

Trends in Transmissibility of 2019 Novel Coronavirus-infected Pneumonia in Wuhan and 29 Provinces in China

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Abstract

Background The 2019 novel coronavirus infected pneumonia (COVID-19) represents a significant public health threat. The COVID-19 emerged in December 2019 in Wuhan, China and rapidly spread to other regions and countries. The variation in transmission patterns and disease spread in regard to time or among different locations, partially reflecting the public health intervention effects, remains to be quantified. As most transmissibility-related epidemic parameters are unknown, we sought, with minimal assumptions, to estimate real-time transmissibility and forecast new cases using dynamic modelling.

Methods Using the cases reported from the National Health Commission of China and transportation data, including the total number of travelling hours through railway, airplane, and car outbound from Wuhan, we have built a time-series model to estimate real-time underlying transmission rates

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of newly generated cases sequentially from January 20, 2020 to Feb 13, 2020 in Wuhan, Hubei province and other 28 provinces in China. We quantified the instantaneous transmission rate and relative reproduction number (R_t) of COVID-19, and evaluated whether public health intervention affected the case transmissibility in each province. Based on the current estimates, we have predicted the trend of disease spread with a high level of certainty.

Findings We estimated that R_t declined from the range of 4 to 5 towards 1 and remained below unity, while there was an initial growth followed by a decline in a shorter period in Hubei and other provinces. The ratio of transmission rates decreased dramatically from January 23 to 27 likely due to the rigorous public health intervention implemented by the government beginning on January 23, 2020. The mean duration of the infectious period was 6 to 9 days. We have predicted the trend of infection sizes which became stable in provinces around February 19 to 24, 2020, and the date of containment would be one-week later in Wuhan.

Conclusions Public health interventions implemented at both the social and personal levels are effective in preventing outbreaks of COVID-19 in Wuhan and other provinces. Model prediction results suggested that COVID-19 will be contained around the end of February 2020 in China.

Keywords: COVID-19, transmissibility, dynamic reproduction number R , statistical modelling, pneumonia outbreak
