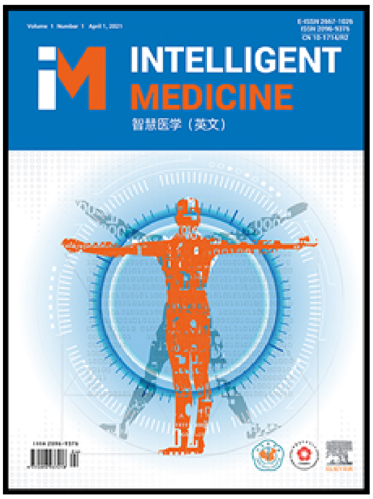

Real-time digital data of international passengers will shine in the precaution of epidemics

Naizhe Li , Lu Dong

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Editorial

Real-time digital data of international passengers will shine in the precaution of epidemics

Naizhe Li[1,2], Lu Dong[1*]

[1] MOE Key Laboratory For Biodiversity Science And Ecological Engineering, College of Life Sciences, Beijing Normal University, Beijing 100091, China

[2] State Key Laboratory of Remote Sensing Science, Center for Global Change and Public Health, College of Global Change and Earth System Science, Beijing Normal University, Beijing 100091, China

[*] Corresponding author: Lu Dong, MOE Key Laboratory For Biodiversity Science And Ecological Engineering, College of Life Sciences, Beijing Normal University, Beijing 100091, China (Email: donglu@bnu.edu.cn)

Abstract
International movement plays an important role in spatial spread of infectious diseases. Here, we share two successful COVID-19 interventions based on real-time digital information collected from international passengers, which have been performed in Greece and China respectively. Both of the interventions demonstrated good performance and showed the potential of real-time digital data in containing the spread. However, several key points should not be ignored when we promote similar strategies.
Keywords Digital data; Border surveillance strategy; International movement; Real-time

Frequent population movement facilities the spread of infectious diseases on spatial scales in the context of globalization. Studies show that imported cases could be the "seeds" of local transmission. After the successful suppression of COVID-19 epidemics on April 8, 2020 when the number of infected people was reduced to 0, local outbreaks in the mainland of China were mainly triggered by imported COVID-19 cases. It is reported that the imported Delta variants have caused at least 1,390 cases of COVID-19 in 50 cities in China as of August 26, 2021[1]. China is not the unique country suffering from the epidemics due to imported cases. A modelling study estimated that imported cases would contribute more than 10% of total incidence in 102 countries in May, 2020 if there was no restriction on international travel [2].

Interventions focused on importation are effective in mitigating local epidemic [3]. In order to decrease the importation of COVID-19, results of PCR testing have been required for passengers in majority of countries. More than 60 countries ask for PCR testing when arrival in the respective country, some regardless of whether the traveler already had a negative COVID-19 test result before boarding. Countries adopted different border screening strategies using PCR testing data combining with traditional travel and demographic information collected from inbound international passengers, such as the country of departure, gender and age. For example, some European countries, such as Spain, designed different border screening protocols for travelers according to their departure basing on the recommendations of Council of the European Union [4].

However, the effectiveness of the border surveillance strategies is constrained by under-reporting, weakness in identifying asymptomatic travelers in incubation period or delayed report [5-7]. Furthermore, the transmission density and the magnitudes of travel from different sources are heterogeneous and vary in different times, leading to different risk of importation among the passengers [8-9]. An accurate and effective border screening protocol is urgently needed.

Bastani et al. [10] reported a successful border surveillance system, nicknamed Eva, which was designed based on real-time digital data and reinforcement learning system.

Briefly, Eva selected parts of passenger for PCR testing according to the travel and demographic information and the results were used to update Eva to inform the following surveillance. Passengers who were tested should self-isolated during the laboratories process. Normal activities were allowed only if the passengers were tested negatively. With the help of real-time digital data and the constantly updated database, effectiveness of targeted testing could be improved. Eva has been performed in Greece and reputed to be one of the best examples of using data in the fight against the pandemic of COVID-19 [11]. Comparing to the counterfactual scenarios, Eva identified 1.85 and 1.25-1.45 times as many asymptomatic infections as random surveillance testing and testing policies that only use epidemiological metrics separately.

During Beijing 2022 Winter Olympic Games, Wang et al.[12] used the combination of digital information and mathematical models to simulate the COVID-19 risks and guide the support work. Scales of importation were estimated according to the prevalence of COVID-19 and the magnitude of athletes, officials and other stakeholders in each country. Passengers were asked for PCR tests before boarding a plane and the uninfected ones entered the closed-loop of Olympics Games, receiving daily PCR test until departure. They estimated an approximate number of infections who were identified at borders comparing to the observation (357, 95%*CI*: 153-568 *vs*. 323). The simulated number of "seed" cases that entered the closed-loop of Olympics Games was also closed to the actual situation (195, 95%*CI*: 43-335 *vs.* 212). Sufficient materials, isolation sites and other support demands had been prepared according to these estimations.

One of the most prominent advantages of this strategy was the real-time reporting system of PCR testing results based on the internet. The number of the following infections and the demands of support work were estimated timely using mathematical models. The investigators estimated a number of 167 (95%*CI*: 38-285) new infections in closed-loop, considering the transmissibility of both Delta and Omicron Variant. They also evaluated the risk of transmission in different venues using daily PCR testing results and infections and the relationship between vaccine coverage and outbreak risk. They reported that the probability of causing one secondary case could be lower than 0.0008 if the number of people participating in opening ceremony was less than 100 thousand. Benefiting from this strategy, infectors could be identified and managed as soon as possible, and the medical supports were fully covered during the large-scale event. This work was highly praised by the Beijing Organizing Committee for the 2022 Olympic and Paralympic Winter Games [13].

Nowadays, the popularity of smartphones makes it possible for users to share real-time multi-level digital data and saves the time for reporting and aggregation. Massive data provides the opportunity in obtaining critical infectious disease related information for public health experts [14-15], which facilitate the timely design of control methods. The passengers could also check their own status conveniently and seek for medical assistance or self-isolation as soon as possible. The two examples have proved that real-time data is playing an important role in modern strategies for infectious disease prevention and control.

Several key points should be noticed when we used these data. For example, algorithm with high performance should be designed in order to improve applicability. The results of real-time PCR and pairing multi-level digital data from the travelers is large volume and variety in velocity and veracity. These characters challenging how to improve storage efficiency and achieve better integration effect. In order to avoid interruptions due to problems in data processing, the evaluation of the hardware support and calculate ability is indispensable before the implement of a system relying on real-time big data. Fortunately, many new methods have appeared to achieve convenient invocation and calculation of multi-source heterogeneous data, which contributes to thorough data analysis and valuable analysis results.

Secondly, a good coordination mechanism among different institutions (i.e., customs, laboratories and hospitals) needs to be established. It is critical for improving work efficiency and saving costs of medical and human resources especially during peak travel. Solving this challenge requires high performance work system and well-trained staff. Meanwhile, we should not ignore the protection of personal privacy as individual information would circulate among multiple departments and staffs. The leakage of personal information may cause serious loss of health and property. However, the overprotection of the information will limit the data availability. We appeal the improvement both in law and individual awareness to balance the data usage and protection.

Conflicts of interest statement

All authors declare that there is no conflicts of interest.

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Author contributions

Lu Dong and Naizhe Li designed the study, did the literature search and drafted the manuscript.

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