Physicists at HKBU built foundational transmission model to evaluate efficacy of containment measures against COVID-19 pandemic

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Within weeks after the outbreak of the COVID-19 epidemic in Wuhan, it became evident that asymptomatic and presymptomatic transmission played a major role in driving rapid spreading of the disease globally. The silent nature of this transmission mode posed an unprecedented challenge to public health authorities and ordinary citizens. The science of the COVID-19 disease progression and intervention has progressed tremendously since then, yet most countries around the world are still struggling with the pandemic due to the complex human behaviour that facilitates asymptomatic and presymptomatic transmission.

In February 2020, Professor Leihan Tang and Dr. Liang Tian in the Department of Physics started an epidemic modeling project together with their collaborators and former students from HKBU (Fig. 1). The aim of the project was to profile the infected population at different stages of disease progression based on clinical data, and to evaluate the associated transmission capacities (Fig. 2). Upon careful calibration of the model, quantitative evaluation of various control measures to inform decision-makers and the general public became possible. Main results of their research were disseminated on 16 March, 2020 through the preprint archive arXiv.org. The work is now in print in *Nature Communications* dated February 19, 2021. A related evidence review on the efficacy of face masks through an international collaboration was published in *Proceedings of the National Academy of Sciences USA* on 26 January, 2021 whose preprint version attracted more than 385,000 views and 90,000 downloads world-wide.

Their work introduced several novel modelling strategies that facilitate direct calibration of model parameters against COVID-19 incubation period and pairwise transmission statistics. This feature makes their model easily adaptable to local transmission characteristics or viral mutations. Physical perturbation expansion techniques were adopted to simplify key mathematical expressions, rendering their results readily interpretable.

On COVID-19 intervention, their work systematically evaluated reduction of the basic reproduction number (R0) under specific transmission control measures, including contact tracing, expanded screening, social distancing, wearing masks, and regional lockdowns. Implementing these measures in concert, their effects on R0 multiply. For example, the combination of contact tracing and wearing masks in public places has a strong immediate effect on curbing epidemic growth. In reality, governments are often forced to adopt a more gradual approach due to economic and social considerations. The disease transmission model can help to optimise the decision-making process against the changing situation.

Since this work was first posted, it has attracted broad attention from many parts of the world. In particular, evaluation of the efficacy of mask wearing was used in a number of public health initiatives by health agencies, institutions, and media outlets (Fig. 3). The mask model was featured in a YouTube video that registered 1.3M views (https://www.youtube.com/watch?v=Y47t9qLc9I4). Even with countries gradually recovering from the pandemic, the model can still play an important role. For example, by tracing regional spread of the disease and associated social contact pattern, the model can

help decision-makers to dynamically evaluate the effectiveness of their policies and make timely adjustments for better outcome.

Publication links: https://www.nature.com/articles/s41467-021-21385-z; https://www.pnas.org/content/118/4/e2014564118.

Accompanying Figures

Figure 1: The research team

Figure 2: The basic model construct

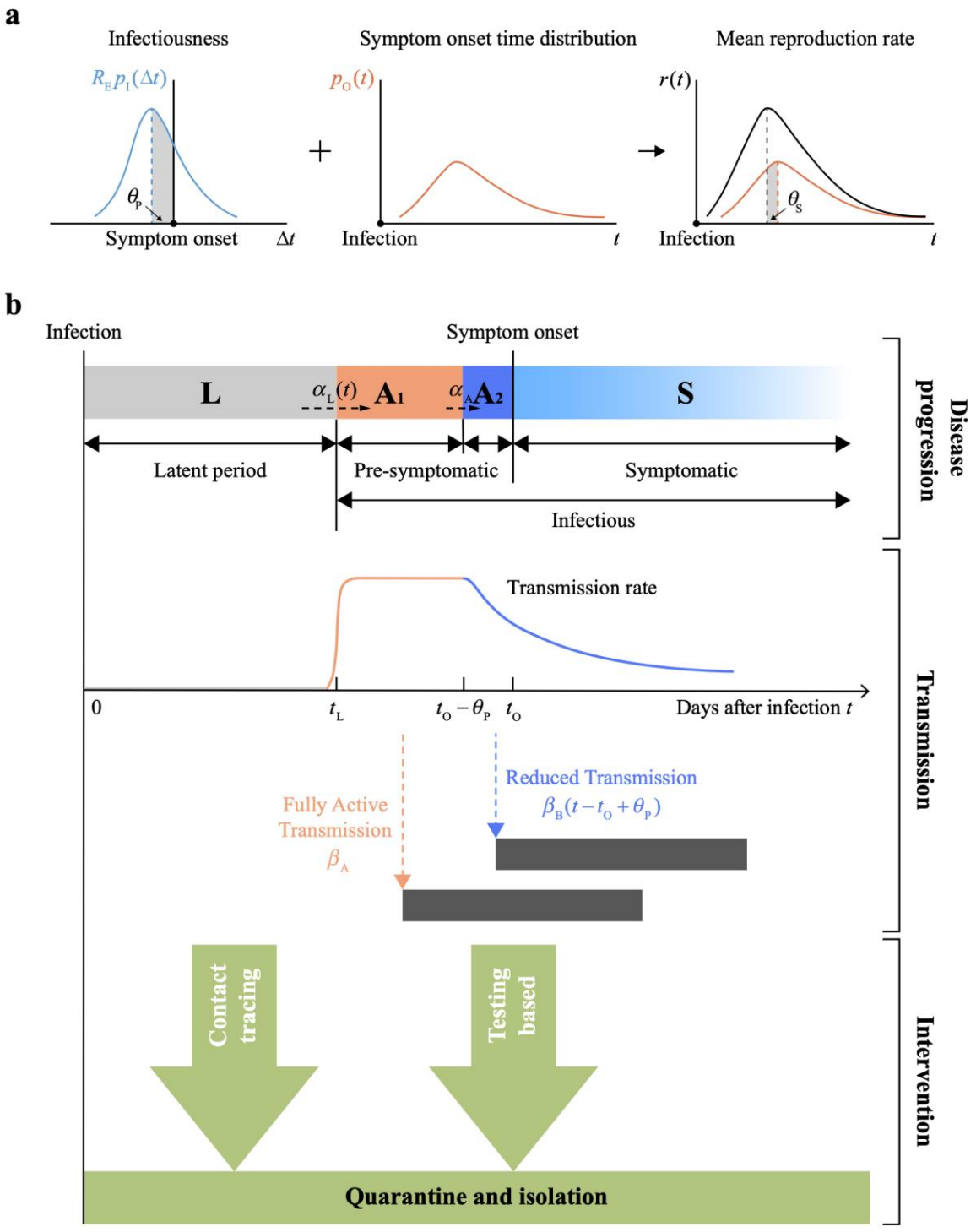

Figure 3: Public mask wearing campaigns in Singapore and Poland, and a book written by Professor Frank Ritter at Penn State U that made use of the team's research findings.

[4] Tian, Liang, et al., *Calibrated Intervention and Containment of the COVID-19 Pandemic*, 2020