7 The Risk, Prevention, and Control of Arthropod-Borne Infectious Diseases

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Arthropod-borne infectious diseases usually refer to a group of infectious diseases transmitted among vertebrates and acquired through the bites of infected arthropods. Arthropod vectors with transmission capacity usually include mosquitoes, midges, lice, fleas, ticks, mites, etc., which become infected when they bite a vertebrate infected with a pathogen [1]. The infected vectors can then spread the pathogen to other vertebrates through bites. In the process of transmission, pathogenic organisms enter into the body of the vector organisms, and the spread of disease is furthered by the proliferation of the pathogen in the vector. Some pathogens can invade the egg cells of vector organisms and be transmitted vertically to the offspring. During the development process, the pathogens can be transmitted across stages—if the infected eggs develop into nymphs, larvae, and adults, they carry pathogens, and when they bite and suck blood, they transmit the pathogens to other vertebrates. Therefore, arthropod vectors could play the role of host to carry a pathogen independently in nature without the help of vertebrates for a certain period.

Historically, arthropod-borne infectious diseases have caused serious harm to human beings. With the significant improvement of the global public health system, some arthropod-borne infectious diseases, such as malaria and Japanese B-Encephalitis, have been effectively controlled in most regions. However, with the effects of global warming, the change of ecosystem and environment, and the rapid development of transportation and logistics, the spread of arthropod vectors is more convenient and the areas affected by arthropod-borne infectious diseases are expanding, some conventional infectious diseases are breaking out again, and new arthropod-borne infectious diseases are emerging [2]. According to statistics, arthropod-borne infectious diseases account for 20% of human infectious diseases and 30–40% of deaths due to infectious diseases.

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Arbovirus is an arthropod-borne pathogen most easy to spread globally, especially in terms of infectious diseases transmitted through *Aedes* mosquitos. There are many kinds of arboviruses. They are widely distributed, but the most closely related to human beings are the viruses in the family of *Flaviviridae*, *Togaviridae*, *Peribunyaviridae, Phenuiviridae*, and *Reoviridae*. When a human being is infected by one of these viruses through mosquitos biting, the clinical manifestations are similar—mainly fever and rash, with or without severe symptoms, such as hemorrhage, shock, and encephalitis. In recent years, areas that are directly affected by these viruses, and in particular, yellow fever virus (YFV), dengue virus (DENV), Zika virus (ZIKV), chikungunya virus (CHIKV), and Rift Valley fever virus (RVFV), are expanding. They are mainly transmitted by *Aedes* mosquitoes, and have attracted worldwide attention.

7.1 The Prevalence of Arthropod-Borne Infectious Diseases in "Belt and Road" Countries

7.1.1 Dengue Fever

Dengue fever is an acute infectious disease caused by the dengue virus, which is spread to people through the bite of an infected *Aedes* species (*Ae. aegypti* or *Ae. albopictus*) mosquito. It spreads rapidly and is one of the most serious arthropod-borne infectious diseases in tropical and subtropical areas. According to the statistics of the World Health Organization, about 2.5 billion people from more than 100 countries and regions around the world live in areas with a risk of dengue [3].

Dengue virus belongs to the flavivirus of the *Flaviviridae* family. Of the four types of viruses, dengue fever can be caused by anyone of them. Different types of dengue virus can circulate in a region simultaneously or sequentially, which increases the incidence of severe dengue fever and its mortality. The natural hosts of the virus are human beings and nonhuman primates, and the main vectors are *Aedes aegypti* and *Aedes albopictus*. In urban areas, the virus circulates between humans and *Aedes* mosquitoes, and in forest areas of Southeast Asia and West Africa, the virus circulates between nonhuman primates and mosquitoes. With the general trend of global warming, dengue fever is showing an increasing trend and the incidence rise rapidly. The number of reported cases increased by more than 30 times in the past 50 years.

In 1779, the outbreak of suspected dengue fever, known as "bone fracture fever" or "bone pain fever," was first reported in Jakarta, Indonesia, and Cairo, Egypt. In 1944, Sabin and others first isolated dengue I and II viruses from soldiers in Indonesia and Hawaii. In 1956, Hammon and other isolated dengue III and IV viruses in the Philippines.

At present, dengue fever is prevalent around the year in Southeast Asia and South Asia. Four serotypes of dengue virus are endemic simultaneously, showing periodicity of 2–5 years. A small number of dengue fever cases and severe dengue like cases have also been reported in the Arabian Peninsula. In Africa, there are also four types of dengue virus endemic, among primates and humans, and dengue fever is prevalent in most of the urban population in West Africa. Since 1977, four serotypes of dengue virus have been introduced into tropical and subtropical areas of the Americas and local transmission has been established. Since 1981, dengue virus have been found in Pacific island countries and Oceania countries, like Australia. By the late 1990s, more serotypes of dengue virus were endemic or cyclical in the Caribbean and Latin America. In 2019, the global dengue fever epidemic shows a trend of high incidence, especially in Southeast Asia, South Asia, and Latin America, and the incidence peaked in many countries in the same period of history.

In China, the prevalence of dengue-like diseases can be traced back to 1873, when more than 75% of people in Xiamen fell ill. At the beginning of the twentieth century, dengue-like outbreaks occurred in Shanghai, Hangzhou, Guangzhou, Hankou, etc. However, the first laboratory-confirmed outbreak occurred in 1978, and outbreaks caused by Type 4 dengue virus were reported in Guangdong Province [4]. In the next 10 years, over 10,000 cases were reported annually in 6 years, among which over 400,000 cases were reported in 1980, mainly in Guangdong, Guangxi, Hainan provinces [5]. By 1985, four serotypes of the dengue virus had appeared in China and caused epidemics. Since the 1990s, the disease has been mostly sporadic or small-scale outbreaks caused by imported cases in Southern China. But in 2014, there was a large-scale dengue outbreak in China, with more than 40,000 cases reported. In 2019, while the world was faced with a significantly high incidence of dengue fever, the number of reported cases in China also increased greatly, the areas with local transmission caused by introduced virus expanded northward, but the total number of cases was lower than that in 2014.

7.1.2 Zika Virus Disease

Zika virus disease is an acute viral infectious disease caused by the Zika virus (ZIKV), which is mainly transmitted by *Aedes* mosquito, and generally occurs in tropical and subtropical areas. *Aedes aegypti* is the main transmission vector of ZIKV. *Aedes albopictus*, *Aedes Africans*, and *Aedes flavipectus* can also transmit the virus. At present, it is endemic in Africa, Asia, America, and Pacific island countries. The clinical manifestations of the disease are usually slight and death is rare. However, some cases may have serious consequences, such as nervous system syndrome, infant microcephaly syndrome, and other birth defects or fetal death. It has attracted extensive attention from the world in 2016.

ZIKV was first isolated from monkey serum in the Zika forest of Victoria River in Uganda in 1947, and also from *Aedes Africans* collected in the same area in 1948 [6]. Then, ZIKV was successively isolated from humans and various mosquito vectors. In the early stage, ZIKV disease was mainly distributed in some countries in Africa and Southeast Asia. In 2007, there was a large-scale outbreak of ZIKV disease in Yap

Island of the Federated Republic of Micronesia. The main manifestations of the cases were sudden systemic macula or papule, arthritis or arthralgia, or nonsuppurative conjunctivitis. From 2013 to 2014, outbreaks of ZIKV disease occurred in French Polynesia, and syndrome of the nervous system increased among patients, with some patients being diagnosed with Guillain Barré syndrome (GBS). In May 2015, a large-scale epidemic of ZIKV disease appeared in Brazil, which spread rapidly to many countries in the Americas, with a trend of global transmission, and local transmission of ZIKV was found in more than 80 countries or regions. In this epidemic, GBS cases were reported more frequently, and damages in the nervous system, eyes, and hearing were found in infant infection cases. Pregnant women infected with ZIKV may cause infant microcephaly and even fetal death.

Phylogenetic analysis of ZIKV genome sequences using bioinformatics technology showed that the virus might have appeared between 1892 and 1943. Around 1940, the virus spread in Africa twice, forming two sub-genotypes of African type [7]. It spread to Malaysia in 1945, forming Asian type, and to Micronesia in 1960 [8].

In Africa, cases or outbreaks have been reported in Nigeria, Sierra Leone, Ivory Coast, Cameroon, and Senegal in West Africa, Gabon, Uganda, and the Central African Republic in Central Africa. Infant microcephaly and neurological complications caused by ZIKV infection have also been found in Africa. In Asia, ZIKV has been isolated in Singapore, Indonesia, Thailand, Bangladesh, Cambodia, Laos, Malaysia, Philippines, Vietnam, etc., and there have been cases acquired through the local transmission. ZIKV has also been isolated in nature, but no human cases of local transmission have been found in China. In 2007, the first outbreak of ZIKV disease occurred in Yap Island [9]. The virus strain originated from Southeast Asia, which may be introduced by humans, host animals during the period of viremia, or mosquito vectors infected with the virus in tourism and trade activities. In the Americas, Chile confirmed the first case of local infection on Easter Island in February 2014. After that, ZIKV epidemic areas expanded and localized. Outbreaks caused by local transmission were reported in 26 countries and regions, and Brazil and Colombia were the most affected countries.

Imported cases of ZIKV disease from abroad have been found in China, Israel, the United States, Canada, Denmark, Finland, Germany, Italy, Portugal, the Netherlands, Spain, Sweden, the United Kingdom, Slovenia, Switzerland, Austria, Australia, etc. Among them, on January 16, 2016, the United States reported the first microcephaly baby born in Hawaii and infected with ZIKV, whose mother traveled to Brazil when she was pregnant in May 2015.

On February 6, 2016, China mainland found the first imported case, a person who worked in Venezuela in January 2016 [10]. Subsequently, imported cases were found in Guangdong, Zhejiang, Beijing, Jiangxi, Henan, and Jiangsu, and they were mainly from Venezuela, Samoa, Suriname, Guatemala, and other American and Pacific island countries. Researchers have isolated ZIKV from mosquito samples collected in the field of Guizhou and Jiangxi provinces, but no case acquired through local mosquito bites has been reported in these areas.

7.1.3 Yellow Fever

Yellow fever, an acute mosquito-borne infectious disease, originated in Africa and then was brought to America through the slave trade [11]. In 1648, the first recorded outbreak occurred in Yucatan Peninsula, Mexico, and a stable epidemic focus of yellow fever transmission was established in Latin America and South America. Outbreaks of yellow fever were reported in North America and Europe (such as New York, Philadelphia, Charleston, New Orleans, Ireland, England, France, Italy, Spain, and Portugal) in the seventeenth and nineteenth centuries [12].

The spread of *Aedes aegypti* has put many cities at risk of re-emerging of yellow fever [13]. In Africa, endemic areas range from 15° N to 10° S, from the Sahara Desert to northern Angola, the Democratic Republic of Congo, and Tanzania. At present, in Africa, yellow fever is mainly prevalent in 34 countries in sub-Saharan Africa, and there is also a risk of yellow fever epidemic in western and northwest provinces of Zambia. Therefore, in Africa, 27 countries are faced with a high risk of yellow fever epidemic and 8 countries with a medium risk of yellow fever epidemic [14]. Thirteen countries are at high risk of yellow fever endemic in South and Central America [14]. Jungle transmission is limited to tropical areas of Africa and Latin America, with hundreds of cases appearing every year. The vast majority of these cases were young men working in forests or transitional areas, or occupational exposure, in Bolivia, Brazil, Colombia, Ecuador, and Peru, suggesting low vaccination coverage [12]. Historically, yellow fever has occurred in many cities in America, but there has been no outbreak of yellow fever in urban areas of North America for more than 50 years. Yellow fever epidemic in Brazil showed a certain periodicity, characterized as an alternative appearance of a sporadic single case acquired through local mosquitos-mediated transmission, and outbreaks among low immune coverage populations in local areas. The epidemic cycle is generally 3–7 years.

In 2006, WHO and UNICEF launched the "Yellow Fever Initiative," which coordinated yellow fever control activities at the global level, called for endemic countries to integrate yellow fever vaccine into children's immunization programs, launched "Yellow Fever Preventive Mass Vaccination Campaigns" (PMVCs) in high-risk areas, and coordinated the management of stockpiled yellow fever vaccines through the international coordination group on vaccine supply (ICG) to respond to global public health Emergency. The number of yellow fever outbreaks in the world decreased steadily, and no yellow fever outbreaks were reported in Africa in 2015. In 2016, due to the large-scale outbreak of urban yellow fever in Angola and Congo, WHO revised the yellow fever prevention and control initiative and the strategic framework, and proposed the global strategy to "Eliminate Yellow Fever Epidemics" (EYE) in 2017–2026. The strategy includes three strategic objectives: to protect populations at risk, prevent international spread, and contain outbreaks rapidly.

In the past 2 years, the yellow fever epidemic in Nigeria showed a rising trend. Since the Nigerian CDC reported a confirmed yellow fever case to WHO on September 15, 2017, outbreaks of yellow fever have been continuously found in a wide geographical area in Kuala state. From 1 January through 10 December 2019, a total of 4189 suspected yellow fever cases were reported from 604 of 774 Local Government Areas (LGAs) across all the 36 states and the Federal Capital Territory in Nigeria [15].

In China, the first imported yellow fever case was confirmed in Beijing on March 12, 2016, which was also the first imported confirmed case in Asia [16]. In the same year, 11 imported cases of yellow fever were found in China, among whom one died. All of them were business or migrant workers in Angola. So far, no local transmission of yellow fever virus has been found in Asia.

7.1.4 Chikungunya Fever

Chikungunya fever (CHIK) is caused by the chikungunya virus (CHIKV), and transmitted by infected *Aedes* species mosquito bites [17]. It is a self-limited infectious disease characterized by fever and joint pain. CHIKV was isolated for the first time in 1952 during the outbreak in Tanzania; and in Asia, CHIKV was first isolated in 1958 in Thailand [18]. Outbreaks of CHIK in Africa, Asia, including the Indian subcontinent, were then detected and reported. There are 37 countries and regions in the world at risk of endemic or potential endemic of CHIK [17]. The natural hosts of CHIKV are human beings and primates. The main vectors are *Aedes aegypti*, *Aedes albopictus*, and *Aedes Africans*, but the efficiency of different mosquito species in transmission varies significantly. *Aedes aegypti* is a domestic mosquito species with the strongest ability to transmit CHIKV. Based on the genetic analysis of the viral genome, CHIKV is classified into three genotypes, namely West Africa, Asia, and East Central South Africa (ECSA). The virus of each genotype is generally endemic in the corresponding geographical region. From 2005 to 2006, the ECSA virus was introduced into Asia, causing large CHIK outbreaks in the Indian Ocean Islands, India, and Southeast Asia.

People are generally susceptible to CHIKV, and the virus infection rate in susceptible people in the endemic area can be as high as 40–85%. The proportion of patients with latent infection in infected people is not clear. In 2006, India reported more than 1.3 million CHIK cases, but the proportion of asymptomatic infection is very low. Although there are few cases of death directly caused by CHIKV, the monthly reported mortality in the population of CHIK epidemic period is significantly higher than that of the nonepidemic period, suggesting that CHIK may increase the mortality of other diseases.

In China, it is reported that suspected CHIKV virus has ever been isolated from patients, vectors, and bats in Yunnan and Hainan provinces, and antibodies have been detected in humans and some mammalian sera. The first confirmed CHIKV was detected from an imported case introduced from Sri Lanka in 2008, which was an Indian Ocean epidemic strain of ECSA genotype [19]. After that, imported CHIK cases were found in many provinces, but no local transmission of CHIKV was detected before 2010 when an outbreak of local transmission was found in Dongguan City, Guangdong Province, with more than 200 cases reported [20].

7.1.5 Rift Valley Fever

Rift Valley fever (RVF) is a viral zoonosis that affects both animals and humans. RVF virus is a member of the Phlebovirus genus [21]. It was first identified in 1931 during an investigation into an epidemic in sheep on a farm in the Rift Valley of Kenya [21]. Although RVFV often causes severe illness in animals, most people with RVF have either no symptoms or mild illness with fever, weakness, back pain, and dizziness. However, a small percentage (8–10%) of people with RVF develop much more severe symptoms, including eye disease, hemorrhage (excessive bleeding), and encephalitis (swelling of the brain). The early clinical manifestations of RVF are nonspecific, influenza-like disease, fever, headache, myalgia, backache, and other symptoms. The mortality of RVF reported in different epidemic areas varies significantly. Since the discovery of the virus, it has been found in more than 30 countries and mainly in Africa, though there was a large-scale outbreak in Saudi Arabia and Yemen. Imported cases have been reported in Sweden, France, Germany, the Netherlands, Canada, and China.

RVFV was isolated from mosquito vectors in Senegal, West Africa, in 1974. A large-scale outbreak occurred in southern Mauritania in 1987, when 284 cases were reported and 28 people died. An epidemic of RVF among animals was detected in the same year in Burkina Faso. In 1977, a large-scale outbreak occurred in Egypt, outside sub-Saharan Africa, with 18,000 reported cases and 598 deaths [22, 23]. Between 2000 and 2001, the first outbreaks were reported outside Africa, in Saudi Arabia and Yemen [24]. Given the limitation of the public health system in Africa, there was a possibility that the epidemic in some countries was not detected in time. By 2018, the following significant outbreaks had been reported:

An outbreak occurred in Egypt in 1977–1978, when 18,000 cases were reported and 598 people died. The actual number of patients may reach 200,000. The outbreak might be caused by the imported virus through the camel trafficking channel from Sudan, where an intermediate stop was set at Aswan Dam; hence, the epidemic in Egypt. Most of the dead cases had bleeding symptoms, a large number of camels died and pregnant ewes aborted [22, 23].

From 1997 to 1998, it broke out in Kenya and spread to Tanzania and Somalia, when 8000 cases were reported and 350–500 people died. The epidemic spread among camels and sheep, resulting in a large number of deaths [25]. The seroepidemiological survey found that the positive rate of the IgM antibody among residents of the Garissa community in Kenya was 8.9%. In 2000, the first outbreak of Rift Valley fever outside Africa was reported in the Arabian Peninsula, when 1087 cases were reported in Yemen and 121 people died, and 883 cases reported in Saudi Arabia and 124 people died [24]. Outbreaks in Sudan, Kenya, Somalia, and Tanzania in 2006–2007 resulted in more than 900 deaths and a large number of livestock deaths [26]. Compared with the information of the human epidemic, there was an insufficient description of epidemics in animals.

In July 2016, an imported case of Rift Valley fever was confirmed in China [27]. Before the onset of the disease, the patient was engaged in outdoor work in Luanda, the capital of Angola. No outbreak or epidemic of RVF was notified before the infection, suggesting that the risk assessment of RVF could not be only based on the epidemic notification, which to some extent affected the effective identification of cross-border cases.

7.2 The Epidemic Risk and the Principle of Prevention and Control of Arthropod-Borne Infectious Diseases

Health authorities should first clarify the background information of corresponding epidemics of arthropod-borne infectious diseases and molecular epidemiological characteristics of related pathogens in local areas, including at least the dominant species composition of arthropod vectors, the infection rate, and the factors affecting the speed of vector-borne transmission. In addition, with the increasing trend of globalization, logistics, and mobility of people, the introduction of nonnative animals and plants increases on a daily basis. The geographical boundaries of the distribution of some arthropod vectors and insects are broken, and long-distance migration can be completed in a very short time. If they can adapt to the local environment, a new breeding area is then established. In the past 50 years, *Aedes albopictus* has been expanding to all continents in the world and adapted to the environment of most regions. In China, *Aedes aegypti* is mainly distributed in southern Taiwan, Hainan, and some coastal areas of Fujian, Guangdong, and Guangxi. It is also found in border areas of Yunnan Province. *Aedes albopictus* is widely distributed, from Liaoning Province in the north to Shaanxi Province in the northwest, Tibet in the southwest, and 34° in the south. The speed of arboviruses transmission by these mosquito vectors varied with regions, and the adapted evolution of viruses or/and vectors often led to unexpected large outbreaks. Cases of viral pathogen introduction, vector adaptation, and local outbreaks have sounded the alarm for the prevention and control of arthropod-borne infectious diseases worldwide.

The principle for the prevention and control of arthropod-borne infectious diseases is generally based on whether there is an autochthonous transmission of pathogens, vectors, and susceptible populations in the area. A graded response is suggested based on the transmission risk, and emphasis should be put in taking decisive measures to control the scale of the epidemic and prevent the escalation of the epidemic in the early stage. If the local epidemic situation has reached a certain level of, rather than above, the response standard, in principle, the response work can be carried out according to the standard of that level. However, for areas where the previous epidemic situation is very serious, the density of mosquito vectors is particularly high, or there are other factors leading to the high risk of the epidemic spreading; the response work can be launched according to the higher level of standards. Institutions at all levels should adjust response measures in time according to the progress of the epidemic and summarize the epidemic situation of each stage. Countries and regions without local epidemics should pay close attention to the progress of international epidemics and carry out a dynamic risk assessment, improve vaccination services, and health education services for travelers to epidemic countries/regions. They should further implement relevant policies and measures for the inspection of vaccination certificates of people to and from endemic areas of arthropod-borne infectious diseases, keep monitoring mosquito density, release early warning timely, ensure mosquito control, prevention and environment protection, and enhance public health education and professional training.

When an outbreak occurs, comprehensive prevention and control measures should be taken in time in the early stage. These measures mainly include case monitoring and management, *Aedes* surveillance and control, risk assessment and situation study, publicity, education, risk communication, as well as policy, material and funding support. Institutions of disease prevention and control should give full play to their role of technical support in the comprehensive prevention and control, guarantee case and *Aedes* surveillance, timely carry out a risk assessment, situation study, and judgment, and provide scientific and reasonable prevention and control recommendations to administrative departments.

To improve case monitoring and management, first of all, it is needed to formulate technology guidelines of case monitoring and laboratory testing, standardize case report, laboratory rapid testing, verification diagnosis, case investigation, search and treatment, and mosquito prevention and isolation, so as to identify the source of infection, determine the epidemic point, find potentially infected persons, and reduce the severity mortality rate, control the source of infection, and slow down the progress of the epidemic.

There are routine and emergency surveillance and control of *Aedes* mosquito. The surveillance results of *Aedes* should be timely shared and regularly reported to superior disease control agencies. Efforts should be made for mosquito control, environmental clean-up, removal of breeding places, and the effect of these efforts should be dynamically evaluated, and a continuous and effective information notification and feedback mechanism be established. These are the core measures to control *Aedes* mosquito activities and cut off the transmission, and key measures for arthropod-borne infectious diseases prevention and control.

Factors, including the epidemic situation, *Aedes* mosquitos, climate, environment, customs, and culture, risk of introduction, etc., should be comprehensively analyzed for dynamic risk assessment, and the affected administrative areas should be scientifically classified into different levels based on risk assessment, which is the core technical support to target the prevention and control measures.

Publicity, education, and risk communication should be carried out in a wide and in-depth way through media, network, communication, teaching, and other ways, so as to give timely early warnings, communicate risks, and popularize disease-related knowledge. Fully mobilize communities, clear the breeding ground of mosquito vectors, and form the habit of mosquito prevention and control, which is a vital part in the prevention and control of mosquito-borne infectious diseases.

According to the response preparedness of the region, governments at all levels should prepare well in personnel, funds, materials, logistics, transportation, and other supports. It is the fundamental requirement for the prevention and control work. The epidemic prevention and control measures should be implemented in accordance with the government leadership and multi-departmental cooperation mechanism. Based on previous experience, the main departments involved include public health, health care, publicity, housing and construction, urban management, education, tourism, public security, finance, inspection and quarantine, etc. The disease control agency can recommend the government to carry out comprehensive prevention and control with reference to the following:

Disease prevention and control institution: carry out epidemic monitoring, *Aedes* mosquito monitoring and assessment, analyze the epidemic situation, carry out epidemic analysis and risk assessment, put forward prevention and control measures and suggestions, and provide technical support for all aspects of the prevention and control work.

Public health administration: be responsible for leading and coordinating medical, public health, health care, health supervision, health education, and other institutions, provide technical support, coordinate experts, strategies, suggestions, etc.

Environmental department: carry out mosquito control, environmental treatment, and elimination of breeding places of *Aedes* mosquitoes, conduct environmental health quality inspection, supervision, and evaluation, and implement the accountability system.

Medical institution: be responsible for the diagnosis, isolation, treatment, and management of cases, sampling, laboratory testing or delivery to qualified laboratories for testing, case report, assistance in case investigation and epidemic analysis, training of medical staff in disease-related knowledge and personal protection, nosocomial infection control, health publicity and education, and case psychological guidance.

Health supervision institution: supervise and inspect the prevention and control of infectious diseases according to relevant laws and regulations.

Health education institution: cooperate with the propaganda department to disseminate diseases prevention and control knowledge, and focus on providing technical support for health communication.

Publicity department: carry out publicity and education on infectious diseases, public opinion tracking and guidance, epidemic reporting, risk communication, and mass mobilization.

Housing and construction department: be responsible for the environmental sanitation management and mosquito control and prevention at construction sites, residential areas, municipal and green facilities, pipeline, and sewage systems, strengthen environmental cleaning and garbage removal, and assist in the management of secondary water supply and mosquito prevention.

Education department: be in charge of mosquito control (killing adult mosquitoes and removing stagnant water) in schools and kindergartens, publicity and education for teachers and students, and call for mosquito control at home.

Urban administration: actively cooperate with environmental, housing, and construction departments to strengthen the supervision and inspection of the environmental health at construction sites.

Tourism department: organize subordinate organizations to publicize knowledge on infectious disease prevention and control, and timely contact relevant departments to handle suspected cases.

Public security department: assist and guarantee all departments to carry out prevention and control work.

Financial department: guarantee funds for the prevention and control work.

Inspection and quarantine department: be responsible for quarantine monitoring and infectious disease screening of entry-exit personnel, and cooperate with the health department on a follow-up investigation of suspected cases found at the port and their close contacts.

Governments at all levels may, according to the actual situation of the region and the needs of epidemic prevention and control, include other departments in the multi-sectoral cooperation mechanism for the prevention and control of arthropod-borne infectious diseases.

7.3 Cases of Prevention and Control

Dengue Prevention and Control in China

1. Overview

In China, the mosquito vectors that can transmit dengue virus are widely distributed, among which *Aedes aegypti* is mainly distributed in Hainan, Leizhou Peninsula, Xishuangbanna, Dehong and Lincang City of Yunnan Province, and *Aedes albopictus*, in Liaoning, Hebei, Shanxi, Shaanxi Province, and South China. The first laboratory-confirmed outbreak occurred in 1978. Outbreaks caused by Type 4 dengue virus were found in Guangdong Province, and more than 20,000 cases were reported that year. In the next 10 years, over 10,000 cases were reported annually in 6 years, among which over 400,000 cases were reported in 1980, mainly in Guangdong, Guangxi, Hainan, and other provinces. By 1985, four serotypes of the dengue virus had appeared in China and caused epidemics. Since the 1990s, the epidemic in Southern China has been mostly sporadic or small-scale outbreaks caused by imported cases, and the epidemic situation has remained relatively stable as a whole. The number of reported cases of dengue epidemic peaked in 2014. In 2019, while the world was faced with a significantly high incidence of dengue fever, the number of reported cases in China also increased greatly, the areas with local transmission caused by introduced virus expanded northward, but the total number of cases was lower than that in 2014. Long-term surveillance and field epidemiological investigations revealed preliminarily that the epidemic of dengue in China still features local transmission acquired by dengue viruses introduced abroad, and a stable transmission cycle of dengue virus thus established.

First, the results of virus serotype and genotype monitoring show that all four types of dengue virus infection cases have been introduced into China and caused local transmission, but the virus of the same highly homologous gene subtype has not caused local transmission cases in the same region for 3 consecutive years, and the epidemic situation caused by the same highly homologous gene subtype virus in the same region for 2 consecutive years was also rare. The second is the age distribution of the patients. In China, the majority of the patients are adults, and the proportion of child patients is low. It is accepted that in endemic areas, the proportion of children cases is high, and the proportion of adult cases is low. Third, the results of China's vector surveillance show that the vector density in the southern region peaks in July, but only sporadic local case reports were reported in China, and the local epidemic begins in August, while the epidemics peak in July in Southeast Asia. Virus genome sequence monitoring indicates high consistency with those of the imported viral pathogens. These monitoring results preliminarily suggest that dengue fever has not formed a stable epidemic focus in China. Although there are outbreaks through local transmission every year, they are mainly caused by the rapid establishment of local transmission after the importation of the virus, but the epidemic characteristics do not exclude the risk of a large-scale epidemic of dengue in China. It is inseparable from the fact that China has not formed a stable epidemic focus, thanks to its prevention of the local epidemic of dengue fever for many years in a row, that the government has attached great importance to the prevention and control of dengue fever, effectively implemented measures of prevention and control, and that the living and working conditions of residents have changed rapidly.

2. Prevention and Control Measures

In recent years, China's national dengue prevention and control work mainly include the following measures. After the outbreak of dengue fever in 1978, the Ministry of Health issued the "Dengue Prevention and Control Plan (Trial)" in 1981, which clarified the responsibilities of departments at all levels in the prevention and control of dengue fever, and determined the prevention and control strategies in the hierarchical management of dengue epidemic areas, dangerous areas, and susceptible areas. Technically, the prevention and control measures focused on strengthening epidemic monitoring, dealing with epidemic spots and disease diagnosis and treatment. The laboratory diagnosis program was standardized, and relevant scientific research, publicity, and education for the masses were emphasized.

In 1988, according to the epidemic situation, the Ministry of Health adjusted the dengue prevention and control plan and focused on epidemic reporting, monitoring, mosquito control, epidemic spots treatment, and the strengthening of border quarantine to prevent virus importation. It stressed that measures should be taken according to local conditions. Local governments could formulate specific implementation measures according to the plan in combination with local conditions. Among them, the hierarchical management strategy of key monitoring area and susceptible monitoring area was determined. Coastal areas with frequent or continuous outbreaks of dengue fever were listed as key monitoring areas, long-term monitoring sites were set up, and regular monitoring work should be carried out on vector, pathogen, and human group serology. Areas with *Aedes albopictus* distribution, no case acquired through local transmission reported, but frequent contact with personnel in key monitoring areas was set as susceptible monitoring areas, and the mobile population and vectors were regularly monitored. A comprehensive response system of dengue epidemic reporting, active monitoring, and emergency control were established.

The Ministry of Health issued "Diagnostic Criteria and Principles of Management of Dengue Fever" (Standard of the Ministry of Health, ws216–2001) in 2001 and revised it in 2008. In 2003 and 2008, the Disease Prevention and Control Bureau of the Ministry of Health edited and published the first and second editions of "Dengue Prevention and Control Manual," which updated and standardized the technical problems in specific disease control and prevention. In 2014, the National Health and Family Planning Commission issued guidelines for diagnosis and treatment of dengue fever, and China CDC improved a series of guidelines for dengue prevention and control technology (including case monitoring, laboratory testing, *Aedes* surveillance, *Aedes* control, etc.). In 2015, the epidemic risk of dengue fever in each province was further clarified and divided into three levels, namely, High-risk Area I, Medium-risk area II, and Low-risk Area III, and the "Technical Guidance for Grading Prevention and Control of Dengue" that adhered to the principle of government leadership, multi-sectoral cooperation, joint and mass prevention and control, public and expert integration, and scientific prevention and control was issued. The main purposes of these technical documents were to control the outbreaks at early stages and small scale. The actual goal of prevention and control was to prevent the spread of the epidemic and reduce severe cases and mortality.

3. Experiences and Lessons

Dengue cannot be eliminated, but with proper measures timely adopted in an outbreak, the scale of the epidemic can be effectively contained. Effective prevention and control measures should include rapid case identification, standardized case management, community participation, and community involvement in mosquito vector control, rapid laboratory testing, etc. The case definition for surveillance can be optimized according to the progress of the epidemic and the characteristics of different epidemic areas. Of course, the coordination and leadership of the government, the coordination and action of multiple departments, and the joint prevention and control should never be forgotten.

Yellow Fever Control and Prevention in Nigeria

1. Overview

Nigeria is located in the southeast of West Africa, with a population of 201 million and more than 250 ethnic groups. It is adjacent to Cameroon in the East, Chad Lake in the northeast, Benin in the west, Niger in the north, and Gulf of Guinea in the Atlantic Ocean in the south. The borderline is about 4035 km long and the coastline is 800 km long. The terrain is high in the north and low in the south. There are many rivers in the territory. It belongs to the tropical monsoon climate, which is divided into the dry season and rainy season. The annual average temperature is 26–27 °C. The geographical, climatic environment, and dense vegetation of the country are suitable for the survival and reproduction of *Aedes*, an important vector of yellow fever, and Nigeria accounted for above 90% of all yellow fever cases in the world during 1989 to 1993 [28].

In recent years, Nigeria's overall medical level and public health system have improved significantly, but infectious diseases are still a major public health problem facing the country, and infectious diseases, such as malaria, tuberculosis, AIDS, polio, yellow fever, and Lassa fever, are still important health threats. On September 15, 2017, according to the International Health Regulations (2005), the centers for disease control (CDCs) of Nigeria officially reported a confirmed case of yellow fever in Kuala Prefecture, and from 1 January through 10 December 2019, a total of 4189 suspected yellow fever cases were reported from all the 36 states and the Federal Capital Territory in Nigeria [15].

2. Prevention and Control Measures

According to the reports from WHO, the outbreak response activities in Nigeria are being coordinated by a multi-agency yellow fever Incident Management System (IMS) (15). Assessments were conducted by rapid response teams of local government jurisdictions and national agencies, and problems of low yellow fever vaccination coverage in Nigeria and incomplete routine immunization documentation were identified. Although routine vaccination against yellow fever was included in Nigeria's Expanded Programme on Immunization (EPI) in 2004, most adults are still vulnerable to infection and the overall population has low immunity.

An Emergency Operations Centre (EOC) was activated for the third time, in response to the upsurge of confirmed yellow fever cases reported in a wide-geographic distribution in Nigeria on September 5, 2019, multiple departments and agencies jointly working at CDCs to coordinate and respond to the yellow fever epidemic. The national rapid response team, including experts from the Nigerian CDCs and the National Primary Health Care Development Agency, has been deployed to Bauchi and other affected States to conduct case discovery, case management, and risk communication, mobilize partner support, and provide emergency yellow fever vaccination in important epidemic areas, like Alkaleri, where 407,708 people were vaccinated. Similar campaigns were planned in local government districts adjacent to the affected states.

Nigeria is currently implementing a 4-year (2018–2021) national Preventive Mass Vaccination Campaign (PMVC) plan for yellow fever prevention with the support of GAVI and partners so that all states in the country can be covered. By 2025, the campaign is expected to have been launched in all Nigerian states to protect high-risk groups from yellow fever. This year's phased prevention campaign will be aimed at Anambra, Ekiti, Kazina, and river states, with special activities in Borno. At the same time, the assessment of the states included in the next phase of the plan was started to cope with the epidemic situation. WHO and partners give support to local authorities in implementing these interventions to control the current outbreaks. The yellow fever vaccine is safe and efficient, which can provide lifelong infection protection. As far as international travels are concerned, the International Health Regulations (2005) is revised, and the validity period of relevant international certificates of yellow fever vaccination and the protection period against infection after yellow fever vaccination are changed from 10 years to whole life. As of July 11, 2016, no WHO contracting state shall require international travelers to be vaccinated or vaccinated against yellow fever as a condition of entry, regardless of whether they hold an existing certificate or a new certificate, and regardless of when the certificate was first issued.

3. Experience and Lessons

Nigeria is a high-priority country in the strategy to eliminate yellow fever. Vaccination is the main intervention to prevent and control yellow fever. It is very important to detect and investigate yellow fever cases through strong monitoring as early as possible, so as to control the risk of spread. Prevention of mosquito bites (e.g., insecticides and long clothing) is an additional measure to reduce the risk of yellow fever transmission. The adoption of targeted mosquito vector control measures in cities also helps block transmission.

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