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Challenges of SARS-CoV-2 prevention in flights, suggested solutions with potential on-site diagnosis resembling cancer biomarkers and urgency of travel medicine

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Abstract. – OBJECTIVE: The current pandemic makes the international flights facing multiple challenges including infection during flights. Here the objective is to analyze the infection trend of flights from a regional data set and discuss the solutions for diagnosis and travel medicine.

MATERIALS AND METHODS: The public data was applied for trend analysis and new solutions were provided based on the current diagnosis information and resembling cancer diagnosis.

RESULTS: Flights infection has decreased since the large-scale cease of flights. Challenges of prevention of SARS-CoV-2 infection in flights exist due to testing accuracy, asymptomatic and many other factors including people gathering. To avoid the pandemic worsen, the solutions are provided for new coming flight resumes. Hotel, mandatory PPE, airport diagnosis, rapid imaging/biomarker diagnosis by advanced high-technology and emergency-travel medicine department are suggested as solutions.

CONCLUSIONS: SARS-CoV-2 prevention in flights needs multiple solutions by potential on-site diagnosis and urgent establishment of a travel medicine unit at airport.

Key Words:
COVID-19, Travel medicine, Infection, Diagnosis.

Introduction

Since the outbreak of COVID-19 worldwide[1], how to control the rapid spread of the virus has become an important topic for international travel health. Suspending flights is the expeditious approach to cut off the spread of the virus, since March, for most countries. However, economic recovery needs resuming a large-scale of flights. With the decrease of infection cases in many countries, the resume of flights is in urgent demand and ongoing. However, the challenges will appear once resumed on a large-scale. For example, the infection case number may be re-boosted after quarantine. Here we analyzed the flight infection trend from the outbreak of the pandemic to present when there is small-scale resumption of flights and proposed the solutions. In addition, resembling cancer biomarkers, advanced technology should be applied to rapid diagnosis of COVID-19 by simplified bioimaging, biosensor, molecular markers or other techniques.

Materials and Methods

Data were obtained from a public official website[2] (https://www.health.nsw.gov.au/Infectious/covid-19/Pages/flights.aspx) and analyzed by Excel software. The proposed resolutions were based on the data analyzed by searching literatures as references.

Results

Flights Infection Trend from a Regional Data

Since the outbreak of COVID-19, a large number of international flights have been ceased due to pandemic concern. With the development of diagnosis by Polymerized Chain Reaction (PCR) test of viral DNA, a large number of flights infected cases have been reported[2]. SARS-CoV-2 coronavirus can be transmitted through the respiratory tract, and the aircraft cabin, as a relatively closed space, has become a hotbed for the spread of the virus. According to the example data with statistical analysis, the number of people infected with SARS-CoV-2 detected on airplanes has increased sharply since February 2020, and only

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dropped significantly after the large number of suspending of international flights or restricting regional flights[2]. The good trend is that the current infection reporting flight cases are largely decreasing, which might be due to the large-scale quarantine and few numbers of flights. However, how to prevent infection is still a big concern.

Infection Trends of Seat/Position on Board

Passengers have a risk of effortlessly infected in the cabin due to the following three reasons. First, the area of the aircraft is too small to preserve the between people. Secondly, the flight normally takes several hours and even longer, and if a superb positive patient is present, the titer of the virus in the air will step by step expand till it becomes very susceptible. Thirdly, due to the fact passengers in the cabin share the equal aisle, lavatory, and different common areas, it is tough to keep away from contact with others. According to statistics, the rate of infection detected in the passenger in the rear of the cabin was much higher than that in the front[2]. The possible motive is that there is higher density of passengers in the middle and rear section as antagonistic to the front part, whilst the front seats are in first and business classes, where the space is larger and social distance between passengers might be met. Based on a policy, as there is no verbal exchange between the cabins, passengers in the front components have a lower likelihood of infection.

Challenges of Large-Scale Resumption of Flights

Flight is an important aviation tool, and full resumption of flights have been put on the agenda since the small-scale recovery, which is required for global economic recovery. How to avoid the epidemic of infectious diseases in the plane as much as possible is challenging. The big concern is the gathering of large-scale passengers in the checking in area and gate waiting area. On the air, the contact with other potentially infected passengers or exposure to infected air during meal or lavatory time are big concerns. Asymptomatic false-positive passengers[3] boarding is also a concern. On arrival, customs checking of visas and exits with luggage claimed by large groups of people are easily infecting factors for healthy people if positive patients are present. While most airlines exert the policy of requiring PCR testing before boarding, international standard and protocol is recommended to keep unified and consistent[4]. However, due to the shortage of diagnostic kits or labs, PCR testing takes 4-7 days in some countries while pooled testing[5] may be applied for fast testing in airports. Another point of view is that one time PCR results may not be accurate, as sometimes it needs multiple times reproducing data to confirm the infection. Thus, PCR testing is relatively confident for passengers to avoid infection. Therefore, from starting checking in, passengers will face the challenge of infection during all procedures and all steps of prevention are needed to meet the large-scale flight resumption.

Proposed Design of Large-Scale Flight Resumption in Pandemic Era

In addition to the strict epidemiological inspection of the boarding personnel, human contact in the plane should also be, to a large extent, avoided. An airplane, for example, carries only half the number of passengers, leaving an empty seat between passengers to maintain a social distance. In addition, the frequency of disinfection should also be increased. With these strict measures listed below, as shown in Figure 1 drown with aid of a software tool[6], the opportunity of infection may be greatly reduced.

- Hotel-based early checking in and travel medical center associated with the screening of infection on site. To avoid large-scale passengers gathering inside the airport, a hotel-based model is proposed to allow passengers to reside in the hotel while waiting for viral screening results and boarding. The designed super clean hotels are medical-level managed, airport associated hotel chains. The hotel provides sample collection, pre-flight services including boarding pass print, checking in, luggage claim, passport control upon passing virus screening. Passengers can come 48hrs in advance to start checking in to avoid rush hour gathering. All food can be served immediately before boarding to reduce the onboard food supply. The flight will be associated with the special hotel management for easy checking in and Travel Medicine Center for positive patient management (Figure 1). Personal protection equipment (PPE) should be mandatory for boarding. The most important issues are passenger-self-protection. Therefore, mandatory protection is recommended to keep medical travel medicine standard. All PPE should be provided by the airport medical services department. The PPE includes medical gowns, eye protection glasses, face shields, masks, shoe covers, and gloves.

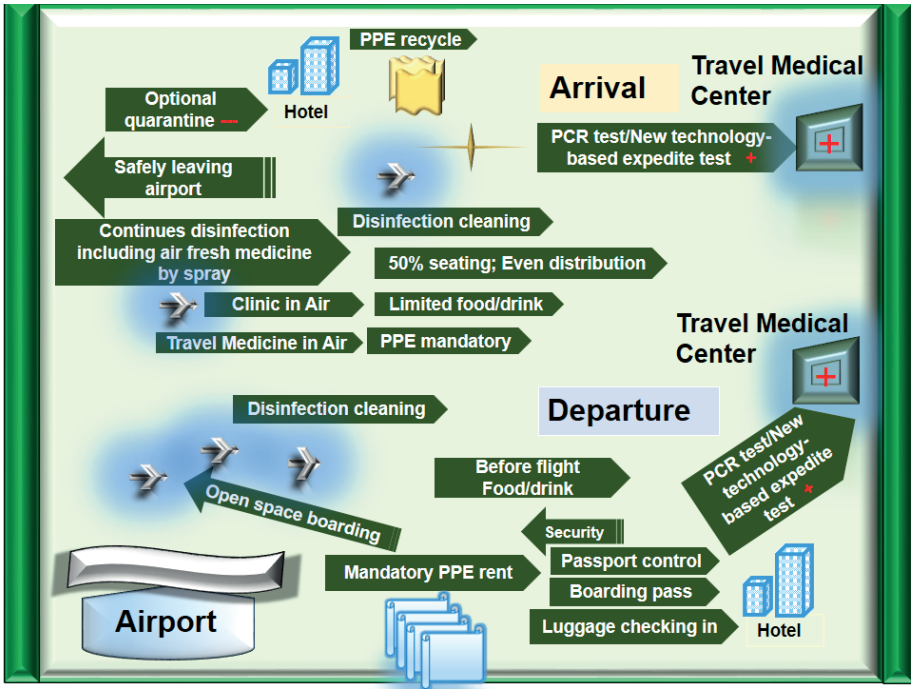

Figure 1. The design of the efficient prevention of COVID-19. The 3-D airport design is performed with learning aid of Tinkercad (https://www.tinkercad.com/learn/designs) and drawn with aid of powerpoint 3-D tools. PPE, personal protection equipment including closed glasses for eye protection, medical gowns, shoe covers, masks and face shield in mandatory.

- 50% or less seating and even distribution. As the social distance is required to avoid infection, emptying seats are recommended. Based on Figure 1, the seats should be evenly distributed.
- Continues disinfection on board. The medical disinfection and cleaning should be constant for seating, doorknob, and air spray. The international standard protocol shall be set up. Researchers should invent more healthy disinfection reagent. More strategy that is viable is herbal antiviral natural medicinal drug or "green" natural anti-viral products options for spray to avoid alternatively of alcohol or hazardous chemical-based agent[7,8]. Thus, green natural products are urgently needed for onboard spray use.
- Emergency clinical service and isolation area on board. For PCR false-negative passengers, the potential possible symptoms may appear on the thus, for healthy concern, emergency service should be provided by breathing machine, and isolation area.
- Upon arrival, hotel quarantine/open tent based luggage claims and PPE recycles should be conducted. As PPE is expensive and in shortage all over the world, the recycled PPE is strongly recommended. After arrival, to avoid gathering of passengers, the hotel-based separation is recommended and luggage claim can be performed at hotel, or open space with a tent.
- Travel medical center should be established in the airport. Nurses, doctors and public health officials should be recommended to work in airports to keep integrity of health management. International travel standards need to be set up. The cleaning, disinfection standard, health monitor, emergency room, and testing centers should be set up. Passengers who may develop symptoms during checking in, flight or arrival, should be taken care of and isolated immediately.
- Fast diagnosis of SARS-CoV-2 should be developed resembling cancer. As the PCR testing is time- and cost-consuming, more advanced and accurate diagnosis methods should be developed by advanced technology such as nanotechnology, or biosensor. This is a multidisciplinary collaboration project and scientists should get the funding for the advanced research. The ideal methods should be scanning-based quick identification of viral stages and infection conditions as early stage or recovery. Nanotechnology and AI would possibly advance the diagnosis by biosensor or robotics[9,10]. In addition, police trained dogs may also help the fast

screening of the positive patients[11]. Recently, while we are revising the manuscript, a report showed that in Almaty international airport, the fast PCR test can be obtained with results within 24 hours inside the airport by email[12]. The immediate test at the airport will prevent the post-test infection to avoid risk of onboard spread of the virus. In addition, the antibody-based test can be realized even faster as 15 minutes[12]. The example supports the evidence that our suggestions would be promising and potentially realized by airport-based travel medicine operations. While cancer diagnosis techniques are advancing rapidly with imaging, biosensor, nanotechnology, and biomarkers, COVID-19 testing should also be advanced by these technologies for rapid screening in a large-scale such as lab-on-a-chip, next generation sequencing or molecular based markers with fluorescence[13-15]. For example, carbon nanodots exhibit strong fluorescence and would be potentially used for biosensor of COVID-19 through in-depth studies[16]. For large-scale testing, a biosafety BSL-2 level mobile laboratory can be established in the airport travel medicine department.

Conclusions

In summary, the proposed method, even, is costly but may be effective in prevention of COVID-19. Most importantly, green-, open air, and recycle concepts should be applied in the airport. With the strict policy, the large-scale resumption of flights may not cause chaos of infection.

Author Contributions

Ainur Shaimoldina collected data, analysed data and drew the figures; Yingqiu Xie proposed solutions, analysed data, and wrote the manuscript.

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Conflict of Interests

Ainur Shaimoldina and Yingqiu Xie have no competing interests.

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