

Travel Between Zones

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The challenge of regulating travel during a pandemic is that the travel has both indirect economic benefits and indirect economic costs. The cost of a missed business trip or leisure travel is highly variable, as is the economic costs of induced outbreaks, as well as the disease, suffering and death that can arise. Unfortunately, wishful thinking based upon non-pandemic conditions may guide decision making so that clarity is needed both about what is known and not known for effective action.

Who should be allowed to travel freely between zones? With cases reduced in some countries and the number of remaining cases being inherently heterogeneous due to localized outbreaks, one important question is how should travel be regulated. There are three categories of zones: Green zones without transmission risk because the number of community transmissions within the most recent 14 days is zero, Red zones where there is active transmission, and Yellow zones which neighbor Red zones and therefore require extra precautions. In recent times there is an effort to distinguish zones based upon statistical risk specified by the number of cases per capita. Here we discuss the considerations that make travel between zones risky for a zone that receives travelers from a non-green zone.

Green Zone to Green Zone: Travelers from confirmed green zone to green zone are ideal as candidates to travel freely. However travel itself carries risks of infection. For example, conventional travel with multiple hops through hub airports and potential layovers does not satisfy these conditions.

In order to ensure safe conditions the airplanes should fly direct from green zone to green zone. These planes would be restricted to green zone routes and the crew would live in the green zones. Trains, busses or cars can travel across intermediate zones but should not stop without special precautions in those areas. Departing from these strict conditions requires understanding the role of travel safety.

Transit safety: The challenge of developing safe travel in a pandemic is made more difficult by the limited regulatory systems as well as financial interests of travel associated organizations. For example, it is apparent that airlines have been irresponsible actors in the outbreak and its response, with manifestly unsafe conditions, and resistance to implementing travel restrictions. Their financial vulnerability, that plays a strong role in their behavior, is not the starting point for effective travel safety. The cost of even one infected individual and resulting outbreak in a country where it occurs is very high. That these costs are not borne by the airlines results in economic motivations that are counter to the interests of both passengers and destination countries.*

At this time there are insufficient baseline standards for safe

in-flight conditions including airplanes and crew. There isn't an authority that is responsible for monitoring travel-induced transmission. National authorities are responsible only for their own country data. They do not have the necessary authority for collecting data and identifying risk and precautions. This means that we don't actually know what is the risk in travel.

For example, if someone shows up infected in one country, or locality within a country, we don't know if that infection arose during travel or prior to travel. Given the known high risk for indoor transmission and the limited understanding about the role of airplane ventilation, the challenge of passenger to passenger transmission as well as to and from the flight crew have not been adequately analyzed or addressed.

Technical note: In principle the effect of travel on infection transmission might be studied from the distribution of delay times of showing symptoms after arrival having a peak at the typical incubation period after travel. However, that study has not been made. Since analysis involves a deconvolution of the infection times with the incubation period, the statistical signal is reduced. Direct information about individuals prior to and after travel would be a more effective means for analysis. In the meantime, decisions must be made in absence of complete information.

Other forms of travel, by train, bus and car, require similar and additional conditions. Absent a concerted effort to develop clear guidelines this will continue to present an unreasonable risk with consequent outbreaks.

Travel Between Zones that are not Green: Travelers from red to green zones must undergo effective quarantine, monitoring and testing. One of the key questions is can travel be allowed between zones of similar disease incidence. There are multiple reasons that travel between zones introduces additional risks. In particular, people do not behave in a statistically average way. A randomly selected individual in one country, moved into another country, does not behave and does not have the same risk level as a randomly selected individual in the other country. Countries have to take strong actions to prevent outbreaks even if there is a single non-quarantined infected individual. Information is a key part of that process, and the transfer of individuals from one location to another means key information is not available. In particular:

- 1) the travel itself creates a higher level of risk that has not been sufficiently evaluated (see above).
- 2) the population in a particular area has an existing network structure, adding individuals that change that network structure changes the transmission dynamics.
- 3) in particular, the geographic network of contacts of travelers that come in contact with an infected traveler is typically much larger than the one originating from a

*In order to counter this adverse incentive structure, China has adopted a specific incentive mechanism: If no passenger arriving by flights on a route operated by an airline tests positive for three consecutive weeks, that airline is allowed to add one flight to the current weekly quota without exceeding the limit set in the route operating permit and with a cap of two flights a week. On the other hand, a penalty will be triggered when five passengers traveling by one route operated by an airline test positive. In this case, if less than ten passengers show positive results, the airline's flights on this route shall be suspended for one week. If ten or more passengers test positive, the suspension will be extended to four weeks. Quotas reduced by penalty shall not be transferred to other routes. The airline can only resume its one-flight weekly schedule after the suspension ends.

local individual, leading to more difficult contact tracing and potential for wide-spread outbreak.

- 4) individuals who are typical travelers have a different network structure than local residents, with a tendency to engage in social behaviors and visit locations that are highly connected, including restaurants and bars for tourism and recreational travelers. Business travelers participate in meetings in addition to visiting restaurants and bars.
- 5) there is information the traveler doesn't have about the local conditions (what are the existing restrictions on behaviors, where to go about testing, who to contact about symptoms, etc.)
- 6) travelers have a different, and potentially reduced, incentive structure to protect others that are within the local population leading to behaviors with dramatically greater risk.
- 7) traveler information and incentives lead to a reduced probability of self-reporting of symptoms due to incomplete information, language barriers, absence of local healthcare coverage, etc. This is exacerbated by the fact that a traveler usually has a clear goal—meetings, sight-seeing, shopping, etc.—which makes days more purpose-driven. Any activity that deviates from this purpose (going for testing, going to see a doctor, looking for local information) has a higher opportunity cost both psychologically and financially.

- 8) there is missing information about the traveler and their contact network compared to local individuals that have regular and known behavior patterns.
- 9) the prior behavior patterns of local individuals are implicitly known because they are part of the history of the individual in the system, and their effects have already been incorporated in precautions that are being taken. This is not true about travelers.
- 10) the prior behavior patterns are explicitly known in the social records of individuals, i.e. contact tracing information is available between individuals, including who was near whom. This information is more difficult to obtain for travelers with temporary and unusual encounters.

Each of these adds risks that are much larger than those of the resident population.

The implications of these additional risk factors is that

- 1) Equivalent levels of population incidence does not translate into equivalent risk for individuals who travel compared to those that are present in the population.
- 2) In order to achieve effective risk control stronger measures must be taken for the travelers and also for the population given the risk of transmission.
- 3) These stronger measures should lead to reduced transmission and thus an impetus to getting to zero. Importantly, this should motivate all countries to get to zero so that normal free travel can take place.