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Original Article

β-coronavirus infectious diseases: recommended strategies for the prevention and control of transmission

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Abstract: In recent years, the incidence and mortality of infectious diseases in China are increasing. Infectious diseases, especially new infectious diseases, seriously threaten people's lives. Recent works found that most of the emerging infectious diseases come from wild life. At the same time, the impact of human activities on the environment has further deteriorated the living environment of wildlife. However, with the conducted in-depth research on virus, human beings increase the risk of getting infected. Taking Beta Coronavirus as the example, we analyzed the transmission risks of coronavirus in the prevention and control of the outbreaks of emerging infectious diseases, and recommend the prevention and control strategies before, during and after the viral outbreak. Additional works are urgently needed to better define the biological and epidemiological characteristics of these viruses.

Keywords: β-Coronavirus, infectious diseases, wildlife, environment, preventive measures

Introduction

Since the first virus "tobacco mosaic virus" was discovered in 1892, emerging infectious diseases of animals, plants and human caused by this type of viruses, which may cause serious consequences after infecting humans, continue to appear throughout the world.

Coronaviruses (CoVs) belong to the Coronaviridae family, which includes 4 genera namely Alpha Coronavirus (α-CoV), Beta Coronavirus (β-CoV), Gamma Coronavirus (γ-CoV), Delta Coronavirus (δ-CoV), all would infect humans and various animals, causing respiratory, intestinal, liver, and nervous system diseases in the host. Among the four genera, β-CoVs are the most harmful to humans [1]. The morbidity of infectious diseases caused by the virus and the mortality of other diseases secondary to infectious diseases are high, which leads to enormous mental and economic losses to the patients [2].

In 2002, an outbreak of severe acute respiratory syndrome (SARS) with the main feature of causing atypical pneumonia took place in China and quickly spread around the world. In April 2003, the World Health Organization announced that the pathogen was a new type of β-coronavirus, namely Severe acute respiratory syndrome coronavirus (SARS-CoV) [3]. In 2013, researchers isolated strains similar to SARS-CoV from Chinese chrysanthemum bats, which are highly similar to human SARS viruses, and pinpointed that the true natural host of SARS virus was chrysanthemum bats [4].

The Middle East Respiratory Syndrome (MERS) is a viral respiratory infection caused by newly discovered β-CoVs (MERS-CoV). The first identified case occurred in 2012 in Saudi Arabia and it has been referred to as Saudi Arabia's SARS-like virus. In the same year, researchers isolated a virus that is 100% homologous to human MERS-CoV in the feces of Egyptian tomb bats, so it was concluded that bats may be the true host of MERS-CoV [6].

With the change of the environment, the virus is constantly mutating and evolving, leading to growing cross-species transmission. The migration, reduction, or extinction of the virus host caused by human activities will also increase the uncertainty and corresponding risk of the virus infecting humans. This review

focuses on β-CoVs infectious diseases, analyzes the risk of transmission of β-coronal virus infectious diseases during prevention and control, and proposes prevention and control strategies before, during and after the outbreak. We hope to improve the work efficiency and research capacity for the prevention of the outbreaks of emerging infectious diseases through various research modalities and collaborations.

Possible sources of transmission risks in the prevention and control of β-coronal virus infection

Chinese people's blind pursuit of wildlife products

For a period of long time, due to traditional customs and food culture, wildlife consumption in China is not uncommon, and even China was once recognized as the world's largest wildlife consumer country. Many Chinese consider that wild animals' taste and nutritional value exceeds that of poultry and domestic mammals. This is because wild animals run in the wild to survive, which leads to developed muscle fibers and less fat. However, it has been disproved. The nutritional value of wild animals is not different from that of poultry and domestic mammals, and on the other hand, people who consume non-quarantine wild animals may be infected with infectious diseases.

Wildlife (animals) are considered as the de facto main source of many major human diseases. Including SARs, up to 75% of emerging infectious diseases such as HIV, Nipa virus (NiV) and H5N1 influenza are derived from the wildlife [7].

In recent years, outbreaks and epidemics of various infectious diseases directly or indirectly caused by wildlife have led to enormous losses of life and property to human beings. Therefore, Chinese laws strictly prohibit wildlife smuggling and require animal quarantine, which are involved in the management and control of virus epidemics. However, as a two-edged sword, it has also turned profit-driven wildlife trading channels into illegal underground trading or smuggling, making inspection and quarantine of organisms carrying infectious sources such as epidemic viruses more difficult.

Impact of human activities on the habitat and environment of the virus host

With the drastic changes in the global natural and social environment, the pattern of infectious diseases' occurrence and transmission has also changed. The light pollution, inter alia, caused by the urbanization process has become an environmental pollution and has a significant impact on the living habits of pathogen hosts, that cannot be ignored. Light pollution includes pollution caused by improper use of visible light, infrared and laser. To some extent, light pollution will disrupt the circadian rhythms of animals, resulting in their inability to behave properly, and even affect their eating, survival and reproduction (**Figure 1**).

Nocturnal animals are more active at night than during the day, which leads them more prone to the light pollution. For example, to avoid natural enemies, snakes and lizards are less active during full Moon nights. The night lights of the city affect the survival and reproduction of such animals. When the light is bright, fireflies cannot mate normally, and moths lose their basic resistance [8]. During the bat migration period, it is easy to get lost because of being attracted by green lights, which increases the probability of disease transmission between humans and animals in the area [9].

Laboratory biosafety

In a global environment where the incidence of infectious diseases is constantly increasing and pathogenic viruses are constantly mutating, laboratories specializing in the research of pathogens and new drug discovery for infectious diseases have continued to increase in various countries. At the same time, laboratories working on infectious diseases are at an increased risk of virus leakage.

In September 2003, cross-infection of West Nile virus samples with SARS coronavirus resulted from improper operation of laboratory procedures by laboratory personnel, causing a graduate student at the National University of Singapore to contract SARS virus [11]. In December 2003, a case of SARS occurred in Taiwan, China due to negligent handling during the disposal of waste from the laboratory transport cabin [12]. More training and equipment on laboratory biosafety are needed to reduce or eliminate those cases.

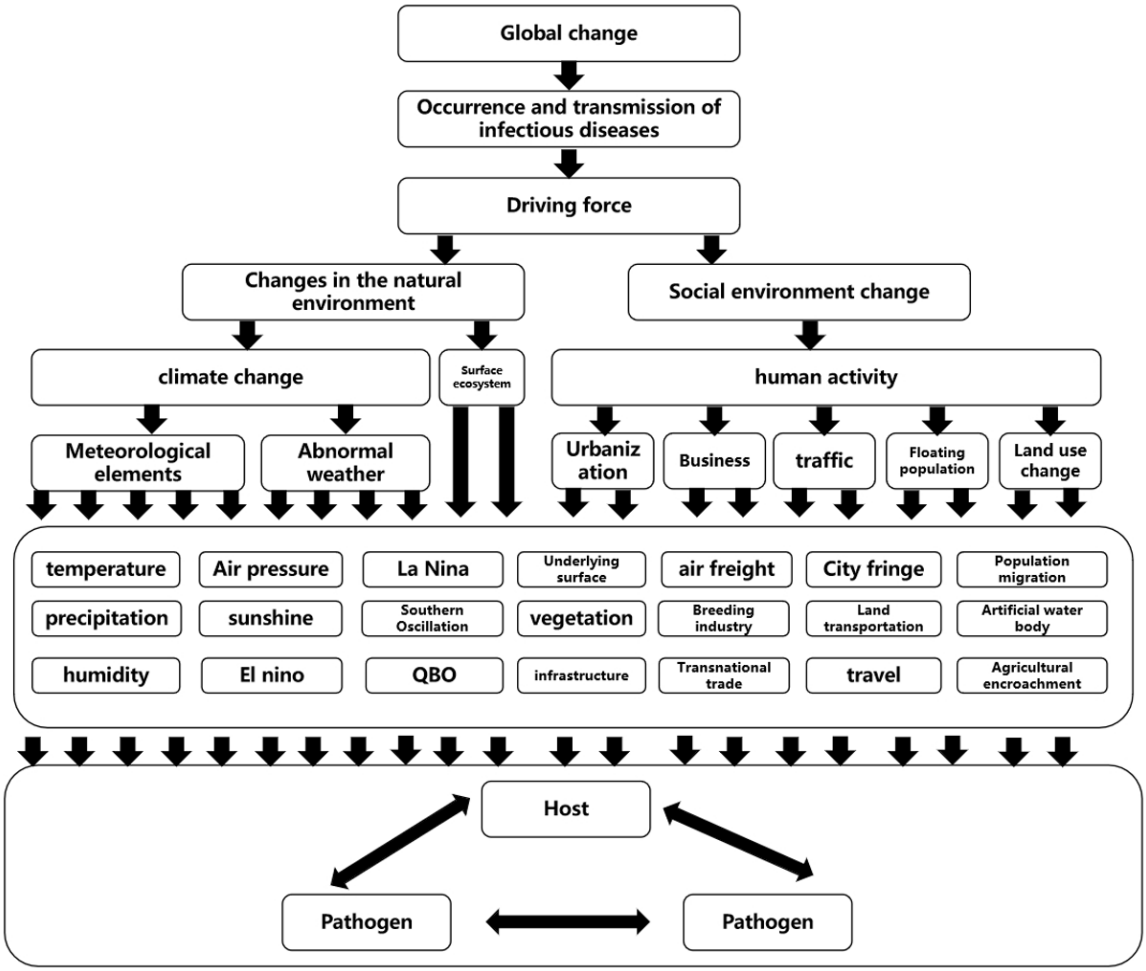

Figure 1. Impact of global change on the occurrence and spread of human infectious diseases.

Epidemic prevention and control strategies for β-coronal virus

Isolation, prevention and surveillance after the epidemic

Before the SARS outbreak in 2003, there was a lack of research on public health emergencies across China, and also an underdeveloped functional body. That led to inferior preparedness for and response to public health emergencies. With the outbreak of the SARS epidemic [13], causing deaths and negatively affecting social stability, the Chinese government and the disease surveillance system began to pay attention to the prevention and treatment of public health emergencies, which also stimulated related research progress.

The outbreaks of infectious disease can spread rapidly, causing enormous losses to the health and livelihood. However, the best strategy to stop their spread in our view should be at an early stage, or prevent them altogether. To do this, we rely on very early detection of the appearance of disease or disease-causing agents to control the source of infection [14]. Early detection, early reporting, early isolation, early diagnosis, and early treatment are all essential to stop or control the spread of infectious diseases.

Furthermore, it is essential to cut off the transmission of infectious diseases in a timely manner. Specifically, education to the public is needed to remind individuals to pay attention to personal and food-consumption hygiene, so as to eliminate the transmission media. Moreover, protections of the susceptible groups to reduce or eliminate their contact with the source of infection are needed. Further, using antimicrobials or vaccines to may help protect

susceptible people such as children, elderlies and immunocompromised patients [15].

Strengthen the supervision and quarantine of the food sources to prevent the introduction of viruses

In order to prevent and control the spread of animal epidemics, regulatory measures should be targeted at both legal and smuggling channels. For the legal sale and transportation of animals, epidemic prevention and clinical inspection stations should be set up at the all governmental levels, including those of the nation, province, city, and county. In particular, provincial (city, county) animal epidemic prevention and clinical inspection stations should be set up in the bordering areas to prevent and control diseases. In addition, the implementation of animal quarantine must be strictly implemented and regularly audited to effectively control the littering of sick and dead animals and their products on the way, which will cause environmental pollution and spread of the diseases.

Regarding the illegal smuggling of wild animals, efforts should be put into investigating and punishing illegal trades, improving the level and intensity of law enforcement, taking active and effective measures to carry out smuggling crackdowns. For example, in the case of bordering areas where wildlife smuggling is highly prevalent, multilateral cooperation should be established to jointly enforce the laws to combat smuggling [16].

Strengthen wildlife protection and reduce the impact of human activities on animals

Ever since people realized the importance of protecting the natural environment, wildlife protection has attracted much attention from humans. China has continually promulgated and improved wildlife protection regulations and measures, and strived to create a "sustainable development" social environment. In today's society, how to properly handle the relationship between humans and animals, especially wildlife, is particularly important. It is a long-term project to prevent human beings from being harmed by humans in the living environment and to achieve harmonious symbiosis between humans and animals [17].

Studies have shown that every 2.5 to 3.75°C increase in the ambient temperature can double the rate of dengue transmission, and Aedes mosquitoes may carry and transmit yellow fever and dengue virus simultaneously [18]. At the same time, as mentioned earlier, animal migration is also affected by urbanization, which increases the incidence of infectious diseases.

In addition to further studying the habits of wildlife, the government should also formulate corresponding laws and regulations to restrict behaviors that affect wildlife activities, and at the same time promote the public awareness of that individual's misconduct may be a risk factor for outbreaks of infectious diseases.

Recommended approaches for improving emergency responses

Since 2003, relevant policies or measures for emergency response to public health emergencies in China have been further improved, organizational responsibilities are clearly defined, and related personnel is given detailed and standardized operation protocols. However, China is still responding to emergencies in a passive way. The policy initiative and guidance to practice still need to be improved and/or more effectively implemented [19].

Therefore, relevant policies and measures need to be continuously improved and updated through: (1) Raising awareness and effectively strengthening joint prevention and control; (2) Enhance custom controls to reduce the risk of epidemic import; (3) Extensively mobilize and launch health campaigns among the people; (4) Strengthen monitoring of the epidemic situation in a timely and effective manner; (5) Standardize the diagnosis and treatment of infectious diseases; (6) Raise the awareness of disease prevention measures among the people; (7) Pay close attention to the implementation of preset emergency-response protocols [20]. All of these approaches are designed to take proactive measures to prevent outbreaks caused by wildlife carrying and spreading viruses.

Strengthen the management of biosafety laboratory waste

High-level biosafety laboratories are powerful tools for people to carry out scientific research.

At the same time, laboratory experimental items and waste generated in the laboratory are likely to undermine the safety of the natural environment. Based on it, preventing the leakage of biological materials and wastes is a standard practice in laboratory operations. Specifically, biosafety laboratory professionals and employees need: to understand and practice the laboratory experimental product use specifications and the decontamination of waste; the supervisors of the biosafety laboratory need: to strengthen the safety of laboratory virus experimental products Use standards and waste discharge supervision, establish laboratory experimental products and waste management systems that are in line with scientific research rules and are suitable for national standards. Only by combining these measures can it be possible to completely and effectively eliminate the pollution potential of high-level biosafety laboratories [21].

At present, the perception that our health challenges are mainly due to chronic non-communicable diseases has prevailed in the society and the medical industry: some believe that the prevention and control of infectious diseases is no longer the focus which we should pay attention to. Based on historical experience and lessons, the government should not relax in the efforts to prevent infectious diseases, especially for countries with large populations like China, because it is still Class A and Class B notifiable diseases that have a significant impact on the psychology and physiology of the people. To assess the impact of disease on humans, it is not comprehensive enough to simply use health economic evaluation methods to decide how much attention should be paid to infectious diseases [22]. With the deepening of the reform and opening up and the Belt and Road Initiative, China's tourism exchanges will increase, and its trade exchanges will become more frequent. As a result, infectious diseases related to changes in the natural environment, changes in human activities, and living habits may also increase. World Health Organization has demonstrated that the infectious disease prevention and control always matters whether in the past, present, or future. For China's infectious disease prevention strategies, it is crucial to formulate policies and strategies, and more importantly, to implement them.

In summary, β-CoV remains a healthcare and socioeconomic challenge to the world, particularly to China. We here recommend various approaches to prevent and control the outbreak of β-CoV. However, attention must be paid to the implementation and regular audition. It is also important to continue public health research on the subject, besides the web-lab based biomedical research.

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Disclosure of conflict of interest

None.

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