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Pests on a plane – airports and the fight against infectious disease

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Regular flyers are all too aware that air travel can, on occasion, be bad for your health. Jetlag, deep vein thrombosis (DVT), airsickness, dehydration, ear pain, and respiratory infections are just some of the conditions that are reported. Yet while seat-based exercises, air conditioning filters, flight socks, earplugs, boiled sweets, inflatable pillows, and eyeshades may lessen some of the risks and discomfort associated with flying, the warm, pressurised, sealed cabins of passenger aircraft continue to offer the perfect environment in which certain pests and diseases may thrive and spread. Medical journals are replete with stories of airline passengers contracting a range of infectious diseases, including tuberculosis, meningitis, measles, and influenza, from fellow (infected) travellers, while the rapid spread of the SARS virus to over 25 countries around the world in 2003 was attributed, in part, to the long-haul airline network. Since the birth of commercial aviation at the beginning of the twentieth century, airports have found themselves at the forefront of a worldwide battle against the spread of tropical and infectious diseases, and a range of public health interventions have been deployed to try and prevent pests and diseases being transported around the world aboard aircraft. This article reviews some of the public health directives that were devised to prevent the spread of disease by air and explains their implications for the design and operation of airports.

The early years

While the globalisation of infectious disease is not a new phenomenon, commercial aviation posed a new and challenging set of global public health issues. For the first time, passengers could board an aircraft in one country and alight in a distant land a few hours later; journeys that had once taken weeks or months to complete by land could now be accomplished in a matter of hours by air. As a consequence, diseases that had once been the exclusive preserve of the tropics began spreading to new regions of the world along the contours of the global airline network. The realisation that aircraft could be vectors of human disease led to the development of specific

sanitary regulations for aviation and the implementation of new public health directives at airports, some of which continue to be practiced today.

One of the earliest recorded examples of a disease being transported from one country to another by air occurred in 1918 when an English fighter pilot inadvertently reintroduced rabies into the United Kingdom as a consequence of bringing an infected dog into the country aboard his aircraft. The inauguration of regular cross-Channel passenger flights in 1919 increased the potential for diseases to be spread, and fines were introduced to deter passengers from trying to import animals without a licence. As airlines grew, and new long-distance routes were added to the network, passengers and crew were faced with a new and increasing range of exotic diseases, including yellow fever, typhus, and malaria, for which they had no natural immunity. There was also concern that passengers travelling from endemic smallpox or cholera areas in Africa and Asia could reintroduce diseases that had been effectively eradicated in Europe. To reduce the risk of contracting infection, passengers and crew on long-haul services were encouraged to sleep under mosquito nets, and curtains impregnated with insecticide were hung over aircraft doorways to try and prevent insects from flying in.

Though slow by modern standards, the speeds attained by early passenger aircraft in the late 1920s and 1930s revolutionised notions of time and distance and enabled many parts of the world to be reached by air within the incubation period of major infectious diseases. Cholera, which was endemic in India and Iraq at this time, had an incubation period of 2-5 days, several days longer than the minimum journey time from these places to Europe by air. Likewise, the incubation period of Plague (2-6 days) was considerably less than the flight time from endemic areas in East Africa (4 days) and India (4-5 days), and passengers could fly from endemic yellow fever zones to Europe in as little as three days, the same duration as the minimum known incubation period of the disease. The situation was even more pronounced for smallpox and typhus, which had far longer incubation periods. During the mid-1930s, the flight time from endemic smallpox and typhus areas in the Middle East and Central Europe respectively was approximately ten days shorter than the incubation period of the two diseases. This meant that infected travellers could potentially fly back to Europe with no symptoms, pass health and customs officials at the airport,

and spread the disease amongst their community before a diagnosis could be made or treatment started.

The airport, the aerial gateway through which diseases could be introduced into new territories, was identified as a place of significant risk, and individual countries began taking steps to monitor the health of incoming airline passengers. However, in light of the somewhat haphazard and inconsistent measures that were applied in different regions of the world, it was decided that internationally binding procedures governing the health of airline passengers and the sanitation of airports and airlines should be devised.

The first Sanitary Conventions

The international community began taking the first tentative steps towards the internationalisation of sanitary measures for aviation in the mid 1920s. The first multilateral international health agreement to deal with aviation appeared in 1924 as a result of the 7th Pan American Sanitary Conference that was held in Havana. Here, delegates from countries in North, Central, and South America signed a Sanitary Code which called for the adoption of measures to “prevent the introduction and spread of disease” into other territories by air. In April 1933, the First International Sanitary Convention for Aerial Navigation was convened in The Hague. The resulting Convention, which became effective in August 1935, contained 67 separate Articles and dealt with threats posed by Typhus, Smallpox, Plague, Cholera, and Yellow Fever. The possibility of medical inspection of passengers and the control of tropical diseases were discussed, and detailed methods concerning the eradication of insects – especially the mosquito that transmitted Yellow Fever – in and around airports were proposed.

In addition to fulfilling certain aeronautical operating requirements, the Convention stipulated that designated “sanitary aerodromes” had to have a dedicated medical facility staffed by trained physicians in which medical inspections of passengers could be carried out and where travellers with suspected cases of infection could be isolated and treated. Separate lavatories had to be provided for the two sexes and, if possible, a scientific laboratory for the bacterial analysis of medical samples constructed on site. Sanitary airports also had to be able to guarantee supplies of clean drinking water and

have suitable facilities in which human waste and other refuse could be safely and hygienically disposed. To keep the aerodrome free from mosquito infestation, powerful insecticides were regularly sprayed over the airfield and its immediate environs to try and disrupt the breeding cycle of the insects. In endemic yellow fever areas, preventative measures were taken a step further. Designated 'anti-amaryl' aerodromes had to be sited at least one mile windward of all human habitation, all buildings for staff and passengers had to be insect-proof, and an isolation area in which potential air passengers could be kept under observation for up to six days before embarkation had to be provided.

All aircraft engaged on international services were also required to carry a logbook in which all matters relating to public health were entered. Upon arrival, the commander of the aircraft was responsible for informing the airport's resident medical officer of any suspected cases of infection amongst the passengers or crew. Departing air passengers, meanwhile, could be required to submit to a medical examination prior to boarding, and the aerodrome's medical officer was empowered to prevent any person who showed signs of infection from flying. The medical officer was also responsible for ensuring that no infected bedding, clothing, or cargo was loaded onto the flight and that the aircraft itself was free from rodent and insect infestation.

Faster jets and new disease threats

In 1944, in anticipation of the post-war growth in commercial air travel, a revised Sanitary Convention for aviation was devised. This document called for 'special measures to prevent the spread by air across frontiers of epidemic or other communicable diseases'. The modified Convention introduced new documentation in the form of aircraft and passenger health declarations, international certificates of inoculation against Cholera, Yellow Fever, Typhus Fever and Smallpox, and certificates of immunity against Yellow Fever. The required number of inoculations now depended both on the route that was to be flown and an individual passenger's personal vaccination and travel history. Upon arrival, it was the responsibility of airport officials to check the validity of these certificates and offer vaccination to passengers with incorrect or invalid documentation. This naturally increased the time taken to process passengers in the arrivals hall.

Though it was hoped that the revised 1944 Sanitary Convention would set the standard for disease control measures around the world only 14 countries, including the United States, Canada, and the United Kingdom, ratified the amendments. Other countries continued to take few if any precautions, while others imposed restrictions that went far beyond what was required. In light of the different medical requirements individual countries demanded and the inconsistencies involved in their policing, airlines advised passengers to be inoculated against every conceivable disease. This reportedly led to confusion, resentment, and excessive inoculation, with prospective travellers being forced to submit to multiple injections. Not only was this time consuming, expensive and very bureaucratic, the regulations were frequently undermined by fraudulent documentation and passengers who deliberately made false health declarations to avoid being detained for further health checks at the airport.

Given these problems, a pan-global directive aimed at controlling the spread of disease by air was enshrined in Chapter II Article 14 the 1944 Chicago Convention on International Civil Aviation. Here, each contracting State agreed ‘to take effective measures to prevent the spread by means of air navigation of cholera, typhus (epidemic), smallpox, yellow fever, plague, and other communicable diseases’ and agreed to consult with international public health organisations and share epidemiological data on diseases.

The 1950s and 1960s represented important decades in the development of sanitary regulations for air travel. Though the introduction of more effective insecticides, preventative vaccines, and new methods of treatment helped facilitate the control of plague, typhus, and urban yellow fever, a new generation of faster, longer-range jet-powered aircraft brought the temperate regions of Europe and North America metaphorically even closer to the endemic centres of tropical disease. Throughout the remainder of the twentieth century the sanitary regulations governing aerial navigation were continually revised and updated in light of advancing medical knowledge and the emergence of new diseases. Regulations regarding the movement of non-human cargoes were also strengthened in recognition that aircraft could also introduce alien (and often highly destructive) plant and animal pests into new areas. To counter such threats, a raft of legislation, from pet passports to phytosanitary certificates and importation licences have been devised to protect the biosecurity of

national borders by regulating the movement of global flora and fauna through airports. When one considers that the animal reception centre at Heathrow airport alone handles in excess of 35 million fish, and hundreds of different species of birds, mammals, reptiles, and amphibians every year, the need for vigilance is obvious. Yet, in addition to these ‘documentary’ interventions that seek to intercept potentially harmful shipments at airports, more direct practices of disease control using powerful insecticides are also practised.

Disinsection

The legal basis for eradicating insects and other stowaways in aircraft, or ‘disinsection’ as it was termed, through the application of pesticides and insecticides, was enshrined in Article 5(e) of the 1933 Sanitary Convention. This Article decreed that all sanitary aerodromes must have at their disposal the ‘apparatus necessary for carrying out disinfection, disinsectisation and deratisation’ of aircraft in order to prevent the spread of disease.

Airlines had first attempted to address the problem of insects travelling aboard their aircraft in equatorial regions in the late 1920s, but most of the hand-held sprays they used were largely ineffective. Under the direction of their senior medical adviser, Imperial Airways’ Experimental production section at Battersea in London devised a more effective system of aircraft disinsection. The Phantomyst Electrical Disseminator or Phantomyst Vaporiser discharged a fine, dry, near odourless cloud of Pyrethrum-based insecticide into the passenger cabin. The device reportedly left no unpleasant odour, did not stain clothing or upholstery, and was considered harmless to humans. Furthermore, the insecticide was not flammable and did not damage the structure of the aircraft. An alternative system, the ‘Larmouth carbon dioxide sparklet method’, was also developed and, in order to assess the relative performance of the two devices, both were installed in Imperial Airways’ flying-boats *Cassiopeia* and *Cambria* on the Southampton to Durban route with apparently satisfactory results.

Today, despite concerns about the toxicity and human health implications of exposure to chemical insecticides, over 35 countries around the world still require commercial aircraft to be routinely disinfected, arguing the practice is necessary to protect public health, domestic agriculture, and native ecosystems from alien pests and diseases.

Four different methods of aircraft disinsection are currently approved by the World Health Organisation (WHO), and include blocks away, top of descent, on arrival, and 'residual' treatment. Residual treatment, in which insecticide is applied to the interior of the aircraft during routine maintenance, has the advantage that passengers are not directly exposed to chemical aerosols during flight, but there is potential that passengers may inadvertently come into contact with the insecticide as a consequence of touching treated areas. While individual countries can select which of these disinsection methods they want performed on aircraft entering their territory, the WHO specifies the type of insecticides that can be used. These chemicals are either pyrethrins, naturally occurring insecticides extracted from chrysanthemum flowers, or synthetic forms of pyrethrum called pyrethroids.

Airport Malaria

While the debate concerning the pros and cons of aircraft disinsection continues, evidence shows that mosquitoes and other insects imported in aircraft have been responsible for outbreaks of disease around airports. Between 1969 and 1999, 89 cases of airport malaria (i.e. incidents of malaria in and around major airports in which people who have not recently travelled overseas are infected) were reported in 12 countries around the world. These included cases at London Heathrow, Madrid, Paris Charles De Gaulle, Geneva, and Brussels. In 1994, six cases of airport malaria were recorded around Paris CDG. It was reported that all the afflicted individuals lived close to the airport but had neither travelled to a malarial area nor received a blood transfusion. It was believed the cases were the result of an infected mosquito flying out of an aircraft and biting them. Passengers and crew may also be at risk of contracting 'runway malaria' in certain areas as a consequence of being bitten by an infected mosquito while on the ground during a stopover. The need to keep airports free from mosquitoes and other pests therefore remains vital.

Infestation and fumigation

While reports of aircraft infestation by rodents, reptiles, or insects are unusual, they are not unheard of. Usually, the creatures enter an aircraft through open doors or access panels, are inadvertently loaded alongside catering supplies, or escape from cargo containers or passenger baggage. In the past, aircraft fumigation involved pumping toxic gases, such as methyl bromide or hydrogen cyanide into the aircraft,

but concerns about the use and potential side effects of these chemicals have led to them being replaced by carbon dioxide and more targeted pesticides. Nevertheless, fumigation remains expensive and time consuming, as the aircraft must be taken out of service for hours, if not days, at a time, and must be treated in a remote corner of the airport, well away from passenger areas. The emphasis is thus on stopping unwanted 'passengers' from gaining access to, and stowing away in, aircraft. As ever, prevention is better than cure.

Contemporary health screening

While the practise of screening passengers for infectious diseases at airports is not new, the emergence of new, increasingly virulent and drug resistant strains of bacterial and viral infection are leading to new procedures regarding passenger health screening at airports. In July 2003, the Taiwanese authorities required all inbound passengers arriving at their two international airports to complete a SARS Survey Form before landing and have their body temperature taken by a thermal imaging camera. Any passenger whose body temperature exceeded 37°C was subject to additional health checks. The screening programme helped identify numerous cases of fever and diagnosed several cases of imported dengue fever. Elsewhere, prospective long-term immigrants to certain countries are required to submit to chest x-rays to check for signs of tuberculosis or sign forms to state that they are free from infection. Other passengers, for example those travelling on religious pilgrimages to the Middle East, must be in possession of valid health and vaccination certificates before they are allowed to travel. However, while passengers using the 'usual channels' at major airports are intensively policed and often screened for signs of infection, those using smaller or unlicensed airfields, or those flying into a country illegally (in some cases smuggled in on aircraft literally 'under the radar') may undermine the effectiveness of international disease control measures.

Rising numbers of air passengers also make it increasingly difficult to actively screen everyone for infection and individual passengers must take some responsibility for their health and mobility. However, the rise in demand for 'exotic' holidays to far-flung destinations and the increase in the size and capacity of passenger aircraft mean that not only are more people being exposed to tropical diseases at their destination, but more people are being exposed to disease as a consequence of sitting in an aircraft

with hundreds of other people for hours on end, any one of whom may be carrying an infectious disease.