

Preliminary Estimation of the Transmission Risk of Novel Coronavirus in Hubei Province

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Abstract A novel coronavirus(COVID-19) causes an outbreak of viral pneumonia in Wuhan, Hubei province, China. In this paper, the deterministic compartmental model is given based on the clinical progression of the disease and the intervention measures implemented by the Chinese authorities. Simulations of the model are given to estimate the basic reproduction number for COVID-19 based on the daily reported cases from China CDC. The basic reproduction number of the model is used to assess the transmissibility of COVID-19. The results indicate that COVID-19 will be controlled at the end of March if there are no imported infections people into China. Then the first-level public health emergency response can be adjusted to the second-level or the higher-level response.

Keywords COVID-19, the basic reproduction number, two-stage mathematical model

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1. Introduction

The World Health Organization (WHO) reported that a novel coronavirus (SARS-CoV-2) was identified as the causative virus by Chinese authorities on January 7th. The first case of the new pneumonia was identified in the city of Wuhan. The virus is related to the SARS coronavirus but is distinct from each of those viruses [6]; the virus causes a range of symptoms including fever, cough, and shortness of breath [6]. The government of China activated the first-level public health emergency response and took a series of measures to contain the outbreak of the epidemic. In order to curb population flow, the government canceled mass gatherings, extended the Chinese New Year holiday, and closed scenic spots, to make fewer trips outside et al. Then most people were quarantined in the cities where they were. Fifty days

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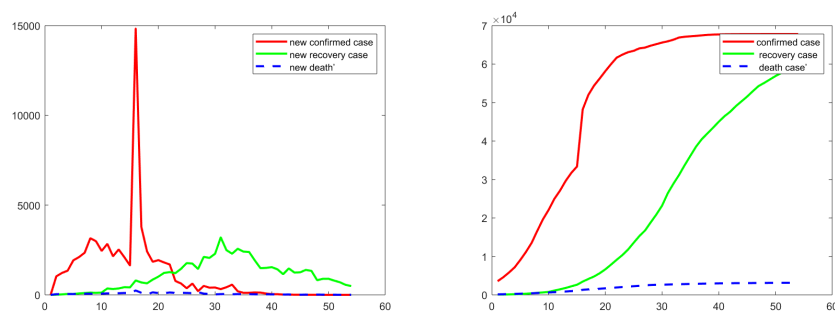


Figure 1. Reported data of the COVID-19 pneumonia in Hubei Province(2020.1.16-2020.3.19).

later, the number of confirmed cases of the novel coronavirus had increased to more than 80000. There were 67800 confirmed cases in Hubei Province in late March.

There are many works about this object [3, 9, 10]. In this paper, we try to analyze the case in the origin of infectious disease. That is the deterministic compartmental models are given based on the clinical progression of the epidemic and the intervention measures of Hubei Province. Simulations are used to show the potential transmission from the infection source to humans. The basic reproduction number has also been computed from our model, with which the transmission ability of COVID-19 can be estimated. We aim to find the transmitted regulation of the epidemic and predict the number of infectious people in Hubei Province. Then the appropriate suggestions will be given to Hubei authorities for the duration of the quarantine.

2. The two stages SCIAR model

Scientists have tried their best to expose the origins [7, 8, 11], the spread of the virus [1, 2, 5], and to find the treatments [4]. More information about COVID-19 has been obtained than the early detection of disease. In the following three months, people have been quarantined. They reduce the contact with others unless urgent cases. In our model, we will not consider the impact of the bat population, and the other hosts (probably be wild animals), only the health of the people here. From the daily reported cases from China CDC, we can see the reported data of the 2019-nCoV directly from the following Figure 1.

Hubei Province reported zero new confirmed cases of COVID-19 for three days, the minimum number of confirmed case since March 27th. Only 3 cases were reported outside Hubei province. But more than 210,000 cases have now been reported to WHO, and more than 9,000 people have lost their lives. The countries include Korea, Italy, Iran, Japan, and so on. Individuals, families, and communities still should follow the advice provided by local health authorities. All researchers and scientists need to try their best to prohibit the transmission of the virus.

In fact, at the beginning of the first several days, all people did not pay attention to the transmission of COVID-19 and they lived in their own way. Then the virus spread very quickly. On Jan 23rd, the lockdown of the city Wuhan was initiated on. Later, the Chinese authorities activated the first-level public health emergency response and implemented a series of measures to curb the transmission of the