Title: Navigating the Risks of Flying During COVID-19: A Review for Safe Air Travel

Running Title: FAQs about Flying During COVID-19: A Review for Safe Air Travel

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Word Count: Abstract: 297 Text: 4705

Abstract

Rationale for Review: With air travel restarting, there has been much discourse about the safety of flying during the pandemic. In Travel Medicine, risk assessment includes estimating baseline risk to the traveller, recognizing factors that may modify that risk, considering the role of interventions to decrease that risk, and accounting for a traveller's perception and tolerance of risk. The goals of this review are: to identify the in-flight transmission risks of commercial air travel, to provide recommendations about the risks of flying during the pandemic, and to propose strategies to mitigate the spread of COVID-19.

Key Findings: The airline industry has taken a layered approach to increase passenger safety through effective onboard ventilation, extended ventilation at the gate, boarding and deplaning strategies, improved aircraft disinfection, and pre-flight screening such as temperature checks and COVID-19 testing. Proximity to an index case may contribute to the risk of transmission more than the seat type or location. The use of face masks has significantly reduced onboard transmission and mandatory inflight mask wearing policies are being enforced. Innovations such as digital health passports may help standardize screening entry requirements at airports and borders, allowing for a safer return to travel.

Recommendations: In-flight transmission of SARS-CoV-2 is a real risk, which may be minimized by combining mitigation strategies and infection prevention measures including: mandatory masking onboard, minimizing unmasked time while eating, turning on gasper airflow inflight, frequent hand sanitizing, disinfecting high touch surfaces, promoting distancing while boarding and deplaning, limiting onboard passenger movement, implementing effective pre-flight screening measures and enhancing contact tracing capability. Assessing risk is a cornerstone of travel medicine. It is important to evaluate the multiple factors contributing to the cumulative risk of an individual

traveller during the COVID-19 pandemic and to employ a multi-pronged approach to reduce that risk.

Key Words: Travel Medicine, Flying, Air Travel, In-Flight Risk, COVID-19, Airplane, Pandemic

Introduction

In January 2020, a cautionary warning was made about the potential for rapid global spread of a novel pathogen, coronavirus 2019-nCoV, via commercial air travel.[1,2] While many parts of the world are still grappling with containment of the COVID-19 pandemic, international travel restrictions are starting to lift, with data from the United Nations World Tourism Organization showing 40% of all worldwide destinations easing restrictions.[3] Travel and transportation related spread of COVID-19 is already recognized for its outbreak potential and rapid transmission risk from one region to another. [4,5] The estimated risk of in-flight transmission is challenging to quantify with limited evidence. There is limited published data on probable and proven in-flight transmission of SARS-CoV-2.[6–10] However, there have been five well-documented flights describing mass transmission events, and over 2000 flights with known COVID-19 cases on board. In Travel Medicine, risk assessment includes: estimating baseline risk to the traveller,

recognizing factors that may modify risk, considering the role of interventions to decrease risk, and accounting for a traveller's perception and tolerance of risk.[11,12] With air travel restarting, how safe is it to fly during the pandemic?

The goals of this review are: (1) to identify the transmission risks of in-flight commercial air travel, (2) to provide recommendations for physicians fielding questions about the risks of flying safely during the COVID-19 pandemic, and (3) to propose strategies that mitigate the transmission of COVID-19.

1) How safe is the air on the plane?

Air quality aboard modern aircraft is very safe. The cabin air is exchanged every 3 to 4 minutes and about 50% of recirculated air is mixed with outside fresh air, which is free of microorganisms at cruising altitude.[13,14] First, recirculated air goes through a prefilter which traps the largest particles, then passes through high-efficiency particulate air (HEPA) filters before re-entering the passenger cabin. HEPA filters have proven to be highly effective in maintaining the circulating air with very low concentrations of bacteria, fungi and viruses. They are 99.97% effective in removing particles between 0.1 μm and 0.3 μm in diameter and 100% of larger particles.[15,16] The SARS-CoV-2 virus particle diameter ranges from 0.06 μm to 0.14 μm, however the droplets and aerosols the virus travels in are larger than 5-10 μm in size, and would be captured by the HEPA filters.[17–20] The risk of being exposed to an airborne pathogen on a plane is lower than in many other enclosed spaces because of the filters and more frequent air exchange.[21] The aircraft cabin airflow is laminar, with vertical movement downward from top to bottom at 1m/sec.[22] Longitudinal airflow (from forward to back) is minimal, further reducing the risk of respiratory pathogens spreading on a plane. Airbus, Boeing and Embraer have recently

conducted research using separate computational fluid dynamics (CFD) models. Even though the ceiling air inlets are positioned differently for these different airplane manufacturers, their conclusions are similar: the data confirms that aircraft airflow systems control the movement of particles in the cabin, limiting the spread of viruses. [23–26] In October 2020, the US Transportation Command (TRANSCOM) released the results of its commercial aircraft cabin aerosol dispersion test, the largest validation experiment to date. Performed on Boeing 767-300 and Boeing 777-300 wide body airframes using a 100% seating capacity model, there was a minimum reduction of 99.7% of 1 μm simulated virus aerosol from the index source to passengers in the next seat, showing no aerosol transmission for 12-hour flights.[27] To maximize cabin airflow and reduce passenger-generated contaminant concentrations when engines are off during ground operations, the International Air Transport Association (IATA), the International Civil Aviation Organization (ICAO) and aircraft manufacturers have made the following recommendations: (1) fresh air and recirculation systems should be operated to exchange the entire volume of cabin air before boarding, (2) air conditioning should run at least 10 minutes prior to boarding, throughout boarding and during disembarkation, and (3) for aircrafts without air conditioning systems, the aircraft doors should be kept open to facilitate cabin air exchange. [28,29]

2) Does turning on the personal air flow (gaspers) above the seat increase transmission risk?

The air from the personal air vents (gaspers) above each passenger seat is either clean air from the air conditioning packs or recirculated filtered air, depending on the model of the aircraft.[21] Using the gasper will create an airflow driving the particles to the floor faster, which are then filtered by the HEPA filters, reducing the exposure time of airborne particles in front of the

passenger and the transmission of contaminants between passengers.[30–33] One study surmised that if a gasper is turned on, it could produce a high contaminant concentration in the region above a passenger's head, bringing in more contaminants into their breathing zone. However, this study found that the overall risk by turning on a gasper was neutral.[34] There is new emerging evidence to support the overall low transmission risk related to personal air vents. Gasper supply (on or off) does not make a significant impact on aerosol risk.[27] Therefore, it is recommended that the gasper airflow be turned on to improve travel comfort, air quality and reduce person-to-person transmission of exhaled contaminants.[24,27,35,36] Further study is needed to examine the interaction of passengers with airflow and the resulting droplet and aerosol dispersion to substantiate the evidence.

3) How does passenger movement on a plane contribute to increased transmission risk?

Infection transmission within the aircraft cabin depends on exposure time, contact points, as well as proximity and movement of passengers. The likelihood of passengers coming into contact with each other and contaminated surfaces is highest during boarding and deplaning.[16] The risk is higher with boarding than deplaning, for all seating configurations in various aircraft, thought to be due to the section-based order in boarding compared to the front-to-back order in deplaning.[37] Zone-based boarding was shown to have a higher rate of contact between passengers than random-based or back-to-front boarding.[23,38] Contact with other passengers was shown to be further decreased with column-wise exiting during front-to-back deplaning (all aisle seats exit first, followed by middle seats, followed by window seats), though associated with higher time to deplane.[23] In larger aircraft, deplaning had higher risk of transmission.[37] Passengers should be vigilant during boarding and deplaning, with attention to wearing masks,

hand hygiene, avoiding fomite contact such as touching seat backs, maintaining physical distancing as feasible, and minimizing carry-on luggage.

4) Are sitting in some seat types higher risk than others?

Aisle seated passengers have more contact with others than those seated in middle or window seats. [38,39] In a study of norovirus transmission aboard an airplane, sitting in an aisle seat was found to be associated with contracting the illness, whereas using the lavatory on that flight was not.[40] Experimental studies of aerosol dispersion suggest that due to the airflow in the cabin, there are two air circulation zones at the sides and one in the middle. The downward airflow near the sidewall suppresses aerosol dispersion and lateral dispersion is greater in the centre section of the plane where there is some upward mixing of air.[41] This would suggest that those seated near the window are subject to less infectious particles. Contrarily, seat mapping of SARS-CoV-2 inflight transmission of a Sydney-to-Perth flight suggested that window seats conferred a higher risk of being infected.[42] While movement of passengers within the aircraft cabin could account for this discrepancy, two of the window-seat passengers denied ever leaving their seat during the flight. It is unknown how movement of passengers and crew could have altered the airflow in the circulation zones, or what contacts occurred during boarding. Examining seat mapping of more cases of SARS-CoV-2 inflight transmission would be useful to establish if this flight was a signal of a unique characteristic of transmission in a real-world scenario versus modeling. Passengers seated at the front of the cabin are reported to have longer cumulative duration of contact, presumably due to lavatories often being located at the rear of the airplane.[39] This was reflected in the finding on the Sydney-Perth flight, where being seated in the forward economy cabin conferred a greater risk of secondary SARS-CoV-2 infection.[42] The number of contacts for

those in first class are thought to be much lower than for economy class, given that first class seats are closer to the exit and there is larger distance between seats.[37] Evaluation of inflight transmission of SARS-CoV-2 on a flight from London to Hanoi, however, demonstrated one business class passenger secondarily infected 12 other business class passengers, which challenges the thinking of business or first class being safer.[43] Proximity to an index case rather than the seat type may contribute more to risk of transmission.[39] An international flight into Ireland with 13 positive cases onboard were linked by genomic sequencing to a common unknown source.[10] Transmission presumably occurred during the flight since cases were divided into four groups, originating from three different continents, who had minimal contact with each other pre-boarding. Masks were reportedly worn by 9 of the 13 passengers throughout the flight. Flight occupancy was sparse (17%) with positive cases clustered throughout the forward and aft economy cabins, in window, middle and aisle seats. This case illustrates that masking may be more important than seat location, with strict onboard infection prevention measures and limitation of passenger movement also essential to reduce the risk of inflight transmission. Where choice is available, a business class window seat is conventionally thought to be the safest option—though recent studies are questioning this—with a non-aisle seat towards the back of the plane a relatively safe economy class option. Once seated, passengers should avoid moving about the aircraft cabin to minimize exposure to others, which may be more feasible on a short-haul flight.[39]

5) Should the middle seat be left empty?

There has been much discussion about leaving the middle seat empty to promote physical distancing on an aircraft. The highest exposure risk for contagion are economy class passengers

seated in a 2-metre diameter surrounding an infected passenger, 5 seats in all directions, up to and including 3 rows in front and 3 rows behind.[39,44] A recent study examining potential transmission of SARS-CoV-2 during a long flight found a clear association to proximity of an index case to risk of infection when seated less than two seats away.[43] Physical distance between passengers can be increased, although not to the 2m suggested distance, if the middle seat is left empty. Further distancing can be achieved by leaving every other row unoccupied. However, doing so would have a negative economic impact on airline operations as well as a negative environmental impact.[45] IATA has recommended against leaving the middle seat empty.[46] Other measures to decrease droplet spread such as mask-wearing with limited eating (unmasked) time, and decreased passenger and crew movement throughout the aircraft cabin must be employed to offset the risk posed by being unable to physically distance if the middle seat is not left empty.

6) What are the highest risk touchpoints and areas on a plane?

Transmission of disease by contact with contaminated surfaces is less than by inhalation.[47] Horizontal surfaces such as laptops and tray tables are more likely to collect respiratory droplets.[47] High touchpoint surfaces inside the aircraft that are potentially contaminated includes tray tables, armrests, seat covers, door knobs and toilet flush buttons.[48] The Centers for Disease Control and Prevention (CDC) states that handwashing is the single most important infection control measure to prevent the spread of disease on commercial aircraft. It is advisable that travellers wipe down surfaces such as headrests, tray tables, and arm rests and carry alcohol-based hand sanitizer for frequent hand disinfection.

Aircraft manufacturers recommend the use of a 70% isopropyl alcohol as a disinfectant for the touch surfaces in the cockpit, cabin and cargo holds. For other surfaces, as per the World Health Organization (WHO), cleaning and disinfection products should have at least 60% alcohol to effectively destroy the SARS-CoV-2 virus.[49] Delta Airlines recently announced that it would become the first US airline to install hand sanitizer dispensers near the boarding door and bathrooms on every aircraft. While in the air, high-touch surfaces in lavatories should be frequently disinfected during flight. Some airlines are adding touchless features in aircraft lavatories, such as faucets, flush levers and waste lids. Every interior surface is being sanitized prior to boarding using electrostatic sprayers.[50] Electrostatic spray disinfection systems turn disinfectant liquid into aerosols and then apply a charge to each droplet so that they are attracted to surfaces. Other methods of disinfection such as ultraviolet (UV) irradiation are being considered by the airline industry, as UV has been shown to be effective at inactivating large viral loads of SARS-CoV-2. [51] Boeing is developing a new portable UV wand to sanitize airplane interiors, including flight decks, lavatories and cabins, which is a dry process that protects the sensitive electronics in the cockpit. United Airlines, for example, has already started using ultraviolet C technology to disinfect flight deck interiors. With the increased frequency of disinfection practices in the aircraft cabin, the risk of infection with SARS-CoV-2 via fomites inflight is very low.

7) Are lavatories areas of high-risk transmission on an aircraft?

In August 2020, the CDC confirmed a report of a woman who contracted SARS-CoV-2 during an evacuation flight from Milan to South Korea. An epidemiologic investigation concluded that transmission was most likely from an asymptomatic but infected passenger while using the toilet

onboard.[52] ICAO recommends restricting lavatory access while in-flight. Where sufficient lavatories exist, one lavatory should be designated for crew only and passengers should use a designated lavatory based on seat assignment.[53]

Lavatories are ventilated with cabin air from an individual air outlet. The ventilation air is exhausted directly overboard.[54] There is sufficient ventilation in aircraft lavatories to minimize virus transmission between users, even if they demask. Mainstream media recently reported on the possibility of COVID-19 being transmitted during the flush of a toilet since there is evidence of SARS-CoV-2 virus in faecal matter.[55] A study using CFD calculated that a toilet flush can generate upward velocity capable of expelling aerosol particles out of the toilet bowl to cause large-area-spread. However, the height of these particles reach 106.5 cm from the ground, insufficiently high to be inhaled for most people.[56] Although potential risk of contagion is indirect from droplet deposition on and around the toilet, rather than by inhalation, it is advisable to remain masked in the lavatory. Further safe procedures to adopt when using a toilet include lowering the toilet lid before flushing, cleaning the toilet seat before using, washing hands carefully after flushing, and sanitizing hands after touching the door handle.

8) Is it mandatory to wear a mask while flying?

Given asymptomatic people can transmit the SARS-Cov-2 virus, the WHO encourages the use of fabric face coverings in public places. As of April 2020, Transport Canada made it mandatory for all air passengers over 2 years of age to wear a face-covering.[57] Wearing a mask while flying is also recommended by IATA, ICAO and the CDC.[46,58,59] A fabric mask worn properly can serve as a barrier to droplet transmission at airports and in-flight, where social distancing is difficult to maintain. Passengers are required to wear face covering at all times during the

boarding process, throughout the flight except when eating, and while exiting the aircraft until they are inside the air terminal building.[60] The type of mask worn is also an important consideration. A new study regarding the effectiveness of different masks and mask alternatives to suppress the spread of respiratory droplets during regular speech shows that some masks, particularly neck gaiters, disperse the largest droplets into a multitude of smaller droplets which may be aerosolized. The valved N95 mask performance was also reduced due to the exhalation valve, which opens for outwards airflow and might contaminate nearby persons. In comparison, the performance of the fitted non-valved N95 mask or surgical mask was far superior. [61] Although masks are not 100% effective, wearing them does decrease viral spread.[62,63] Therefore, standard surgical masks or a two-layer fabric (cotton or cotton/propylene) pleated-style mask should be worn. Bandanas, gaiters or masks with exhalation valves should not be permitted onboard.[64] Should passengers forget to bring their own mask, a small "health kit" will be offered to passengers at check-in or onboard by several airlines as part of passenger protection and reassurance. As the cost of surgical masks is nominal and the supply chain has improved, airlines should provide them to passengers free of charge.

Between January and March 2020, there have been three in-flight transmissions reported by IATA, and several other reports of probable in-flight transmission, although these lack genomic evidence.[6–9] Of note, all the suspected cases of in-flight transmission occurred prior to mandatory masking on flights.[9,43] The limited number of cases of in-flight transmission reported after mandatory masking support the major role that masking may have in disease transmission mitigation.[65] Mask wearing is a key measure to decrease the spread of COVID-19 on airplanes and should be enforced as mandatory. Further studies on inflight COVID-19 transmission before and after masking requirements is needed.

9) Is it safe to eat and drink on a plane?

Contracting COVID-19 from food or food packaging is unlikely.[66] The main concern stems from eating in proximity to others within an enclosed space. A study published by the CDC suggested that adults diagnosed with COVID-19 were twice as likely to have dined at a restaurant in the previous two weeks, likely due to the increased risk of being in close contact, defined by being within 2m of an infected person for a cumulative total of 15 minutes or more. According to IATA, removal of face-coverings for short periods to eat and drink "is permitted, necessary and safe".[67] Some of the cabin design elements may help to reduce droplet and aerosol transmission between passengers while eating, such as forward facing seating that limits face-to-face interactions, the physical solid barrier of seatbacks blocking droplet spread, the direction of airflow from ceiling to floor and the use of HEPA filters to clean re-circulated air.[67] Nevertheless, limiting the duration of mask removal during eating will minimize potential risk of exposure, and should be limited to under 15 minutes. Travellers on short-haul flights may consider refraining from eating and drinking, and airlines should consider limiting or eliminating meal and beverage services on those flights. Passengers sitting next to each other could negotiate eating and drinking at different times. Airlines could also offer staggered meal service by alternating seats, and food and beverage should be packaged for fast and convenient consumption.

10) What Personal Protective Equipment is recommended for air travel?

Airlines and aviation authorities have been proactive in protecting their cabin crew and passengers. Cabin crew are required to wear masks onboard with or without face shields or

goggles. Due to fomite transmission risk, crew members also wear gloves and gowns, depending on the airline. Aviation authorities have required passengers to wear face coverings as an effective means of reducing droplet spread. [62,63,68,69] Failure to do so may result in a denial of boarding or removal from a flight. CDC, IATA and Transport Canada do not recommend wearing gloves inflight except for cleaning or taking care of someone who is sick.[46,70,71] People who wear gloves are less likely to wash their hands between tasks and are more likely to contaminate themselves.

11) How effective is temperature screening on entry at the airport?

Thermal screening has been implemented in many airports around the world as one of the many preventive safety measures against the spread of COVID-19. It was previously used in 2003 during the SARS epidemic and in 2009 during the H1N1 epidemic. The idea is to detect fever and prevent symptomatic passengers from travelling and exporting infection to another country. The concept is rather controversial and it has several limitations. First, fever is not specific to COVID-19. Individuals can have fever caused by other infections or causes. Second, the median incubation period of COVID-19 is around 5 days, and can be as long as 14 days.[72] Individuals who have just been infected may not have developed fever and would not be picked up by exit or entry temperature screening.[73] Third, not everyone with COVID-19 will develop fever. 80% of cases are mild, even at their peak, and may not show fever or other symptoms. A mathematical model published by the London School of Hygiene and Tropical Medicine estimates that for every 100 infected travellers taking a 12-hour flight, 46 (95% confidence interval 36 - 58) would pass through both entry and exit screening undetected.[73] Lastly, different methods of thermal screening have different specificities and sensitivities, and there is lack of evidence on their

accuracies and effectiveness. One study suggests that infrared thermal image scanners for mass screening of travellers at airport has a specificity of 71% and sensitivity of 86% to detect fever, but there are variations depending on where the camera is positioned, which part of the body is being scanned, and other environmental and individual factors that can affect the precision of these thermal scanners.[74,75] Overall, temperature screening at airports may offer some reassurance to travellers, and could act as some form of barrier to prevent individuals with fever from entering the airport or from boarding a flight. It certainly cannot detect every traveller infected with COVID-19, and by itself is not an effective tool to prevent entry and spread of COVID-19 into another country.

12) Are pets allowed onboard during the pandemic?

According to the World Health Organization, several dogs, ferrets, and cats in contact with infected humans have tested positive for COVID-19. There is currently no evidence that these animals play a role in transmission of the disease to humans.[76,77] However, since animals can carry the disease, some carriers suspended all international and domestic pet travel. Other airlines are not allowing animals on flights with connections. Animals may also be required to undergo a 14-day quarantine prior to departure or show a document signed by an accredited veterinarian stating that the pet has not been in contact with any humans or animals infected with COVID-19. It is advisable to check with the airline before travelling with an animal.

13) Is a negative COVID-19 test required before departure?

In September 2020, IATA called for the development and deployment of systematic COVID-19 testing for all passengers before departure as an alternative to quarantine measures to re-establish

global air connectivity. Since quarantine requirements on arrival and on return are major barriers to travel, this is a reasonable strategy to promote safe air travel and minimize global spread as a result. IATA stipulates that the test must be fast, accurate, easy-to-operate, capable of large volume and cost-effective to not create logistical or financial barriers. Many countries and airlines already require passengers to undergo COVID-19 testing and to present proof of a negative test completed 24 to 96 hours before departure. Several airlines and airports are now offering rapid pre-flight tests for travellers. This may facilitate travel and trade between countries to establish "travel bubbles", "travel corridors" or "corona corridors", permitting quarantine-free travel between countries.[78] Limitations to pre-testing include high rates of false negative tests, potential exposure between date of test and date of travel, and potential exposure during pre-boarding, inflight, or post flight journey. Travellers need to source specific entry requirements through national and international health agencies and ministries, airline websites or travel specialists, as regulations continue to change.

14) What is a digital health passport or an immunity passport?

Several new innovative ideas are underway to standardize documentation and presentation of COVID-19 status. One such idea is using a digital health passport for international travel. CommonPass, a project initiated by the World Economic Forum, is a digital health passport currently under trial with Cathay Pacific Airways and United Airlines. CommonPass functions as an adaptable secure platform allowing travellers to document their COVID-19 status electronically, which can then be presented at boarding or borders.[79,80] The pass could be used to verify test results or vaccination status, while protecting the privacy of health information. It aims to support a range of country to country health screening entry requirements, be

interoperable between and across countries, and be operated openly, independently and on a not-for-profit-basis. Depending on the success of these trials, the pass will expand to other airlines and routes globally, with the sustainable goal to safely increase travel and trade.

The concept of an 'Immunity Passport' or 'Immunity Certificate' is based on the idea that a passenger could be documented as having recovered from COVID-19 infection and thus be immune.[81,82] Immunity status would essentially exempt a traveller from airport and onboard processes such as temperature checks, and they would not require protective measures such as face masks, distancing, quarantine or testing. However, medical evidence of immunity from COVID-19 is still inconclusive, with many unknowns such as duration of protective immunity.[83] As such, WHO, IATA, and ICAO currently do not support immunity passports, but they may be a possibility in the future, when a vaccine is introduced or when there is more evidence supporting immunity.[84]

15) Are airlines employing contact tracing for positive cases in-flights?

Currently, contact tracing is not being done by airlines for positive cases inflight. Some public health authorities are indirectly providing contact tracing. For example, the Government of Canada hosts a webpage that lists the locations or flights where people may have been exposed to COVID-19.[85] The data includes the airline, flight number, route, date and flight row numbers affected if known. This data is gathered from public health authorities but is not exhaustive. Although updated daily, contact information that is more than 14 days old is deleted. Moreover, flight manifests are not kept indefinitely, do not contain contact information on all travellers and are not immediately available to public health authorities. Airlines should work closer with public health authorities to make contract tracing more robust and timelier.

Three well-documented in-flight mass transmission events showed evidence of case-clustering, and the overall limited data suggests proximity to a SARS-COV-2 infected person as a major risk factor for in-flight transmission.[9] Canada uses a Bluetooth application called *COVIDAlert* that anonymously notifies close contacts of positive cases – defined as anyone who has been within 2 meters for longer than 15 minutes. Accordingly, the airline industry could implement a similar universal Bluetooth application that can be downloaded pre-flight, would be functionable inflight and for two weeks post travel. Ideally this would be combined with a digital health pass. This is an area for innovation as contact tracing is a key component to contain transmission.

Conclusion

Travellers have played a critical role in spreading the disruptive SARS-CoV-2 virus worldwide, resulting in a paralyzing pandemic, with the number of scheduled flights worldwide down by 47.5% as of August 2020. [86] Flying during the pandemic presents increased risks, whether directly or indirectly related to COVID-19 infection. The risk of infectious disease transmission aboard commercial flights is a real and significant concern.[16,43,87] Determining the actual or estimated risk of COVID-19 transmission during air travel is difficult to accurately quantify due to several variables, including asymptomatic and pre-symptomatic spread of COVID-19, in-flight density, strategies for screening passengers at airports and by airlines, and flights originating from countries with high Infectious Disease Vulnerability Indexes.[87–91] Although currently not quantifiable, onboard acquisition of SARS-CoV-2 is possible, but deemed to be low risk if mitigation measures and infection prevention standards are observed.[92] To protect travellers, masks should be strictly mandated on flights, frequent hand sanitization promoted, and physical distancing ensured when feasible from boarding to deplaning. High frequency

touchpoints should be disinfected between flights and inflight, with passengers advised to wipe down tray tables, headrests and armrests before use. Pre-screening and pre-testing measures should be consistent across the airline industry and used in addition to the preventive measures enforced onboard. The implementation of a standardized digital health pass for COVID-19 and more robust contact tracing may be key factors to allow for a gradual safe return to sustainable and responsible travel. By assessing the multiple risks of flying and using a multipronged strategy to mitigate cumulative risk, the actual risk to the traveller may be minimized.[93] As restrictions slowly ease and travel regulations rapidly evolve, further studies to assess in-flight transmission risk is needed.

DECLARATIONS

Ethics approval and consent to participate: Not applicable

Consent for publication: The authors consent to publication of this work.

Availability of data and material: All data are presented within the text.

Competing interests: Drs. Anna-Maria Carvalho and Vincent Poirier are medical consultants for Air Canada and Air Transat and directors for the Onboard Medical Emergencies course. Dr. Aisha Khatib is a travel doctor and Clinical Director of Travel Medicine at Medcan. Dr. Kent To is a medical consultant and aeromedical examiner for Emirates Airlines.

Funding: This work was unfunded.

Authors' contributions: AK conceived the idea. AK, AMC, RP, KT, and VP contributed to literature review, analysis, and interpretation. All authors contributed to drafting and writing. AK, AMC, RP and VP edited and revised the manuscript.

Acknowledgements: We would like to acknowledge Dr. David O. Freedman for his expert guidance and data provided.

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