law.

2. Establish and improve emergency rescue system

The enterprises should work out a scientific, comprehensive and feasible emergency plan for the accident, be equipped with protective and emergency devices and conduct drills carefully so as to test and improve their emergency plans continuously. Meanwhile, the local government should pay attention to the connection and interaction between the emergency plans of both sides (government and enterprises), integrate the emergency rescue of enterprises for serious accidents into the overall emergency response and rescue system of the society and establish a reliable way of contact and a feasible plan of joint action so as to achieve the goal of controlling disasters, reducing losses, protecting the safety of people's lives and property, and maintaining social stability.

3. Revise, improve and implement the national and industry standards for safety production

The relevant departments should examine and straighten out various safety production standards and rules in petro and chemical industries that may cause social disasters and revise those that failed to meet the requirements so as to improve safety production technologies. Meanwhile, construction projects should be strictly examined and approved after undergoing relevant procedures and supervision should be carried out to ensure that enterprises can strictly follow relevant national and industry standards for safety production.

4. Carry out work on education

Education work should be carried out by local governments to enterprises and their subordinating units and let them have the general knowledge of disastrous accidents that may happen in the local areas.

Chapter 3 Food Safety

Section 1 The Event of "Toxic Bean Sprouts" in Germany

In May 2011, Germany saw a HUS/EHEC outbreak of the largest scale in its history. This HUS outbreak was also seen in its largest scale in the world according to the number of the reported HUS cases. Cases of infection were reported from all federal states of Germany, but the 5 northern states were most seriously affected (including Hamburg, Schleswig-Holstein, Bremen, Mecklenburg-WesternPomerania and Lower Saxony) Moreover, cases of the infection were also discovered in Britain, Sweden, Danmark and Netherlands. This outbreak was caused by serotype O104 :H4 and was quite different from the previous HUS/EHEC cases which were caused by other serotypes because the victims of the infection were not only childeren, but those above the age of 40 on average. On May 22, the number of cases rose up to its peak and then started to decline on June 9. The outbreak lasted for 2 months and ended on July 26 when Robert Koch Institute (RKI) of Germany announced that the outbreak was over.

I. The Course of the Event

The first outbreak-associated case-patient fell ill on May 1, followed by a sharp increase in the number of HUS case-patients on May 9.

On May 18, the first outbreak-associated case (patient's onset of diarrhea was May 2) was reported to RKI. On the same day, a local hospital notified the local health department of Hamburg North about a cluster of HUS in 3 children[36]. RKI was alerted to the outbreak cluster on May 19 by email. On May 20, a team from RKI arrived in Hamburg to assist with the public health investigation. It quickly became clear that the case numbers were continuing to rise, that there were also cases in adults, and that other areas of Germany, especially northern Germany, were also affected[37]. Case numbers peaked around May 22. On May 23, the local health departments and state health departments agreed to report cases every working day.[36]。

At the end of May after the EHEC outbreak in Germany, the Hamburg medical laboratory conducted bacteria nurturing experiment and the result suggested that the serotype might be carried by cucumbers from Spain. On May 31, The European

Commission was informed that the results of tests on cucumbers made by the Hamburg (Germany) authority did not confirm the presence of the STEC serotype O104, which is responsible for the outbreak, despite the fact that the sampled cucumbers tested positive for STEC. Cucumbers were considered as one of the possible sources responsible for the Shiga toxin-producing E. Coli (STEC) outbreak affecting Germany and other Member States.[38]。According to the report of RKI on June 9, the number of notified HUS/EHEC cases reported to it declined over the past few days. The daily absolute and relative numbers of patients presenting to hospital emergency departments also decreased. On July 26, RKI announced the end of the outbreak[39,40]。

II Analysis of the Event

1. Cause of the Event

On 10 June, authorities from RKI, the Federal Institute for Risk Assessment and the Federal Office of Consumer Protection and Food Safety jointly stated that mounting epidemiological and food-chain evidence indicated that "bean and seed sprouts" (including fenugreek, mung beans, lentils, adzuki beans and alfalfa) are the source of the outbreak in Germany caused by the O104:H4 bacteria. The outbreak remains primarily centred in Germany.

2. Disposal of and Response to the Event

(1) Early Warning

On May 22, the German government informed EU member states of the EHEC outbreak through the EU Early Warning and Response System (EWRS). On May 24, the German government sent an official report on the event to WHO, taking the event as a potential public health crisis of international concern.

(2) Standardization of Clinical Diognosis and Report

After the outbreak of the event, the existing RKI surveillance case definition was adapted to the outbreak situation to ensure systematic data collection. Modifications included limitations of time (onset of disease from 1 May 2011), place (epidemiological link to Germany) and person (e.g. consumption of a food item that was acquired in Germany) concerning exposure as well as inclusion of suspected

cases. From May 26, a uniform and specific reporting form was used by clinicians in reporting HUS cases.

(3) Enhancement of Emergency Surveillance

1) Centralising the epidemiological information exchange**:** On May 23, 2011, the 'Lagezentrum' at the RKI was activated as a central emergency operations centre. A large number of RKI staff was involved in coordinating the collection of epidemiologic information and organising the public health response. From May 23 onwards, teleconferences were conducted almost daily with the responsible state, national and international authorities. Starting on May 24, epidemiological reports were distributed daily to the responsible authorities, physicians and laboratories to feed back relevant information.

2) Accelerating the data flow to the national level: From 23 to 27 May 2011, state health authorities were asked to transmit aggregated data via email on a daily basis to the RKI. On May 27, health authorities could transmit data via the electronic surveillance system daily, thus the case by case reporting could overtake the aggregated reporting

3) Implementing a syndromic surveillance system for bloody diarrhoea in emergency departments: Since STEC patients often present with bloody diarrhoea, emergency departments (ED) constitute appropriate facilities for the assessment of the temporal trend of an STEC-outbreak. They implemented the surveillance of patients with and without bloody diarrhoea on May 27.

4) Initiating active laboratory surveillance: Since May 25, the RKI has asked four laboratories for daily data transfer via email or telephone. On June 12, it was confirmed through the regular legal system that among the 3228 STEC/HUS cases, 195 (6%) had been caused by STEC/VTECO104 and the data from the acitive surveillance system indicated that at least 335 sample cases were linked to the outbreak-associated serotype.

5) Regional Cooperation: the CDC of Erurope and WHO established close contacts with Germany and other countries so as to assist the investigation.

6) Stress on information release: reports on the outbreak situation were distributed daily by RKI to EWRS, EPIS and WHO. Several outbreak-related articles were published in *Euro surveillance* and the *German Epidemiological Bulletin*. The public was regularly informed of the outbreak situation via the RKI website starting on May 23, and press releases were issued on June 3 and 10.

(4) Accelerating the determination of food contamination sources

Since May 20, 2011, the RKI has been investigating the outbreak in collaboration with health and food safety authorities of the federal and state governments and has adopted a series of epidemiological researches to look for the source of contamination. It conducted analysis on an satellite outbreak in two canteens of a Frankfurt-based company, implemented "recipe-based restaurant cohort study", and carried out case-control studies on raw vegetables in three worst affected cities.

(5) Assessing HUS treatment capacities in Germany

From 30 May onwards, the German Society for Nephrology collected data on the HUS treatment capacities in Germany and reported these regularly via email to the RKI.

(6) Implementing health education

Since 24 May, the Federal Centre for Health Education has provided outbreak-related public health advice to the public. On 10 June, the authorities recommended that people in Germany should not eat raw bean and seed sprouts of any origin. Households, caterers and restaurants should dispose of any bean and seed sprouts that they have, and any food items that might have been in contact with them. Meanwhile, they recommended withdrawal from the market of all food products from a farm in Lower Saxony, where the implicated bean and seed sprouts originated. The authorities also recommended strict adherence to general hygiene advice when handling food items, after using the toilet and when health professionals are in contact with patients [41].

3. Impacts of the Event

(1) Health impact

By July 25, a total of 4,321 cases had been reported to the RKI, including 3,469 EHEC cases and 852 HUS cases. In total 50 patients died, including 18 EHEC patients and 32 HUS patients. According to the European Centre for Disease Prevention and Control, 76 EHEC and 49 HUS cases (as of July 22, 2011) were reported across other countries of the European Union[40].

(2) Social impact

Since 27 May, the prices of many vegetables in France have dropped by 35% and the sales volume of cucumbers in the food wholesale market (the largest in Europe) of

southern France have decreased by more than 80%. Due to the stagnation in sales of vegetables, farmers in Spain and France had to destroy vegetables produced by themselves.

After the EHEC outbreak in Germany, Russia immediately announced bans on import of tomatoes, cucumbers and lettuce from Germany and Spain. Although the EU has cancelled its warnings to avoid eating cucumbers produced by Spain across the whole Europe, consumers are still concerning about the safety of raw fruits and vegetables, and more "scared of" cucumbers and tomatoes.

(3) Economic losses

By June 7, EU Ministers held an emergency meeting in Luxembourg and proposed issuing 150million Euros as an agricultural compensation to their farmers who had suffered losses from the EHEC outbreak. But some major agricultural countries in EU were dissatisfied with this compensation deal, saying that the sum was too small to compensate for the losses of farmers. Then On June 8, the European Commission increased its offer of compensation from 150million Euros to 210 million Euros and at the same time raised the percentage of compensation for losses (with the maximum of 70%). According to the estimation made by the Association of European Businesses, the EHEC outbreak caused a weekly loss of 400 million Euros to fruit and vegetable producers in Europe, with Spanish farmers suffering a weekly loss of 200 million Euros and German farmers, 30million Euros[42].

III. Experience and Lessons from the Event

In the context of the outbreak it became immediately clear that the provisions of the routine surveillance system were not sufficient for an adequate emergency response. In Germany, STEC/VTEC and HUS are reported through legal procedures according to the *Protection against Infection Act.* While STEC/VTEC surveillance is based on laboratory analyses, HUS surveillance relies on physicians. Heads of laboratories and physicians must report cases to the local health authorities within 24 hours. The incoming data is validated by the local health authorities and documented electronically. Cases fulfilling the surveillance case definition as issued by RKI are transmitted in anonymous form to the state health authorities by the third working day of the following week. The state health authorities again validate incoming cases and transmit the data to the RKI within the following week. Hence, transferring information on a case from the local to the national health authority may take from a

few days up to 16 days. Epidemiological information is fed back from RKI weekly to the stakeholders, e.g. responsible authorities, physicians and laboratories. Information exchange includes teleconferences, reports in the RKI's weekly Epidemiological Bulletin and the internet database. Therefore, in the aftermath of the toxic sprouts event, Germany promptly revised its reporting system according to the demand so as to detect the increase of unusual infectious diseases in a timely manner. It also integrated the data from physicians and laboratories into a centralized database, thus the information resources can be shared among local health departments, state health departments and RKI[43]. Moreover, Germany also made amendments to its reporting system based on this outbreak[44]:

1) Centralising the epidemiological information exchange,
2) Accelerating the data flow to the national level,
3) Implementing a syndromic surveillance system for bloody diarrhoea in emergency departments,
4) Assessing the capacities for HUS-treatment in Germany,
5) Initiating active laboratory surveillance

The implementation of these measures has improved the country's surveillance system and effectively controlled the spread of disease.

Section 2 Melamine

A dairy-product contamination event occurred in Mainland China in 2008. The event was caused by melamine, an industrial chemical, discovered in milk powder produced by Sanlu Group (one of China's larges diaries) after many of its baby consumers were found to have kidney stones. The event aroused great attention and concern from many countries about the safety of dairy products. And the situation was aggravated after the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ) released a report on the result of melamine test on milk powder for infants and young children produced by domestic dairies. The test showed that milk powder from many famous brands in China contained melamine. The event has seriously damaged the reputation of China's dairy producers and as a result, many countries banned their import of dairy products from China. On 24 September, the AQSIQ declared that the milk event had been brought under control as no melamine was discovered in the sample tests on major liquid milk products such as yogurt, pasteurized milk and sterile milk newly produced after September14 [45].

I The Course of the Event

On June 28, the first baby with kidney stones was accepted by the First Hospital of the People's Liberation Army in Lanzhou city, Gansu Province. The parents of the baby said that their baby had been fed on milk power produced by Sanlu Group in Shijiazhuang city, Hebei Province since the day he was born. In mid-July, the Health Department of Gansu Province began to investigate into the event immediately after receiving report about the infant urinary calculus case and reported it to the Ministry of Health. In the following two months, the number of sick babies accepted by the hospital increased rapidly to 14.

On 11 September, similar cases were discovered in other provinces such as Shanxi, Ningxia, Hunan, Hubei, Shandong, Anhui, Jiangxi and Jiangsu, etc. In the evening of the day, the Ministry of Health pointed out that most of the infants and young children in urinary calculus cases reported from Gansu and other provinces had been fed on the powdered formula produced by Sanlu. The investigation of relevant departments showed that Sanlu infant milk powder formula produced by SanLu

Group Co., Ltd. was suspected to be contaminated by melamine. An expert from the Ministry of Health pointed out that melamine was an industrial chemical which might cause stones in the urinary system of human body. In the evening of 11 September, Sanlu Group issued a declaration, saying that some of the infant milk powder produced by its factory before August 6, 2008 had been contaminated with melamine and it had decided to immediately recall all the contaminated milk powder weighing about 700 tons from the market so as to show its responsibility for consumers[47].

On 13 September, China initiated the national Grade-I response to serious food safety accident and set up a steering group for emergency response. On the same day, Gao Qiang, the Party Secretary of the Ministry of Health, pointed out at a press conference that "Sanlu milk powder accident" was a serious food safety accident and that melamine contained in some of Sanlu's milk powder was illegally added to increase the protein content of raw milk or milk powder[48].

II Analysis on the Event

1. Causes of the Event

(1) Direct Cause

The direct cause of the event was the melamine contamination of dairy products. The rapid automated systems in China for testing dairy products could only test the content of protein but failed to test the content of fat and other ingredients, thus were ineffective for detecting fake protein. In order to increase the content of protein, some producers illegally added melamine to dairy products because melamine was not clearly listed as an illegal additive prior to the event. This directly caused the occurrence of the event.

(2) Indirect Cause

The Chinese dairy sector began to grow rapidly in 2000 following a more moderate growth rate between 1995 and 2000. It is highly likely that the event occurred are due to this fast growth. In 2000, the annual production of cow's milk amounted to just over 8 million tons. By 2008, this had increased close to fivefold to over 36 million. Similar growth rates were observed for milk powder products, which went up from one million tons in 2000 to four million in 2007. This rapid growth not only brought huge profits to the whole dairy sector, but also provided chances for lawless persons to make more profits by adding illegal additives to dairy products.

Many Chinese dairy giants, including Sanlu Group which is mainly responsible for the event, were exempted from supervision from the government and their dairy products were exempted from tests. Therefore, loopholes in supervision also contributed to the occurrence of the event.

2. Disposal of and Response to the Event

(1) Joint response of different departments

On September 13, China initiated the Grade-I response mechanism for serious food safety accident and set up a steering group for emergency response led by the Ministry of Health with the participation of AQSIQ, State Administration for Industry and Commerce, the Ministry of Agriculture, the Ministry of Public Security, State Food and Drug Administration as well as Hebei Provincial People's Government, so as to jointly settle the problem. The government also declared to provide free treatment for sick babies with urinary stones caused by Sanlu milk powder.

(2) Emergency Disposal

The Ministry of Health organized professionals to conduct research on work criteria in order to regulate the diagnosis and treatment of sick babies. It made emergency arrangement for medical rescue effort and organized rapid trainings on diagnosis and treatment given by relevant experts to doctors of local medical institutions. It set up an expert team of diagnosis and treatment so as to help local medical institutions to carry out medical rescue effort. It also offered free diagnosis and treatment so as to ensure immediate rescue of sick babies and did a good job in collecting data and following up information without delay. Moreover, it required medical workers to go to the remote rural areas of the country to detect patients and conduct centralized rescue and treatment in medical institutions at or above the county level.

The AQSIQ initiated the overall emergency management mechanism and required the quality supervision, inspection and quarantine departments at various levels to spare no efforts to deal with the event and extend the supervision and inspection to all dairy products. In the morning of September 14, the AQSIQ called an emergency teleconference and sent work groups to Hebei, Guangdong and Heilongjiang provinces and Inner Mongolia Autonomous Region to supervise the emergency response and disposal efforts there. On September 17, it announced that the exemption system of food industry was cancelled and all the finished products and

labels of exemption from quality inspection printed on the package of products were no longer valid.

On September 13, the State Administration for Industry and Commerce issued an emergency notification which required the local administrative authorities of industry and commerce at various levels to investigate the local milk powder markets immediately and order the operators to stop selling Sanlu infant milk formula produced before August 8, 2008 and withdraw the products from market shelves and handle the problem according to law. It also worked together with the relevant departments to seal up the infant milk powder of 2,176 tons that hadn't been carried out of the warehouse of Sanlu Group and withdrew all the Sanlu infant milk powder from the market, including the small amount of Sanlu products scattered to the remote rural areas.

In the aftermath of the event, the Ministry of Agriculture required the agricultural and animal husbandry departments at various levels to set up special work groups for quality inspection on fresh milk, hold the local agricultural authorities at all levels responsible for the management of quality safety of agricultural products, clearly define the work system and complete the special inspection task on time so as to prevent the flow of unqualified fresh milk into the market. The Ministry of Agriculture also carried out special surveillance on the quality of fresh milk in about 50 counties of dairy production bases such as Heilongjiang, Henan, Hebei, Shandong, Shanxi provinces, Inner Mongolia and Xinjiang Uygur Autonomous Regions and Beijing Municipality, as well as cities with the largest milk consumer groups. Meanwhile, it also enhanced the management of standardized dairy cow raising area (or borough) and machinized milking stations, guided the cow raisers to centralize the feeding, stressed the skill trainings for feeding, and tried to popularize standardized scale breeding model. It also required the competent departments responsible for livestock fodder to carry out comprehensive inspections to producers of milk cow fodder and milk cow fodder made by dairy cow raising areas so as to prohibit addition of illegal medicine and hazardous chemicals.

In the aftermath of the event, the public security organs immediately interrogate and investigate the suspects, take evidence from them and sent them to the procuratorial organs for examination so as to crack down on the illegal activities in accordance with the law. On 15 December 2008, the Ministry of Health and the Ministry of Public Security jointly announced[49] that they would carry out 4-month

special rectification activities, which aim at cracking down on illegal addition of inedible materials and abuse of food additives [50].

3. Impacts of the Event

(1) Health Impact

According to the statistics provided by China CDC, the amount of melamine intake by babies from infant milk formula adulterated with melamine ranged from 8.6 to 23.4 mg per kilogram body weight per day if calculated on the median of melamine content in the most seriously contaminated milk brand, which was 40-120 times that of the tolerable daily intake (0.2 mg per kg body weight per day). This has brought extremely serious damage to babies' health: more than 51,900 babies were hospitalized due to urinary problems such as renal tube blockage and kidney stones caused by ingesting melamine-contaminated milk powder, and among them 6 died[51].

(2) Social Impact

Enjoying an advantage in the international market with a high performance-price ratio of its dairy products (especially milk powder), China saw a rapid growth in the export of dairy products. However, the "stone milk powder" scandal seriously damaged the reputation of China's dairy products in the international market and led to crisis in its domestic dairy sector, thus securing the market status of their foreign-invested competitors which takes up 80% of China's high-end infant milk powder market[48].

In an investigation into the event, 84% of the public expressed their concern about China's food safety. The sales of liquid milk declined sharply by 80% over the same period of the previous year, the sales of refrigerated milk (including yogurt, pasteurized milk etc.) decreased by 60%, and adult milk powder dropped by 45%.

[52] Following the event, China made many amendments to its *Food Safety Law*, including the regulatory responsibilities of local governments and the relevant departments, risk assessment and surveillance for food safety, criteria of food safety, management of individual food processing workshops and stall-keepers, regulation of food additives, food recall system, food inspection and food accident disposal etc. These amendments are considered to be a direct result of the "Sanlu infant powder scandal".

III Experience and Lessons

The prevention of food safety accident calls for joint efforts from enterprises, governments and non-governmental organizations (NGOs) and consumers. And a prevention system for food safety should be established where enterprises, governments and NGOs and consumers can complement and restrict each other so as to conduct joint supervision on food safety[53].

1. Enterprises

The enterprises' sense of social responsibility should be strengthened at an age of low margin. With the fierce competition in the market, enterprises have entered into an age of low margin where competition among enterprises are focused on their brand value which means the trust of consumers. Enterprises, in order to cultivate the loyalty of their concumers, should cultivate their loyalty to consumers first because the competitiveness of enterprises lies in the trust of their consumers. Therefore, enterprises must change their previous outlook of development, cultivate their sense of responsibility and produce quality products so as to foster a good brand by high equality products and gain profits by good brand. They should be very strict with themselves in food safety and face their cusumers with integrity and honesty so as to win long-lasting support from consumers. This is the first key step to prevent food safety accident and also the basic guarantee for long-term survival of enterprises in fierce market competition.

2. Government

After the outbreak of trust crisis caused by Sanlu milk powder which was called "inspection-free product", the public had to once again review the regulatory problems of the government. So enhancement of government functions in supervision and regulation becomes very important for preventing food safety accident. But as a result of the economic chain between government and enterprises, the government is more likey to adopt a protective attitude toward enterprises in performing its regulatory functions. Therefore, greater efforts should be made to educate government employees and instruct them to put first the overall interests of the public, adopt a correct attitude toward their regulatory work and strongly resist unhealthy tendencies such as bezzlement, corruption and rent-seeking. Government officials who bend laws to seek personal gains and neglect their duties should be strictly punished. Meanwhile, the system of relevant laws and regulations should be improved since the loopholes in

legal system are also a big problem in government supervision. Many laws and regulations were too old to suit the current conditions and lack workability and management standards, thus failing to protect the legal rights and interests of consumers.

3. NGOS and Consumers

With a wide coverage, great flexibility and sensitivity, NGOs and consumers constitute an indispensible part of the food safety accident prevention system. They can fill the vacumm space beyond government and enterprise regulations and at the same time function as an external pressure on government and enterprises in standardizing their own regulatory functions. The enhancement of regulatory capability of NGOs and consumers can be achieved by increasing the involvement of NGOs and offering educational programs to consumers on right protection..

Chapter 4 Nuclear Radiation

Section 1 Chernobyl Event

I. The Course of the Event

At 1:23 am on April 26, 1986, a sudden explosion occurred to Reactor 4 at Chernobyl nuclear power plant in Pripyat city, located 140 km away from the north of Kiev in Ukraine, former Soviet Union. The explosion released large quantities of radioactive contamination into the atmosphere, spreading over Ukraine and 20 neighboring countries, as well as other countries such as the U.S. and Canada. This is the well-known Chernobyl nuclear accident that shocked the whole world.

II Analysis of the Event

1. Causes of the Event[54]

On April 25, 1986, reactor 4 at Chernobyl nuclear power plant was shut down according to the plan in order to undergo regular maintenance, and this shut-down period was also taken as a chance to test the turbine generator of the reactor and see whether it could provide short-term power supply in case of power shortage before the backup diesel generator could supply power. During the test, the staff there made the reactor operate under a low power level [200MW(th)] , which went against the basic operating rules and led to failure in the stable manual control of coolant flow and cooling state. Meanwhile, the operating staff removed most of the control rods from the reactor core and shut down some of the safety systems, which was also against the operating rules. Then, more and more steam voids were produced in the reactor core, which increased the reaction. Having detected this situation, workers attempted to stop the chain reaction (because the automatic system didn't work), but since most of the control rods had been withdrawn, it's difficult to shut down the reactor. With the increasing reaction, the energy accumulated and reached the first peak value which was 100 times that of the normal level. The energy released as a result of the increase of power in the reactor turned some of the fuels into particles and these particles at a high temperature led to steam explosion, which moved the lid (with a weight of 1000 tons) covering the reactor and cause explosions to all the coolant tubes on both sides. Then 2-3 seconds later, another steam explosion

happened. The reactor was large in volume and was only covered with a single protective layer in order to lower the construction cost, which caused the radioactive contamination to be released into the atmosphere after the main pressure vessel was broken by the steam explosion in it. After some parts of the roof was damaged by the explosion, oxygen flowed in and mixed with the reactor fuels at an extremely high temperature and graphite moderator, thus causing graphite burning and spreading radioactive contamination to a wider range of areas.

2. Disposal of the Event[54]

(1) Emergency Monitoring

In the disaster-stricken area, airplanes and helicopters monitored the contamination levels of the surrounding area by meteorological and radioactive indicators. In the morning of April 27, the local people started to evacuate along the evacuation route under the instruction of monitoring system. After the event, it was detected that the food there was contaminated by radioactive materials and local milk and other foods were banned for a long period.

(2) Emergency Measures

1) Evacuation of people: taking into consideration the release of radioactive gas and aerosol, further evacuation was conducted to people at the accident site and altogether 115,000 people were evacuated.

2) Keeping the reactor stable and implementing emergency rescue and treatment: after the accident, the first measure that was taken was extinguishing the fire and stabilizing the reactor. On April 25-26, about 300 on-site workers and fire men injured by the fire or possible radiation were sent to hospital.

3) Health education and enhancement of individual protection: after the nuclear radiation accident, both the government and the health department gave health education to the local residents in a timely manner and asked them to decontaminate their skin and even change their clothes.

4) Reduction of outdoor and group activities: in the morning of April 26, residents in Pripyat were told to stay indoors and close their doors and windows. To prevent the gathering of radioactive iodine (mainly Iodine-131) in thyroid, potassium iodide was distributed to people in the affected area. Thousands of livestock were also transferred from the contaminated area.

5) Reduction of contamination and control of nuclear proliferation: many measures were taken to reduce contamination outside the plant. Houses and public buildings within the area of 7000km^2 around the nuclear power plant were repeatedly disposed and those houses whose radiation level couldn't be reduced to the acceptable one were demolished and buried. Roads and other contaminated land surface were also covered with asphalt, gravel, sands or clean soil, which reduced the radiation dose by 10-100 times. In the contaminated agricultural areas, contamination was also reduced by ploughing the land deeply and adding mineral fertilizers.

3. Impacts of the Event

(1) Health Impact

In the aftermath of the accident, 237 emergency workers presented Acute Radiation Syndrome (ARS), of which 134 were diagnosed with ARS, and 28 of them died from exposure to high dose radiation. No ARS cases were discovered among ordinary people. During the period between 1991 and 2005, 5,127 cases of thyroid cancer were discovered among the group under the age of 14 in 1986 and 6848 cases among the group under the age of 18 in 1986 in such areas as Belarus, Russia (including the 4 worst affected areas) and Ukraine, etc. [55]

The number of victims of the Chernobyl disaster is heavily debated. WHO believes that the number of deaths from nuclear radiation was 9,000. A report published by the Greenpeace asserts that the number of deaths from tumors caused by the nuclear release accident was 93,000. A research report of National Academy of Sciences of Belarus (NASB) says that altogether 2 billion people in the world were affected by Chernobyl accident, and that 270,000 of them suffered from cancer, of which 93,000 died[56]。.

(2) Environmental Impact[57]

1) Cities: in the aftermath of the accident, there's accumulation of large quantities of radioactivity in Pripyat city and the surrounding areas. In other cities, accumulation of radioactivity to various degrees also brought low-level exposure to the local people. After 1986, contamination on the land surface began to decrease due to meteorological factors such as wind and rain and human activities. At present, the air dose rate on solid surface of the contaminated area has returned to the level before

the accident, but still remains high in the gardens and parks of some areas in Belarus, Russia and Ukraine.

2) Agriculture: radioactive iodine went into milk immediately after the accident, affecting people, especially children in Belarus, Ukraine and Russia. In some areas of southern Europe, radioactive iodine with high dosage was also detected in the milk. Having a long half-life, Cs-137 in plant food and crops increased the internal dose of people. Even today, Cs-137 concentration in the milk of some areas still remains above 100Bq/kg.

3) Forest: in the forest and mountainous areas, both plants and animals absorbed an enormous amount of radioactive material which will be reduced very slowly and last for several decades. People there were exposed to radiation through the chain of plant- reindeer meat-human being.

4) Water environment: radioactive material released from Chernobyl nuclear power plant affected the surface water system. Even today, water and fish are still affected by Cs-137 in Ukraine, and this effect will last for decades.

(3) Social Impact

As the result of the accident, the former Soviet Union suffered a loss of bout 9 billion rubles, of which 40 billion was spent on rehabilitation and 40 billion was attributed to losses on agricultural and power production. Experts estimate that apart from the loss of nuclear plant, the cost of decontamination alone will reach several billion U.S. dollars, and the total cost will be tens of billions U.S. dollars.

The radioactive dust produced by this accident was 400 times stronger than the radiation caused by the atomic bombing in Hiroshima, Japan. Over these years, the economic loss of the accident has reached hundreds of billion U.S. dollars, including medical cost, cleaning cost, compensation cost and production cost etc. More seriously, the accident forced ten thousand people to leave their home and caused both physical and psychological pains to countless people, which can never be cured.

III Experience and Lessons from the Event[58] :

1. Emergency arrangements should address severe emergencies to include those of low probability.

The off-site doses immediately after the start of the Chernobyl accident at distances of more than 2–3 km from the site were sufficient to result in early deaths

within hours. However, the officials in Pripyat (located 3 km from the site) were not prepared to take protective actions promptly (actions were taken 24 h after the start of the emergency). Delays in taking urgent protective measures also led people in the affected area to consume milk and vegetables contaminated with radioactive iodine for several days, which caused an increase in thyroid cancer incidence. This increase was seen among the population living at distances up to about 350 km from the site. The fundamental reason for these failures was that severe emergencies were not considered in the preparedness process because it's commonly believed that nuclear power plant was safe and the occurrence of emergencies was inconceivable.

2. Radiation protection principles should be established to handle special situations.

Experience shows that IAEA's *Intervention Measures under Radiological Release or Contamination Emergencies* does not adequately address all the potential protective and other actions, which are in general based on radiological and social considerations. These include personal monitoring, decontamination of persons and property, release of contaminated products, initial medical screening, long-term medical follow-up, counseling of pregnant women, and termination of countermeasures, etc. This lack of predetermined criteria during past emergencies has led decision makers and the public to take actions that would be difficult to justify from a strictly radiation protection point of view. One example was that thousands of abortions were performed throughout Europe due to fear of radiation-induced effects; however, none of the women involved were exposed at levels above which informed decisions should be made based upon individual circumstances.

3. International Guidance should include a clear statement of conditions under which it should be applied.

During the Chernobyl accident, emergency criteria established were well below those recommended in the international guidance. It appears that unjustified conservative assumptions were used to make decisions because it was not clear at the time how to deal with uncertainties and under which conditions the existing guidance should be applied. There appears to be a general tendency to implement actions at levels below those recommended if it is unclear whether the guidance addresses the situation at hand.

4. The criteria for implementing actions should be accompanied by a clear operational instruction or explanation that is easy to understand.

The operational instruction or explanation enables the decision makers to better understand and implement the relevant regulations, and explain their actions to the public and other stakeholders. The explanation must make it clear to the public which actions are appropriate and inappropriate, and how the recommended actions ensure their "safety" and that of all other family members, including unborn children. In working out relevant measures, public officials should consider the possible effects of these measures on the public, and the decision-makers must fully understand the emergency measures against radiation crisis in the instruction so that they can explain them to the public and face their challenges. They can also collaborate with stake-holders to work out measures dealing with nuclear radiation. During the Chernobyl emergencies, members of the public took inappropriate and in some cases harmful actions due to fear and misunderstandings concerning radiation risks and how to reduce them.

5. Protective measures and countermeasures at internationally recognized OILs should be established.

Many decisions for countermeasures are based on measurements in the field while lacking Operational Intervention levels (OILs) under emergencies. This resulted in delays, confusion, and different protective actions being taken by States for the same measured levels. In handling some radiological emergencies, different countermeasures may be implemented at the same time, thus resulting in considerable uncertainty and conflicts that were difficult to resolve or explain to the public. Therefore, the criteria for implementation of these countermeasures should be based on internally consistent radiation protection principles and be consistent in the eyes of the public and decision makers.

6. International guidance should include a process for developing plans for the implementation of post-emergency countermeasures that are justified and optimized.

Chernobyl accident demonstrated that immediately after the emergency there was immense pressure from the public and the media on the officials to take actions to correct the problem and return the situation to normal. Experience during a wide

variety of emergencies shows that officials, when under this intense pressure, take highly visible actions for which no justified or optimized criteria exist. So, default OILs are needed for the full range of anticipated protective and other actions, and are even needed for longer-term actions. However, once an emergency occurs, the default OILs should be reexamined and revised, if needed, to ensure they are justified and optimized. This reexamination should involve consultation with all relevant stakeholders, particularly for the longer-term decisions.

Section 2 Nuclear Radiation in Fukushima, Japan

I The Course of the Event

At 14:46 on March 11, 2011, a strong earthquake of Magnitude-9.1 occurred in Japan, with the epicenter located in the Pacific Ocean to the east of Miyagiken of northeast Japan, at a depth of 24km, with the source region exceeding 400 km[59]. 41 minutes after the earthquake, the first wave of tsunami at a height of 4m arrived. At 20:30 East-European time, the Japanese authority reported to the IAEA that the earthquake and tsunamis had cut off power supply for Fukushima Daiichi Nuclear Power Plant and the spare diesel generator couldn't work as it had been flooded by water. [60]

By 9:00 a.m. on March 12, residents within a three-km radius of the Fukushima Daiichi nuclear power plant had been evacuated and the evacuation of residents within a ten-km radius of the Fukushima Daiichi nuclear power plant and those within a three-km radius of the Fukushima-Daini power plant had been started. At 12:40 (Middle-European time), Reactor No.1 in Fukushima Daiichi nuclear power plant exploded, and at 20:10 the Nuclear and Industrial Safety Agency (NISA) confirmed the presence of cesium-137 and iodine-131 near the reactor Unit 1 of Fukushima Daiichi nuclear power plant. The Japanese authority classified this event happened in reactor Unit 1 of Fukushima Daiichi nuclear power plant as a level 4 "accident with local consequence"[61].

On March 14, the nuclear radiation near Onagawa Nuclear Power Plant in Japan was reduced to the normal level whereas the Unit 3 of Fukushima Daiichi nuclear power plant exploded, with the top of the reactor building being damaged and 11 people being injured.[62]。

At 6:20 local Japan time on March 15, Unit 2 of Fukushima Daiichi nuclear power plant exploded. Soon Unit 4 caught fire and released radioactive materials directly into the air. In the evening of the same day, residents within a 20km-radius around the Fukushima Daiichi nuclear power plant were evacuated successfully[63].

On March 16, the Nuclear Safety Commission of Japan suggested to the local government that the evacuated people should be instructed to ingest stable iodine[64].

On March 20, Japan' s chief cabinet secretary announced that the Fukushima Daiichi nuclear power plant destroyed in the great earthquake of east Japan would be finally abandoned [65].

On April 12, the International Atomic Energy Agency (IAEA) confirmed that the accident of Fukushima Daiichi nuclear power plant was classified as Level-7[66]。.

II Analysis on the Event

1. Causes of the Event

(1) Direct Causes

The core of a nuclear reactor needs continuous cooling so as to be kept at a lower temperature and that's why an independent building was constructed near the Fukushima nuclear power plant to supply power for the cooling system. However, this building is near the sea and was severely damaged after the earthquake[67].

In 2002, the core building was improved and could resist tsunamis at the height of 5.7m. But the tsunamis that arrived soon after the earthquake were 14-15m high and submerged the anti-flood dam, causing failures to the functions of key equipment (including additional 6 power supply machines and an on-site spare diesel generator).

Continuous cooling was needed to dispel the heat released by nuclear reaction before the operating reactor Unit 3 was shut down, but the lack of power supply brought failure to the cooling of nuclear reactors and the spent fuel storage pools. Then the workers there tried to use the turbine installation to start the emergency core cooling system to cool the reactor core and spent fuel pools and shut down the Unit. But as a result of the external damage, it is totally impossible to transport extra resources to the nuclear power plant within a short time. When the equipment lost the cooling function and the pressures in the major reactor containments exceeded the design limit, the workers began to take pressure release measures to prevent damages to reactor tank and serious release of radioactive materials. Later, the vapor containing hydrogen was released to the air above the plant after simple cooling and filtration by the pressure-relief water tank. The water level in the core dropped continuously to the level below the top end of the fuel rod, resulting in the release of a great amount of heat and the melting of fuel coating and fuel pellets. And then the hydrogen explosion occurred to Unit 3 and Unit 2 in succession, with the release of a great amount of nuclear materials[68.]

(2) Indirect causes

Japan's regulations and systems handling nuclear problems are inefficient, complicated and segregated and both the nuclear supervision institutions and nuclear sales agencies are under the protection of Japanese Ministry of Economy, Trade and Industry (METI). NISA is responsible for the supervision of nuclear power plant operations while the Agency for Natural Resources and Energy is responsible for increasing the number of the country's nuclear reactors. Such arrangement makes it impossible for people to believe that Japanese central government is serious about the control and management of nuclear industry.

2. Disposal of and Emergency Response to the Event

(1) Emergency Mobilization

At 15:42 on March 11, the METI established a nuclear emergency preparedness command centre and on-site command centre after receiving the report from nuclear workers. At 16:00, the Nuclear Safety Commission held a meeting and decided to set up an emergency response technical consultancy group. At 16:36, an Emergency Response Office was established. At 19:03, the Prime Minister of Japan declared the nuclear emergency and established a nuclear emergency command centre and an on-site command centre. Meanwhile, other departments and institutions also responded to the emergency. As the commander of the nuclear emergency command centre, the Prime Minister decided the evacuation zone. On March 15, Government/Tokyo Electric Power Company Joint Office was established. On March 16, Ministry of Education, Culture, Sports, Science and Technology (MEXT) started to collect environmental surveillance data from various departments. The surveillance outside the nuclear power plant was jointly conducted by MEXT and Japan Atomic Energy Agency. The Ministry of Health, Labor and Welfare (MHLW) decided that food exceeding the prescribed dose shouldn't be provided to the public and suggested to the government institutions that they shouldn't drink waters exceeding the prescribed dose.

(2) On-site Disposal[69]

On March 11, the diesel generator, cooling system of reactors and electric system of the Fukushima nuclear power plant were severely damaged after the earthquake and tsunamis. The workers of the nuclear power plant immediately injected fresh water into the reactor for emergency cooling so as to prevent the melting of reactor

core. However, because of insufficient storage of backup fresh water, the cyclic dispel of heat was impossible and the demand for cooling couldn't be satisfied. After the nuclear release accident, 500 workers of the power plant was rapidly evacuated while 50 experienced workers formed a suicide squad voluntarily and stayed in the nuclear power plant, continuing their cooling operation by water injection. After that, another group of workers returned to the plant and joined the squad by injecting water and repairing electric facilities.

Because of the lack of cooling water, hydrogen explosion accident occurred at reactor Unit 1, 2, 3 and 4 in succession. To prevent the aggravation of the accident, from March 17, the Japan Self Defense Forces and Tokyo Fire Department drew water from the Pacific Ocean by fire engines and water supply equipment and injected water continuously to the four reactor units. After the water injection, the temperature on the surface of the 4 units dropped to the level below 100℃ and the water injection operations achieved a certain effect. At the same time, in order to prevent hydrogen explosions at Unit 5 and 6, several vent-holes were opened on the top of the reactor buildings. After continued water injection operations, radiation monitoring value of the environment dropped.

While the water injection was conducted, the Tokyo Electronic Power Corporation (TEPCO) accelerated its efforts to repair the external power supply lines and the on-site emergency diesel generator and electric system of the nuclear power plant. Thanks to the hard work of the repairmen, on March 19, the emergency diesel generator and the cooling system of spent fuel pools at Unit 5 and 6 restored their operations, thus the risk at Unit 5 and 6 was eliminated. On March 20, Unit 1, 2, 5 and 6 acquired external power supply and this was a progress in restoring external power supply for Fukushima Daiichi Nuclear Power Plant. On March 22, Unit 4 was connected with the external power network successfully, with the crisis at Unit 4 being diffused. At 23: 29 p.m. of the day, Unit 3 was also connected with the external power sources, thus the lighting of its control room was restored. By then, all the 6 units at Fukushima Daiichi got external power supply. However, since the electric equipment at Unit 1, 2, 3 and 4 was severely damaged in the tsunamis, the cooling systems of these reactor units still couldn't work. Nevertheless, the steady power supply had provided great convenience for rescue operations.

In the afternoon of March 21, Unit 3 and Unit 2 of Fukushima Daiichi emitted grey and white smoke. In the morning of March 24, Unit 1, 2, 3 and 4 of the plant

once again emitted white smoke. Radioactive materials with high concentration appeared in the water accumulated within the buildings of Unit 1, 2, 3, and 4 and the nuclear fuel rods of the reactors were melted and seriously damaged. On March 25, given that the salt in the sea had caused damage to the reactors, firemen began to draw fresh water from the nearby reservoir and injected it to Unit 1 and Unit 3 whose cores had been damaged most seriously. The U.S. aircraft carrier also provided some fresh water for Fukushima nuclear plant. On March 27, cooling water was injected into reactor Unit 1 and Unit 4 and the accident was basically brought under control.

3. Impact of the Event

(1) Health Impact

The radiation-related physical health impact on the general public, including evacuees, is likely to be limited and much lower than that from Chernobyl and the only conclusive radiation-induced health effect was thyroid cancer from children drinking milk contaminated with high levels of radioactive iodine [70]. But the injury accident or event may lead to stress, frustration, worry and symptoms that cannot be explained by iatrology theory. Therefore, psychological counseling and group therapy may be required as well [71]。

(2) Environmental Impact[72]

On May 6, 2011 the Joint Emergency Response Centre set up by the Japanese government and TEPCO published a map of radiation dose and contamination near the land surface jointly made by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the U.S. Energy Department according to the airplane monitoring data. The map shows that the accumulated radiation dose within the large area 30km away from the northwest of the nuclear power plant might exceed 100 mSv in a year and in some areas of Namie-machi and litatemura in Fukushima-ken with a distance of 30km from the power plant, the radiation intensity reached 19uSv/h and the accumulated radiation dose in a year might exceed 100mSv. In some areas of the cities which are 30km away from the power plant, the accumulated radiation dose might be over 20 mSv a year.

(3) Social Impact[73]

On March 19, the chief spokesman of Japanese government announced that radiation levels that exceeded normal level had been detected in milk produced in

Fukushima-ken and in spinach in Ibaraki-ken, raising people's concern that the Fukushima Nuclear Power Plant might trigger nuclear radiation and contamination. Nuclear radiation may seriously affect the confidence of consumers and investors as well as the recovery after the disaster, which will lead to the long-term economic stagnation in the affected areas.

Affected by the earthquake of Japan, many countries have declared the suspension or termination of their plans on repairing and establishing nuclear power plants. The Swiss government announced that it would suspend the plan on rebuilding its old nuclear power plants before the review of safety measures. The Indian government carried out safety-check to all the nuclear power plants within the country to make sure that they can resist earthquakes or tsunamis. The German government postponed its decision for 3 months on extending the operational period of 17 nuclear power plants to more than ten years and immediately closed down two of the oldest nuclear power plants in German. After the nuclear crisis in Japan, the State Council of China issued a proclamation on the government portals that it would suspend the examination and approval of nuclear power plant projects including those projects on initiating preliminary work before the nuclear safety plan was approved.

III Experience and Lessons from the Event[59]

This accident led to a severe accident, shook the trust of the public, and warned those engaged in nuclear energy of their overconfidence in nuclear safety. It is therefore important to learn lessons thoroughly from this accident.

1. Strengthen preventive measures against a severe accident

(1) Strengthen measures against earthquakes and tsunamis

The tsunamis which hit the Fukushima Dai-ichi Nuclear Power Station were 14-15m high, substantially exceeding the height assumed under the design of construction permit or the subsequent evaluation. The tsunamis severely damaged equipment like seawater pumps, etc., causing the failure to secure the emergency diesel power supply and reactor cooling function. The procedural manual did not assume flooding from a tsunami, but rather only stipulated measures against a backrush. The assumption on the frequency and height of tsunamis was insufficient, and therefore, measures against large-scale tsunamis were not prepared adequately.

From the viewpoint of design, the range of an active period for a capable fault which needs to be considered in the seismic design for a nuclear power plant is

considered within 120,000-130,000 years (50,000 years in the old guideline). The recurrence of large-scale earthquakes is expected to be appropriately considered. Moreover, residual risks must be considered. Compared with the design against earthquake, the design against tsunamis is only based on indelible traces of tsunami, not on adequate consideration of the recurrence of large-scale earthquakes.

(2) Ensure power supplies

A major cause of this accident was the failure to secure the necessary power supply. This was caused by the facts that power supply sources were not diversified, and that the installed equipment did not meet the specifications that could withstand a severe environment such as flooding. Moreover, it was caused by the facts that battery life was short compared with the time required for restoration of the AC power supply and that a time goal required for the recovery of the external power supply was not clear.

(3) Ensure robust cooling functions

In this accident, the final place for release of heat was lost due to the damage of the seawater pumps. Although the reactor cooling function of water injection was activated, core damage could not be prevented due to the drain of the water source for injection and the loss of power supplies, etc., and furthermore, the PCV cooling functions also failed to run well. And the cooling system of spent fuel pool is also disabled by the failure of power supply system. In this manner, the loss of various cooling systems aggravated the accident.

(4) Adopt accident management (AM) measures

The accident reached the level of a so-called “severe accident.” Accident management measures had been introduced to the Fukushima NPSs to minimize the possibilities of severe accidents and to mitigate consequences in the case of severe accidents. However, looking at the situation of the accident, although some portion of the measures functioned (such as the alternative water injection from the fire extinguishing water system to the reactor), the rest did not fulfill their roles within various responses (including ensuring the power supplies and the reactor cooling function), with the measures turning out to be inadequate. In addition, accident management measures are basically regarded as voluntary efforts by operators, not legal requirements. Moreover, the guideline for accident management has not been reviewed since its development in 1992, and has not been strengthened or improved.

(5) Consider NPS arrangement in basic designs

Response to the accident became difficult since the spent fuel storage pools were located at a higher part of the reactor buildings. Therefore, possible emergencies should be taken into consideration in the design of NPS.

(6) Ensure the water tightness of essential equipment and facilities

One of the causes of the accidents is that the tsunami flooded many essential equipment and facilities including the seawater cooling pump facilities, the emergency diesel generators, etc., impairing power supply and making it difficult to ensure cooling systems. Therefore, Japan needs to ensure the water tightness of important equipment.

2. Enhance response measures against severe accidents

(1) Enhance measures to prevent hydrogen explosions

In this accident, three explosions probably caused by hydrogen occurred, which aggravated the accident.

(2) Enhance containment venting system

In the accident, there were problems in the operability of the containment venting system. The function of removing released radioactive materials in the containment venting system was insufficient. Also, the independence of the venting system was insufficient and it may have had an adverse effect on other parts.

(3) Improve the accident response environment

In the accident, the radiation dosage increased in the main control room and operators could not enter the room and conduct the relevant operation. Moreover, at the on-site emergency station, the accident response activities were affected by increases in the radiation dosage as well as by the worsening of the communication environment and lighting.

(4) Enhance the radiation exposure management system at the time of the accident

As these accidents occurred, radiation management became difficult as many of the personal dosimeters and dose reading devices became unusable due to their submergence in seawater, personnel engaged in radiation work had to work on site. In addition, measurements of concentration of radioactive materials in the air were delayed, and as a result，the risk of internal exposure increased.

(5) Enhance the training responding to severe accidents

It took time to establish effective communication between the emergency office inside the power station, the Nuclear Emergency Response Headquarters and the Local Headquarters and also to build a collaborative structure with the Self Defense Forces, the Police, Fire Authorities and other organizations. Adequate training could have prevented these problems.

(6) Enhance instrumentation to identify the status of the reactors and PCVs

Because the instrumentation of the reactors and PCVs did not function sufficiently during the accident, it was difficult to promptly obtain important information to identify how the accident was developing such as the water levels and the pressure of reactors, and the sources and amounts of released radioactive materials. In response to the above issues, Japan should enhance the instrumentation of reactors and PCVs to enable them to function effectively even in the wake of severe accidents.

(7) Centralize the control of emergency supplies and equipment and setting up rescue team

Because of the damage from the earthquake and tsunami in the surrounding areas shortly after the accident, it was impossible to promptly mobilize rescue teams to help provide emergency supplies and equipment or to support accident control activities. Therefore, centralized control of emergency supplies and rescue teams should be established.

3. Enhance nuclear emergency responses

(1) Responses to combined emergencies of both large-scale natural disasters and nuclear accident

There was tremendous difficulty in communication and telecommunications, mobilizing human resources, and procuring supplies among other areas when addressing the nuclear accident that coincided with a massive natural disaster. As a result of nuclear accident, some measures such as the evacuation of residents, which was originally assumed to be a short-term measure, have been forced to be extended. Therefore, the communication tools and devices and channels to procure supplies and equipment will be ensured in the case of concurrent emergencies of both a massive natural disaster and a nuclear accident. Furthermore, emergency plans should also be implemented to provide effective support for the affected people.

(2) Reinforcement of environmental monitoring

Currently, local governments are responsible for environmental monitoring in an emergency. However, effective environmental monitoring was not possible immediately after the accident because the equipment and facilities for environmental monitoring owned by local governments were damaged by the earthquake and tsunami and the monitoring workers had to evacuate from their posts after the accident. Therefore, the government should make a reliable and effective environmental monitoring plan to respond to emergencies.

(3) Establishment of a clear division of labor between relevant central and local organizations

Communication between local and central offices as well as with other organizations was not sufficient, due to the lack of communication tools immediately after the accident and also due to the fact that the roles and responsibilities of each side were not clearly defined, especially the rights and responsibilities among relevant government departments and relevant organizations within the Government were not clearly defined.

(4) Enhancement of communication

Because communication tools were damaged by the large-scale earthquake, the subsequent information to residents in the surrounding area and local governments was not always provided in a timely manner. The impact of radioactive materials on health and the radiological protection guidelines of the ICRP, which are the most important information for residents in the surrounding area and others, were not sufficiently explained. Japan should reinforce the adequate provision of information on the accident status and response, along with appropriate explanations to the residents in the vicinity so that they can know the possible effects of radiation, keep alert all the time and have a clear understanding about future risks.

(5) Enhancement of communication with other countries and response to assistance from international community

The Japanese Government could not appropriately respond to the assistance offered by countries around the world because no specific structure existed within the Government to link such assistance offered by other countries to the domestic needs. Therefore, the Japanese Government needs to strengthen communication and cooperation with other countries.

(6) Adequate identification and forecasting of the effect of released radioactive materials

The System for Prediction of Environmental Emergency Dose Information (SPEEDI) could not make proper predictions on the effect of radioactive materials as originally designed, due to the lack of information on release sources. As was originally designed, even under such restricted conditions without adequate information on release sources, it should have been utilized as a reference of evacuation activities and other purposes by presuming diffusion trends of radioactive materials under certain assumptions, but it could not.

(7) Clear definition of evacuation areas and radiological protection guidelines in nuclear emergency

Immediately after the accident, the cooperation of residents in the vicinity, local governments, police and relevant organizations facilitated the fast implementation of evacuation and "stay-in-house" instruction. As the accident became prolonged, the residents had to be evacuated or stay within their houses for long periods. Subsequently, however, it was decided that guidelines of the ICRP and IAEA would be used when establishing Deliberate Evacuation Area and Emergency Evacuation Prepared Area.

4. Reinforcement of safety infrastructure

(1) Reinforcement of safety regulatory bodies

Governmental organizations have different responsibilities for securing nuclear safety. For example, NISA of METI is responsible for safety regulation as a primary regulatory body, while the Nuclear Safety Commission is responsible for regulation monitoring of the primary governmental body, and relevant local governments and ministries are in charge of emergency environmental monitoring. This is why it was not clear where the primary responsibility lies in ensuring citizens' safety in an emergency. So the existing organizations and structures hindered the mobilization capabilities in promptly responding to such a large-scale nuclear accident.

(2) Establishment and reinforcement of legal structures, criteria and guidelines

This accident has brought various challenges to the establishment and reinforcement of legal structures on nuclear safety and nuclear emergency preparedness and response, and related criteria and guidelines. Also, based on the experiences of this nuclear accident, many issues will be identified as ones to be

reflected in the standards and guidelines of the IAEA.

(3) Human resources for nuclear safety and nuclear emergency preparedness and responses

All the experts on severe accidents, nuclear safety, nuclear emergency preparedness and response, risk management and radiation medicine should get together to address such an accident by making use of the latest and best knowledge and experience. Also, it is extremely important to develop human resources in the fields of nuclear safety and nuclear emergency preparedness and response in order to ensure mid-and-long term efforts on nuclear safety

(4) Ensuring the independence and diversity of safety systems

Although multiplicity has been valued until now in order to ensure the reliability of safety systems, avoidance of common cause failures has not been carefully considered and independence and diversity have not been sufficiently secured.

(5) Effective use of probabilistic safety assessment (PSA) in risk management

PSA has not always been effectively utilized in the overall reviewing processes or in risk reduction efforts at nuclear power plants. While a quantitative evaluation of risks of quite rare events such as a large-scale tsunami is difficult and may be associated with uncertainty even within PSA, Japan has not made sufficient efforts to improve the reliability of the assessments.

Chapter 5 Bioterrorism and Biohazards

Section 1 Anthrax

On 4 October, 2001, Jean Malecki, the Director of the Florida Health Department, received the first report of anthrax (pulmonary anthrax) in the past 25 years in the United States. The anthrax attacks began. On 6 October, Ridge, the then Secretary of U.S. Department of Homeland Security, confirmed for the first time that the anthrax letters found across the United States were a terror attack with biological weapons. On 14th, Thompson, the then Secretary of U.S. Department of Health and Human Services, announced at Fox News that this was a severe bioterrorist attack. The United States then started the crisis management and emergency response system for large-scale terror attacks and adopted a series of medical, national security and criminal investigation measures to prevent the attacks and eliminate the consequences. Until June 2003, the anthrax event died down[74].

I The Course of the Event

Case 1: On October 2, 2001, a 63-year-old Caucasian photo editor working for a Florida newspaper awoke early with nausea, vomiting, and confusion and was taken to a local emergency room for evaluation. The patient died on 5 October and postmortem examination revealed B. anthracis in multiple organs[75].

Case 2: On September 24, a 73-year-old Hispanic man, the newspaper mailroom clerk, had onset of fatigue. On September 28, nonproductive cough, intermittent fever, rhinorrhea, and conjunctivitis developed. From September 28 to October 1, he had gradual progression of cough, marked worsening of fatigue with lethargy, onset of exertional dyspnea, fever, and sweats. He had mild abdominal pain associated with vomiting. He was admitted to the hospital on October 1. A nasal swab obtained on October 5 grew B. anthracis. A transbronchial biopsy showed B. anthracis capsule and cell-wall antigens by immunohistochemical staining. Investigations showed that this patient had delivered mail to the patient in Case 1.

Later, several other patients infected with anthrax had been identified. From 2 October to 20 November 2001, investigators identified 22 cases of bioterrorism-related anthrax; 11 were confirmed as inhalational anthrax and 11 (7 confirmed and 4

suspected) as cutaneous anthrax. In March 2002, an additional case of cutaneous anthrax was reported in a laboratory worker processing environmental samples of B. anthracis in support of the CDC investigation of the fall 2001 bioterrorism-related anthrax attacks[76].

II Analysis on the Event

1. Causes of the Event

Twelve (55%) patients (8 with inhalational and 4 with cutaneous disease) were mail handlers, including U.S. Postal Service employees (9 cases), government mail processing staff (1case), and media company mailroom workers (2 cases). Six (27%) patients (one inhalational and five cutaneous cases) were Media Company employees working at sites where powder-containing mail was received: American Media, Inc. (AMI), one case; Columbia Broadcasting System (CBS), one case; National Broadcasting Company (NBC), two cases; and New York Post, two cases. Four (18%) case-patients (two inhalational and two cutaneous cases) were classified as “other”, including a 7-month-old visitor to the American Broadcasting Company (ABC), a 61-year-old Manhattan hospital supply room worker, a 51-year-old bookkeeper from New Jersey, and a 94-year-old Connecticut resident. Of all the 22 patients, 20 of them (91%) either handled mail potentially contaminated with B. anthracis spores or were exposed to worksites where B. anthracis-contaminated mail was processed or received. The mail path is shown in the following figure.

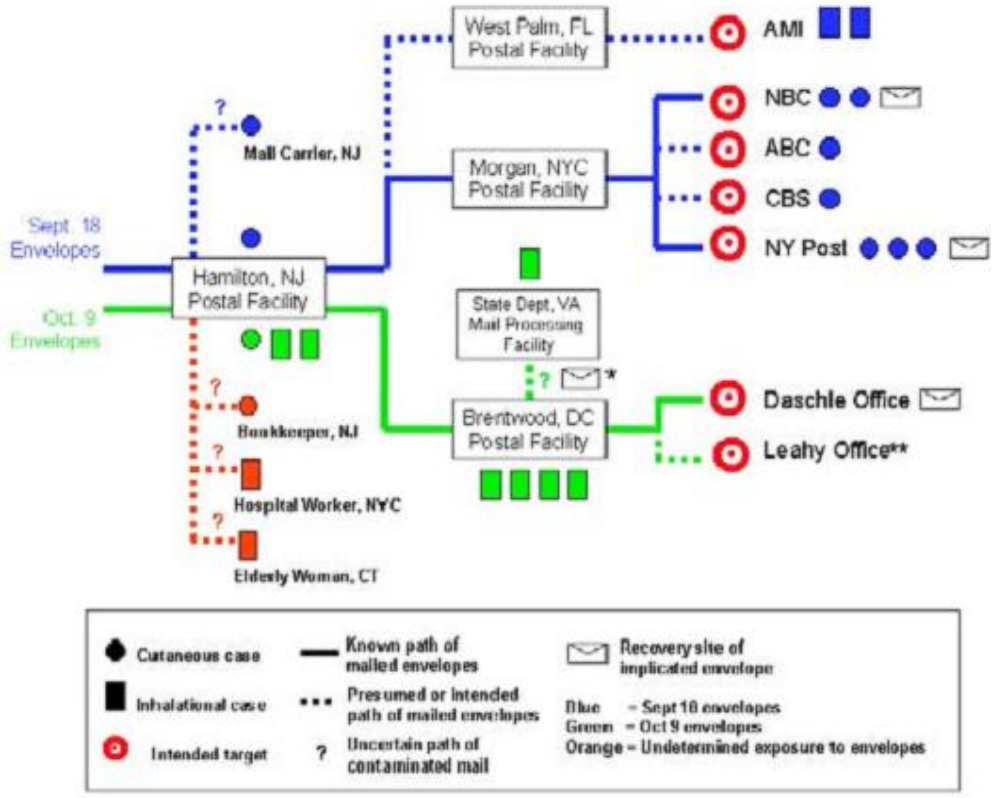

Figure1 Cases of anthrax associated with mailed paths of implicated envelopes and intended target sites.

2. Emergency Response to and Disposal of the Event[76]

(1) Rapid Response

After the first case of anthrax being identified in the laboratory, the U.S. CDC set up the Emergency Operations Center (EDC), which was organized into teams of epidemiologists, laboratorians, environmental scientists, communication specialists, and logisticians. A separate EOC team served as a liaison to state health departments and laboratories. Teams also coordinated interactions with the U.S. Postal Service, Department of Defense, Federal Bureau of Investigation, and other federal agencies and organizations. The official evaluation of the possibility of causing anthrax Local in specific sites obtained, Federal governments immediately distributed antibiotics (Ciprofloxacin and doxycycline). The U.S. National Pharmaceutical Stockpile and its member agencies provided 3,750,000 tablets of antibiotic for 32,000 possible exposed persons.

(2) On-site Disposal

Investigators from public health and law enforcement at the federal, state, and local levels collaborated to identify possible cases of anthrax, describe case and exposure characteristics, and prevent further cases through public health interventions. Cases were classified as confirmed or suspected on the basis of laboratory and clinical findings. Case finding was initiated by local, state, and federal public health agencies in all 50 U.S. states and through government agencies in other countries.

Investigators responded to reports of possible cases from clinicians, law enforcement officials, and the general public. Possible case-patients or exposed persons were interviewed with site-specific data collection forms. Public health laboratories tested clinical specimens, powder-containing envelopes, and environmental samples for the presence of B. anthracis. Demographic data, clinical presentation, exposure risk information, preliminary clinical and environmental laboratory test results, and other findings were collected. Reports of cases meeting the surveillance case definition were forwarded to CDC.

(3) Environmental Investigation and Disposal

Intervention teams were initiated to coordinate environmental monitoring and decontamination, postexposure prophylaxis and vaccination and deployment of National Pharmaceutical Stockpile program assets. Reports of cases and environmental sampling, updates of interventions, and other activities were communicated to the EOC for coordinating the investigation and for communications with federal and state partners, and the media.

Environmental investigations were performed at sites possibly contaminated with B. anthracis spores to assess the presence and extent of contamination and to guide decontamination and environmental remediation. Environmental samples at news media, postal facilities, residences, and other sites were taken by surface sampling with swabs, wipes, HEPA vacuum filtration, and air sampling. Nasal swab specimens were collected to define the area of exposure to aerosolized B. anthracis and ascertain where a person with inhalational anthrax might have been exposed.

Environmental samples were collected by public health, law enforcement, and contract staff and were tested at laboratories participating with the local, state, and federal investigation efforts.

(4) Laboratory Disposal

During the risk responses, a large amount of work had been taken by FBI, Department of Defense, CDC, and the public health laboratories across the U.S. and the delivered samples far more exceeded their testing capacity. The laboratories with advanced testing capacity were integrated through the Laboratory Response Network to meet the technical requirements and also the functional requirement for the sample testing. The Network comprised 100 core and advanced public health laboratories and high-power laboratories.

During the acute phase of the disease outbreak, over 12,000 samples with B. anthracis were tested and processed by laboratories participating in the Laboratory Response Network. This work was mainly undertaken by the state and local public health laboratories, United States Army Medical Research Institute of Infectious Diseases (USAMRIID), Naval Medical Research Center and CDC. CDC was also responsible for implementing and coordinating the epidemiological investigation[77].

3. Impacts of the Event

(1) Health Impact

Twenty-two cases (half with inhalational and half with cutaneous anthrax) were reported in the event, involving seven states. Five patients died, who were all inhalational cases. The fatality rate was 22.72%, but for pulmonary anthrax, it was up to 45.45% (5/11). According to the Washington Post, half year after the anthrax panic some survivors had yet to make a full recovery and were experiencing such late effects as serious fatigue, memory loss and concentration problems[78].

(2) Social Impact

At least 17 post offices and public office buildings were contaminated by the mailed letters and the economic damage was in excess of $1 billion[79]. Project BioShield Act of 2004 was passed by the U.S. Congress and authorized $5.6 billion over 10 years for the government to purchase and stockpile new vaccines and drugs[80]. After the 9/11 attacks and the anthrax attacks, lawmakers were pressed for legeslation to prevent future terror attacks.

After the event, Simon Wessely, Professor in St Thomas' School of Medicine, pointed out that "chemical and biological weapons are quintessentially weapons of terror. The now routine journalistic association between chemical and biological weapons and the word terror confirms that the purpose of these weapons is to wreak

destruction via psychological means—by inducing fear, confusion, and uncertainty in everyday life." The public would be greatly influenced and perplexed by the scenarios frequently being shown on TV that people were removing bacteria in thick chemical protective clothing and the possibility of future bioterrorism being aired by the media. He thought that the increase of anthrax cases caused "mass sociogenic illness" in the United States[81].

The source of the mailed anthrax is still a puzzle. On November 21, 2011, the Federation of American Scientists (FBS) told the 144-nation Biological and Toxic Weapons convention that the U.S. anthrax attacks were "almost certainly" derived from a U.S. government laboratory. On December 16, 2001, the Washington Post reported that genetic tests indicated that the anthrax spores mailed to Capitol Hill were identical to stocks maintained by the U.S. Army Medical Research Institute of Infectious Disease (USAMRIID) at Fort Detrick, Md. However, Mansfield, the spokesman of CIA, denied this and said the CIA laboratory was not the source of the deadly anthrax mailed to Capitol Hill[82].

III Experience and Lessons from the Event

1. Well Preparedness

This issue provides an opportunity to review the valuable lessons we have learned from these experiences. Foremost among them is the knowledge that we cannot afford to be complacent. Throughout the Department of Health and Human Services (DHHS) as well as across other federal, state, and local agencies, we remain alert for the first evidence of a disease outbreak. Multiple systems are now in place, both in the United States and internationally, to detect initial cases. On the local level, clinicians and laboratorians play a key role in this process. Activities such as monitoring emergency room visits, pharmacy requests, calls to emergency response and poison control centers, and animal disease registries for unusual occurrences are also expanding.

2. Change of Operating Mode

These lessons have also led us at the Centers for Disease Control and Prevention (CDC) to change the way we operate. Changes have been made within our programs, among our staff and partners, and in our coordination with other federal agencies. Many of these changes have been based on valuable input provided by public and

private sector experts during numerous consultations. Terrorism response capacity is being integrated into existing infrastructures, further strengthening the foundation of public health.

The anthrax cases highlighted the importance of the "golden triangle" of response between clinicians and clinical microbiologists, the health-care delivery system, and public health officials. Steps have been taken to strengthen these and other critical linkages, including those between professionals in the human, veterinary, and public health communities and between the public health, law enforcement, and emergency response systems.

DHHS has made available through CDC more than $918 million for state and local health departments to enhance their terrorism preparedness programs. These funds are intended to strengthen capacity to respond to bioterrorism, other infectious disease emergencies, and other urgent public health threats. Existing programs that proved invaluable during these events, such as the Laboratory Response Network for Bioterrorism (LRN) and the National Pharmaceutical Stockpile (NPS) have also been strengthened. During the anthrax attacks, laboratories within the LRN tested more than 125,000 clinical specimens and approximately 1 million environmental specimens. The number of these specialty laboratories participating in this network has now increased to more than 100, with at least one in each state, enabling widespread testing for microbes that might be used in a terror attack to cause illnesses such as anthrax, tularemia, plague, and botulism. New facilities have been opened, and improvements in others are in progress. The NPS has also been expanded to include additional medical supplies and personnel. State and local agencies are implementing measures to ensure the successful transport and delivery of these critical components of effective response.

Section 2 Sarin Gas Attack on the Tokyo Subway

I The Course of the Event

About 8 AM on March 20, 1995, a toxic gas attack occurred on 5 trains and in 16 stations within the city's subway system, involving thousands of passengers. Many passengers were suddenly affected by unknown gas, suffering miosis, coughing, and dizziness and breathing difficulties. Some even vomited, blacked out and fainted away. Some small paper-wrapped packets, plastic bags or bottles were found scattered in the train cars. At first, it didn't occur to the subway authority that this was a deliberate poisoning crime. The subway workers were told to examine the trains and remove the foreign objects, but they were also affected. Some foreign objects were even taken to the offices, causing some office workers being poisoned. The victims were carried out one after another from dozens of subway entrances, some panting, and some foaming at the mouth, some out of their minds. During the attack, several main subway lines were forced to shut down, dozens of train stations were affected and the traffic became a mess[84].

II Analysis on the Event

1. Causes of the Event

(1) Direct Exposure[85]

From March 22 to 27, the police in Japan raided thousands of strongholds and rented warehouses of Aum Shinrikyo throughout the whole country, finding a large quantity of chemicals, including raw materials, intermediates, end products, by products, decomposition reaction catalysts, and diluents of sarin. Russian-made chemical agent detectors, gas masks, chemical protective clothing and antidotes for nerve agents had also been found, even the workshops for making sarin. Aum Shinrikyo was proved to have been produced the sarin gas.

(2) Second Exposure

In the course of disposal, only train cars and stations received on-spot decontamination, but not victims. The situation of some victims worsened during transportation. Meanwhile, the on-spot first-aid personnel only wore normal work clothes, with no respiratory protection. Most of them developed poisoning symptoms

when transporting victims. They were presumed to have breathed in the sarin gas evaporated from the victims' clothes.

2. Disposal of the Event

(1) Social Emergency Responses[86]

After the attack, altogether 1,364 Emergency Medical Technicians (EMTs) and 131 ambulances had been sent to the spot. Within one hour after the attack, the contaminated subway stations were shut down by the police and meanwhile the on-spot samples were analyzed. Tokyo Metropolitan Fire Department (TMFD) set up on-spot emergent rescue points and transported the critical patients to the hospitals. In the rescue points, large ambulances and tents were available. Several hours later, Self-Defense Forces came to take steps to control and remove the contamination.

In the subway stations, EMTS triaged the victims and transported them outside. TMFD had requested assistance from prefecture medical associations to triage the mildly affected victims.

Shortly after the attack, the radio controlled taxies played an important role in the transport of victims. Near 25 percent of victims were transported to the hospital by taxi. Besides, two thirds of the patients with cardiopulmonary arrest were transported to the hospital by the passing private cars.

(2) Hospital Emergency Responses[87]

1) Stabilize the victims: After 8:43 AM, when the first ambulance arrived at the hospital, five thousands patients flooded into the emergency room and all the routine operations and tests were cancelled. Control center was set up in the emergency room with staff and medical students participating in the control of the event. Meanwhile, the victims were provided with paper version of news about the event to reduce their anxiety.

2) Simplify the medical process: At first the medical record was done in the normal way, but later when over 500 victims flooded into the hospital, only the name, address, chief complains, working place, physical findings and treatment were taken down in a form, which was in turn put into each patient's general record. On the day of the event, a special form was made for each patient, including such information as exposure (place, time and way of exposure), signs, symptoms, treatment and results.

3) Triage: In St. Luke's Hospital, the triage was mainly done in the emergency room. The triage was finished in the three entrances of the hospital and patients were classified into mild, moderate and severe cases. The 528 patients with mild symptoms

were observed for several hours while they received intravenous infusion and then released.

4) Targeted treatments: Having confirmed that nerve gas was the pathogenic factor; patients' clothes were immediately changed and cleaned. However, due to space limitation, the hospital had no capacity to do the decontamination for the patients with mild symptoms.

The hospital originally had 100 2-PAM injections (one injection with 500mg of 2-PAM) and 1,030 Atropine injections (one with 0.5mg of Atropine), which were only enough for the initial stage. In the early stage of the event, the hospital had bought another 9,000 2-PAM injections, which were transported to Tokyo by air. During the whole treatment period, altogether 700 2-PAM and 2,800 Atropine sulfate injections were used.

3. Impact of the Event

(1) Health Impact

Symptoms of sarin poisoning include dizziness, vomiting, difficult breathing and contraction of pupils. Another characteristic of sarin poisoning is that symptoms may appear six hours after exposure to sarin even if nothing was felt then. When the police announced that the poison gas was sarin six hours after the attack, more and more people were affected and some workers with no signs of poisoning began to develop symptoms after they were back to work. Meanwhile, some of the aid workers from Metropolitan Police Department, Fire Department and Self-Defense Forces were also affected. The number of victims soared to over 3,000 [88].

The attack resulted in over 5,000 victims. More than 1,000 cases required hospitalization, thirty-seven of whom were severe, sixteen critical and twelve dead.

(2) Social Impact

On the day of the attack, several main subway lines near Japanese Government and Parliament were forced to shut down, twenty-six train stations were affected and the traffic in Tokyo became a mess. This attack cast another shadow over the Japanese society and public who had just experienced Great Hanshin earthquake. That year, visitors of the Ueno Park to enjoy cherry blossoms had reduced one third than usual and some Japanese even intended to emigrate. The United States advised her citizens not to travel to Japan. Though 60,000 policemen were mobilized to ensure the safety

during the golden week (the holiday from late April to early May), the tension across Japan was not yet released.

To prevent future poison gas attack, Japanese government has taken decisive measures. Anti bio-terror attack system was established. Evil organizations were strictly supervised and controlled, even banned. The management and technological security of poisons were strengthened to prevent future terror gas attacks.

III Experience and Lessons from the Event [88, 89]

Although the event was effectively controlled with the government's overall arrangement, there still existed many problems in the whole process of the event.

1. Short of Alertness

At 8:09 AM, Tokyo Metropolitan Ambulance Control Center (TMACC) of TMFD received the first emergency call, saying there was an emergency case on the subway. Within the subsequent hour, emergency calls came in from fifteen subway stations and EMTs were sent out accordingly. However, TMACC did not realized the reported event was the same one.

2. Lack of Information Communication

As the rescue went on, TMACC found that they had no capacity to maintain the smooth communication. EMTs once lost contact with the doctors from TMACC and could not know about the development of the situation.

3. Poor On-spot Guidance and Command

The authorities did not give proper guidance to the private cars transporting victims so that most of the patients were sent to St. Luke's Hospital, which had received as many patients as its capacity permitted. If there had been more patients, they would have been transported to other hospitals. But TMFD had no enough ambulances to transport patients, nor did the backup system.

From the response to and disposal of this gas attack, we should learn the following lessons.

1) Poisons should be strictly controlled and any private synthesis and production of poisons should be banned.

2) Police protection of public sites and important facilities should be strengthened. Such crowded sites as subways, stations, airports and large underground

buildings would be the major target of terror attacks and effective measures should be taken to prevent crimes in these sites.

3) Powerful chemical accident emergency organizations should be established in large and medium-sized cities and a certain amount of rescue equipments, materials and drugs should be stockpiled. Thus, rapid and effective rescue operations can be launched to reduce casualties and property losses as soon as a chemical risk breaks out.

4) The army medical workers should enhance their combat readiness and relevant professionals should regularly organize chemical defense and medical service drills and chemical risk emergency practices. Thus, when emergencies occur, first aid treatments, even for large numbers of patients, can be carried out without any delay.

Chapter 6 Secondary Disasters after Natural Disasters

Section 1 Indonesian Tsunami

I The Course of the Event

In the morning of 26 December 2004, an earthquake with magnitude 9.0 occurred at the west coast of Sumatra Island in Indonesia, which is the third largest earthquake in the world since 1900. In this earthquake, over 300,000 people were dead or missing. The earthquake and subsequent tsunami made about 1,700,000 people in fourteen countries in South Asia and East Africa homeless[91].

Located in a tropical rainforest climate, it is hot and wet in Indonesia and the neighboring countries. In Muslim tradition, cremation is forbidden and dead bodies can only be buried. Unburied bodies and lack of medical and health resources led to the outbreak of infectious diseases such as cholera and malaria. Infrastructures were severely damaged and most highways and bridges were destroyed. Supplies of lifeline engineering such as transportation, communication, fuel oil, electricity, food and drinking water were interrupted. In addition, great casualties of government officials completely paralyzed the Banda Aceh government. The complexity of the situation brought great difficulties to the rescue work[92].

II Disposal of and Emergency Response to the Event[93]

After the outbreak of the event, the Indonesian government took steps to evacuate refugees, set up the 24-hour health monitoring centers and provided health and medical equipments for local hospitals. The Health Ministry supplied to the affected areas a great quantity of drugs, body bags, food, clothes and generators. Thousands of solders, policemen, rescue workers and volunteers were sent to the north part of Aceh province to carry out the search and rescue work. The Indonesian government requested for aids from international community and Banda Aceh Airport would offer rescue aircrafts direct landing. To better coordinate the international assistance and receive relief materials, the United Nations Disaster Assessment and Coordination team and the Aceh provincial government collaborated and set up the humanitarian assistance coordination center in Banda Aceh. United Nations Development Program provided rebuilding experts to help the social security minister

to do the coordination. World Food Program set up representative office in Indonesia. International Organization for Migration was responsible for the postal delivery between the United Nations and non-government organizations in Aceh.

Following the disaster, United Nations Office for the Coordination of Humanitarian Affairs (OCHA) successively sent four United Nations Disaster Assessment and Coordination teams (UNDAC) to Indonesia, Maldives, Sri Lanka and Thailand, each of which consisted of 5 to 7 members. This has been the greatest number of UNDAC teams that UN has ever sent out in one natural disaster. Relief staff was sent to and funds were provided for the affected areas by such UN organizations as United Nations Security Coordinator, International Organization for Migration, United Nations Development Program, World Food Program, World Health Organization, United Nations Children's Fund and United Nations Population Fund. Governments and non-government organizations also sent rescue teams to the affected area. Aceh province in Indonesia was the worst-hit area in Indonesian Tsunami and various government and non-government organizations had been to Banda Aceh to participate in the rescue operation.

On account of the tropical climate and poor sanitation, medical teams in the affected areas made great efforts to publicize health and epidemic prevention knowledge, thoroughly disinfected local hospitals, refugee camps and their own living quarters, and gave out disinfection tablets, sprays and antiseptic wipes to prevent the outbreak and spread of infectious diseases

Several days after the disaster, United Nations set up the Humanitarian Information Center (HIC) in Sumatra, with its headquarter in a tent in the disaster center. HIC collected information and data from Indonesian government, non-government organizations and international agencies, and then released relevant information using ArcGIS software, including geographic information and maps.

When the disaster occurred, one of the most pressing issues was to prevent the outbreak of disease and further death of hunger. The locations and physical conditions of survivors must be informationized, as well as food, water and medical supplies in need. Cooperating with WHO, HIC teams sorted and analyzed geographic information and data to draw accurate disaster maps, and set up hospitals and mobile clinics in where necessary. All these efforts have prevented the outbreak of the expected large-scale disease and there were only few cases of death of hunger[94].

III Impacts of the Event

1. Health Impact

According to the figures released by Indonesia Coordinating Office for Disaster Risk Reduction on February 14, 2005, a total of 234,271 people in Indonesia were dead or missing in this earthquake and tsunami disaster, and the death and missing toll in Aceh exceeded 220,000, accounting for more than 90% of the total death[95].

According to a report of health department of Banda Aceh on January 5, 2005, one case of cholera occurred respectively in two victim settlements in the worse-hit Banda Aceh. Despite surviving the tsunami, many victims died of pneumonia due to the inhalation of foreign matter[96].

2. Social Impact

After the tsunami, nations all over the world immediately made responses and carried out a global international rescue. According to the World Bank, sixty countries and regions provided over US$5 billion in aid for damaged regions and private donations reached US$1 billion. Chinese government offered RMB500 million to the countries affected.

The tsunami destroyed many costal villages of the affected countries. The impact on fishing, small-scale agriculture and tourism has been devastating. Infrastructure and private property suffered great losses. While damage to the national economies was minor, the poor were greatly affected in this disaster. According to the estimate of ADB, almost 2 million people were impoverished by the tsunami, with Indonesia alone one million, India 645,000, Sri Lanka 250,000, Maldives half of the whole population.

IV Experience and Lessons from the Event

An excellent emergency plan and emergency command and decision-making system can ensure an organized and effective relief work for the government. Being an earthquake-prone country, India was much better than the other countries affected in the emergency response. Drawing lessons from the experience, the countries affected should train emergency talents and make effective emergency preparation plan.

A sound emergency rescue system is the foundation for an effective post-disaster self-aid and mutual aid with all forces mobilized. The publicity of earthquake and

disaster risk reduction knowledge for the public in peacetime should be enhanced to ensure their self-aid before arrival of outside rescue. The establishment and training of volunteer teams should be strengthened[97].

After the Indian Ocean Tsunami on 26 December 2004, Intergovernmental Oceanographic Commission set up warning systems in Indian Ocean, Caribbean Sea and Mediterranean Sea based on the experience of Pacific regions. The Pacific Tsunami Warning Center is the international warning center for the Pacific Ocean area. Since its foundation in 1965, it has served as the operation center for tsunami warning system of the Pacific regions and issued international tsunami warnings. With 28 member nations, the International Coordination Group for the Tsunami Warning System of Intergovernmental Oceanographic Commission oversees the operation of international tsunami warning system and enhances the coordination and cooperation among the member nations. Since April 2005, cooperating with Japan Meteorological Agency, the Pacific Tsunami Warning Center has provided temporary warning services for Indian Ocean area. Cooperating and exchanging data with U.S. Geological Survey, Incorporated Research Institutions for Seismology, International Acceleration Measurement Station, Paris Institute of Earth Physics, U.S. Alaska Tsunami Warning Center and other national and international agencies with seismic networks, the Pacific Tsunami Warning Center is able to receive seismic data from over 150 monitor stations all over the world[98].

Section 2 Wenchuan Earthquake in China

I Overview of the Event[99]

According to a report by West China City Daily, on 10 May 2008 a large scale toad migration happened in Tanmu village of Southwest Town, Mianyang City, Sichuan Province and millions of toads crossed a highway near a pharmaceutical factory. While some villagers considered it a bad omen, the local forestry authorities explained that this was a normal migration of toads.

At 14:32 on 12 May, the earthquake was strongly felt in Chongqing and buildings in Yuzhong District and Jiangbei District were shaking. One resident called the hot line of a TV station in Chongqing, saying "buildings and highways here are shaking severely", while the other side replied that "ours are shaking much more severely". At 14:31, Hong Kong, China Observatory received reports from many residents in Wong Tai Sin District and Ma An Shan, saying they felt a quake, and the seismograph in the Observatory had vibration record as well.

The violent earthquake of M_s 8.0 occurred at 14:28 on 12 May, 2008 in Wenchuan County of Sichuan Province. With a focal depth of 10-20 kilometers, it was the deadliest earthquake in the last 40 years and released two to three times more energy than Tangshan earthquake. The earthquake ruptured a 200-kilometer fracture zone, with over 4-meter vertical and horizontal surface displacement, which resulted in the sink of the Sichuan Basin and the great rise of Longmen Shan, as well as the rise of some areas in Chongqing. Dozens of cities and counties in Sichuan were severely affected in the earthquake, including Wenchuan, Beichuan, Mianzhu, Shifang and so on. Other provinces and regions such as Gansu, Shanxi, Chongqing and Yunnan were subject to impact of varying degrees.

II Disposal of the Event

1. Emergency Mobilization

At 15:33 on12 May, Chinese President Hu Jintao ordered immediate and utmost efforts for the quake victims. Premier Wen Jiabao immediately flew to the earthquake area in Sichuan to oversee the rescue work. Soon afterward, the National Disaster Relief Commission initiated a "Level II emergency contingency plan" and started the level II national emergency response. In the evening, the Ministry of Civil Affairs sent

relief working group to Sichuan Province to guide and coordinate the disaster relief work. At 16:00, the Ministry of Civil Affairs allocated 5,000 relief tents for the quake-hit area from the central relief supplies stockpile in Xian. At 17:00, as the Authorized User of the International Charter on Space and Major Disasters, the National Disaster Relief Commission requested space data from its members such as European Space Agency, U.S. Geographic Survey, Canadian Space Agency, Japan Aerospace Exploration Agency and Indian Space Research Organization to acquire in time the satellite observation data on the earthquake stricken area. What's more, considering the wide affected area, the rough terrain and persistent heavy rain, the National Disaster Relief Commission also requested observation of military satellite and commercial high resolution satellite data from Headquarters of the General Staff of the P.L.A. and the domestic providers and agencies of satellite data. The State Seismological Bureau initiated Level I emergency plan. The China Meteorological Administration initiated earthquake disaster weather service Level II emergency response in the afternoon, closely monitoring the weather changes and providing the weather forecast service timely. The state Electricity Regulatory Commission initiated the emergency system and went to the quake-hit area to guide the power grid repair. China's Health Ministry sent to the quake-hit area more than ten emergency medical teams of professionals in medical treatment and disease prevention and control. The Ministry of Housing and Urban-Rural Development required reports of the earthquake relief work twice a day and any time reports of urgent situations and major issues. The National Population and Family Planning Commission initiated "population and family planning emergency plan". The army and armed police immediately initiated the emergency system to support the earthquake rescue right at the first time.

2. Epidemic Prevention[101-102]

In the quake-hit area, the health facilities were severely destroyed, as well as the natural landscape and ecological environment. Since garbage, fecal pollution and sewage were everywhere and drinking water was polluted, the victims had to rely on the relief food for living. Due to the hot weather, the fast breeding of mosquitoes, flies and bacteria, the outbreak and spread of infectious diseases such as cholera, typhia, bacillary dysentery and HAV were highly possible. A series of measures were taken, including:

(1) Control of the transmitting media: In the early stage, disinfection and pest killing was the main task. Mosquitoes, flies and other vectors would be killed to prevent epidemic diseases. Disinfection and pest killing have been performed in such key sites as schools, canteens, trash cans, toilets, ruins and victim tents.

(2) Surveillance of diseases: With the support of village clinics or clinics of tent residential area with over one thousand dwellers, health agencies or independent health clinics, sentinel sites for disease surveillance were established to regulate the content, types, time and way of disease reporting. Assessment of disease surveillance was carried out, the developing trend of epidemic diseases was analyzed, targeted prevention and control measures were adopted. Joint defense system for epidemic control was set up between adjacent quake-hit area and military sites to report epidemic situation and coordinate the prevention efforts.

(3) Health education: After the earthquake event, medical staff educated the public on the basic knowledge of disease prevention and control. Health and epidemic prevention knowledge was taught where crowds congregated and when solders were taking a rest, including knowledge about environmental health, drinking water health, dietetic hygiene, pest control, personal hygiene, mental health and disease prevention.

(4) Guidance and supervision of environmental health management: An ongoing health supervision was performed in such public sites as tents, removable houses, public canteens, toilets, temporary garbage collection points and centralized water supply points. Volunteers were mobilized to improve the environment health of resettlement area, level off the land, remove the ponding, clear the breeding grounds for flies and mosquitoes and gather garbage and wastes. Temporary toilets, rubbish dumps or trash cans were set up in the resettlement area. The disinfection, cleaning and shipping of the garbage and wastes were in the charge of specially-assigned persons.

(5) Training of the local health workers: To consolidate the earthquake relief results and prevent the pandemic, training courses of disinfection and epidemic prevention were held. The local disease control workers would master the basic knowledge and techniques of health and disease prevention, know the health and epidemical situation in quake-hit area, grasp the key points for dietetic hygiene, personal hygiene and environmental health, the techniques of exterminating mosquitoes, flies, rats and fleas and also the prevention methods for the post-quake diseases.

III Impacts of the Event

1. Health Impact

The earthquake left over 100,000-km^2 heavily affected area and 5 million victims. Until 12:00 on June 5, the quake caused 69,127 deaths, 17,918 missing and 373,612 injured, adding up to 45,710,965 victims.

2. Social Impact[103]

The direct economic loss in the earthquake was up to RMB 845.1 billion. The earthquake resulted in 23,143,000 damaged houses and 6,525,000 collapsed ones. Six highways were partially damaged. Ten national and provincial main lines, five national highways and ten provincial highways were severely damaged. Over twenty-three thousand kilometers of rural highway in Sichuan Province were ruined. The direct losses in communication industry and electrical facilities exceeded RMB 18 billion. The earthquake left 2,380 reservoirs in danger. About RMB 36 billion would be needed to reconstruct water conservancy facilities. In rural areas, water facilities in 49,949 places and 36,521 kilometers of water supply line were damaged. 996.4 kilometers of dykes and dams were damaged. The damage to infrastructure forced many manufacturing enterprises in Sichuan Province to stop or partially stop production for one to three months while the restoration of normal production and operation for large enterprise requires at least three months. The operation order of social economy was severely affected and the indirect economical losses exceeded RMB 290 billion.

This earthquake is actually a test for the social system of China, a trial for the social moral in China and a baptism of the soul for Chinese citizens. In the relief work, all people are equal regardless of sex, age, urban and rural differences. The government relief serves as the bottom line of the social security and all groups in need have received social relief. The State Council issued Wenchuan Earthquake Recovery Act to regulate the resettlement and reconstruction work. In the process of earthquake relief, news conferences were held regularly by the relevant government departments to timely release the quake-related information, which is vital to avoid panic and maintain social stability.

The earthquake had minor impact on the atmosphere and drinking water in the quake-hit area. However, large area of the forest, which is the climate regulator, was destroyed and the ecological habitat of animals and plants was seriously affected. The

frequent outbreaks of strong seismic secondary disasters were even a more severe threat to the environment.

IV Experience and Lessons from the Event[104]

Under the leadership of the Party Central Committee and State Council, the Wenchuan emergency relief has been a great victory and will be remembered forever in the history of the People's Republic of China.

The Wenchuan earthquake emergency relief has significant inspirations for the improvement of emergency management in China. First, promote the reform of emergency management system. The response to Wenchuan earthquake has been prompt and efficient with coordination among various departments and local authorities. Learning from the experiences of Wenchuan earthquake emergency management, the reform of emergency management system will be reflected on profoundly and innovation of emergency management mechanism will be greatly enhanced. Secondly, strengthen the emergency training and drill of armed forces. Liberation army, armed police and militia should put on the agenda the training for basic knowledge and skills of emergency management and carry out the emergency drill or joint emergency drill with local authorities on a regular basis to effectively mobilize armed forces to take part in the emergency response and to reduce casualties in the outbreak of great disaster. Thirdly, improve the emergency social mobilization mechanism. The government should make compensation for the temporary expropriation in emergency response to guarantee the sustainability of social mobilization. Emergency relief equipments, material reserves and production capacity of the enterprises should be registered to facilitate the urgent expropriation by the government in emergency outbreak. Industrialization of emergency response should be promoted. The government should encourage enterprises to develop emergency relief products and to set up emergency relief companies which mainly recruit retired firefighters and veterans. In addition, professional skills training of volunteer emergency relief teams should be developed and coordination among non-government organizations should be strengthened. The catastrophe insurance system should be developed to share the risk caused by the disaster. Fourthly, promote the emergency management ability of basic units. The emergency management ability of basic units decides whether the damage of emergencies can be minimized. Their emergency response ability is extremely important when emergency relief teams are

hindered by the traffic problems or other reasons. The emergency management ability of basic units should be effectively promoted and the organizational system of basic emergency management be improved. Meanwhile, necessary emergency resources should be allocated for the basic social units. Fifthly, establish the international cooperation mechanism of emergency management. In the era of economic globalization, international cooperation mechanism of emergency management should be established to enhance the exchanges and cooperation with other major countries, thus learning from each other and achieve common progress. Sixthly, carry out public safety education. Public safety education is indispensable to the public's awareness and skills of self-aid and mutual aid. However, public safety education should be carried out on a regular basis, not by a "movement type" mode. Public safety education should be incorporated into the school system to make it an essential component in public life.

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Prepared by
Shanghai Municipal Center for Disease Control and Prevention
No. 1380, West Zhongshan Road, 200336, Shanghai, China
Telephone: 0086-21-62758710
Fax: 0086-21-62756323
And
Fudan University, School of Public Health
Add: 138 Yixueyuan Road, Shanghai, China
Tel : 0086 21 5423 7334

For
Asia Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

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