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# International law for public health in aviation: the challenges of harmonisation†

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ABSTRACT

International laws for commercial aviation have achieved an exceptional degree of harmonisation and greatly improved passenger safety. Yet, despite much international guidance, enforceable laws for public health protection in aviation are mainly the responsibility of national authorities. As a result, public health laws may be incoherent, in conflict with other countries and/or based on disputed scientific evidence. The COVID-19 pandemic has highlighted the responsibility of airlines and regulatory authorities to protect not only air passengers but also populations in destination countries. While the greatest risk to global public health is the potential spread of disease by infected passengers or vectors, lesser-known risks include food contamination, inadequate sanitary facilities and poor air quality within the cabin. In preparedness for inevitable future disease outbreaks and pandemics, an urgent review of international law as it applies to public health in commercial aviation is needed, with greater investment in scientific research to enable more accurate and effective risk assessment and management, supported by enforceable laws and clear responsibility.

**Keywords:** aviation; public health; law; harmonisation.

## INTRODUCTION

The global impact of COVID-19 and the role of commercial aviation in its rapid worldwide spread mandates an urgent re-examination of public health risks in commercial air travel, including the limitations of international aviation laws and regulations in managing those risks. Aviation law is a well-established field of legal expertise, and international public health law has been explored by scholars for decades, but there is a surprising lack of academic literature on international public health law as it applies to commercial aviation.

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In 2019 Cuinn and Switzer[1] examined the fragmentary nature of international aviation governance during the 2014 Ebola outbreak in West Africa, but there are very few other examples.

There remain important questions about the duty of care of international commercial enterprises for public safety, not just to their paying customers but to the global population. Balancing the conflicting pressures of public safety and commerce can be exceptionally difficult in cases where science does not yet have clear answers. Apart from the devastating human and social cost, the pandemic has inflicted unprecedented economic damage on the aviation industry, with predicted lost revenue of $314 billion for 2020, a drop of 55 per cent from 2019.[2] Even with financial support from national governments and radical cost-cutting measures (including mass redundancies), many airlines may not recover from the economic impact.[3] Dube noted the low resilience of the industry and that early signs indicate a 'slow, unpredictable and stretched recovery' with 'colossal cash burn'.[4] Gössling argued that the conflict between volume growth and risks and vulnerabilities is insurmountable, and that the commercial aviation industry should be deliberately shrunk, with financial subsidies reduced or withdrawn.[5] It is clear that commercial aviation faces considerable challenges ahead.

The present article provides an overview of the current international legal framework for public health protection in aviation, some of the key public health risks in commercial air travel with particular focus on risks within the aircraft cabin and provides examples of governance to manage those risks. It looks at liabilities and considers the challenges of developing harmonised, enforceable legislation for public health protection. It does not attempt to give a comprehensive account of all international aviation law, nor can it address the many different national legislative frameworks around the world. It argues that the damage to the aviation industry and its threat to global health requires a 'reset'. There is an urgent need for industry and public health leaders to collaborate in a comprehensive assessment of public health risks

1 Gearóid Ó Cuinn, and Stephanie Switzer, 'Ebola and the airplane – securing mobility through regime interactions and legal adaptation' (2019) 32(1) Leiden Journal of International Law 71–89.

2 IATA Press Release No 29, 'COVID-19 puts over half of 2020 passenger revenues at risk' (14 April 2020).

3 'COVID 19: "Future of UK aviation" at risk, say airlines' (*BBC News* 15 March 2020).

4 Kaitano Dube, Godwell Nhamo and David Chikodzi, 'COVID-19 pandemic and prospects for recovery of the global aviation industry' (2021) 92 Journal of Air Transport Management.

5 Stefan Gössling, 'Risks, resilience, and pathways to sustainable aviation: a COVID-19 Perspective' (2020) 89 Journal of Air Transport Management.

in aviation, and to identify where research investment is needed, how risks should be managed and who should take ultimate responsibility for enforcement.

## OVERVIEW OF INTERNATIONAL LEGAL FRAMEWORK FOR AVIATION

'Legal framework' as used here refers to the broad system of rules that govern and regulate decision-making, agreements and laws, also known as 'governance'. Governance can include both *law* and *policy* and there are important differences between the two. Laws which have been enacted by a national government, by judicial precedent or by custom are regarded as 'hard law', that is, they are usually binding and enforceable. They are fixed and publicly available. 'Soft law' can include policy, guidelines and recommended practice which may have been created for an organisation or industry's internal procedures, and therefore may not be public. It is non-binding and non-enforceable but may carry influence. A particular advantage of soft law, and the reason it is common in international law, is that it can mobilise the consent of countries with different interests and where the commercial interests of private bodies are involved.[6] A key weakness is the lack of an enforcement mechanism, but nevertheless, the intention is to create 'norms' of behaviour, that is, it is 'normative' and by signing international treaties and conventions, countries commit to abide by the terms of those agreements. Sekalala and Masud argue that soft law may be both a precursor and complementary to hard law,[7] and it will be strengthened if its terms are incorporated and enacted in national laws, becoming enforceable.

The uniqueness of international aviation law lies in the level of state compliance with international treaties and how this has enabled harmonisation of national laws worldwide. The importance of internationally agreed rules was recognised from the earliest days of aviation and, despite fundamentally different political, legal and economic contexts, most nations have come together to commit to binding technical standards in aviation. While this was initially to protect air sovereignty, the regulations soon focused on security and the technical safety of aircraft to reduce accidents. The twentieth century saw a succession of major treaties which achieved an impressive degree of conformity and collaboration, such as the Warsaw Convention 1929, the Chicago Convention 1944 and the Montreal Convention

6 Sharifah Sekalala and Haleema Masud, 'Soft law possibilities in global health law' (2021) 49(1) Journal of Law, Medicine and Ethics 152–155.

7 Ibid.

1999, as well as the establishment of the International Civil Aviation Organization (ICAO).

Aviation law has become highly standardised, as well as increasingly complex and specialised, including many subspecialties such as access to airspace, contractual and commercial law, environmental law and now expanding to include unmanned drones and space law. Yet there is a lack of harmonised, enforceable international law for *public health risks* in aviation. International public health is the domain of the World Health Organization (WHO), and WHO's International Health Regulations (2005) (IHR) have specific annexes for aircraft, but these and other international guidelines are unenforceable. National laws to reduce public health risks in aviation may be limited, in conflict with those of other countries or based on still evolving (and disputed) scientific evidence. Public health threats include on-board food contamination, inadequate facilities and poor air quality (although the last is fiercely disputed by the aviation industry). The greatest risk is of spreading highly virulent diseases by carriage of infected passengers or vectors. This is primarily through the movement of infected individuals to new geographical locations, rather than transmission occurring on board aircraft. While rare, such events can be catastrophic and endanger populations.

## CURRENT INTERNATIONAL LEGAL FRAMEWORK FOR AVIATION: INTERNATIONAL REGULATORY BODIES

While WHO is the body with overall authority for global public health, including in aviation, the most important regulatory body specifically for aviation is ICAO, an official body and specialised agency of the United Nations (UN) which was established by the Chicago Convention in 1944. All 193 current member states of the ICAO have committed to accept ICAO Standards, and oversight and enforcement of the regulations is usually the responsibility of the National Civil Aviation Authorities (NCAAs) of each country. Thus a required ICAO Standard for a particular technical modification must be enacted in all 193 member states and be enforceable in each country under national laws.

ICAO's core mandate is 'to help States to achieve the highest possible degree of uniformity in civil aviation regulations, standards, procedures and organization'.[8] Over decades and by consensus of its members, ICAO developed 19 annexes containing over 12,000 Standards and Recommended Practices (SARPs) and five Procedures for Air Navigation (PANs) concerning mechanical safety, aircrew training, use of commercial airspace, environmental controls and

8 ICAO, 'The history of ICAO and the Chicago Convention'.

many more. The SARPs focus on issues such as mechanical safety of the aircraft, aircrew qualifications, right to airspace, customs and freight and air traffic control. In recent years aircraft emissions have also become an area of regulation, as well as working conditions of aircrew and measures to prevent aviation terrorism. 'Standards' are technical specifications, 'the uniform application of which is recognised as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention'. Recommended practices are deemed 'desirable in the interest of safety, regularity or efficiency of international air navigation and to which Contracting States will endeavour to conform in accordance with the Convention'. Thus, standards are considered obligatory, while recommended practices are advisory. States may still avoid compliance with standards if they file a 'difference' with ICAO although this may result in penalties. For example, another state may prevent aircraft with these reduced requirements from entering its own airspace. Also, any state can apply higher national standards than those of ICAO without penalty.

While the system is imperfect, with evidence of some countries falling behind in compliance,[9] in general SARPs have contributed to enormous progress in improving mechanical safety, upheld by international and domestic law. The 19 current annexes contain references to public health issues, but these are limited, and in most cases simply require compliance with WHO guidelines.

The founding of ICAO was rapidly followed in 1945 by the establishment of the International Air Transport Association (IATA), a trade association which has grown to a current membership of 290 airlines from 120 countries,[10] accounting for 83 per cent of total air traffic.[11] IATA has issued many important safety guidelines and valuable guidance through the work of its medical advisor and Medical Advisory Group. However, it carries less authority than ICAO, its standards and guidelines are non-binding and, as a trade association, its priority is the interests of the airline industry.

Other important organisations in international aviation include Airports Council International (ACI) and the International Flight Services Association (IFSA). ACI is a membership body which represents airports across the world. It promotes cooperation between airports and often works with other regulatory bodies, primarily ICAO and IATA, as well as developing its own standards, recommended practices and policies for safety and security. Its role is to 'represent

9 ICAO Safety Audit Results.
10 IATA Current Airline Members.
11 IATA, 'About us'.

the collective interests of airports around the world'.[12] As of January 2022, it had 701 members operating 1933 airports in 183 countries.[13] Apart from its collaborative regulatory work with other bodies it has produced its own *Policy Handbook*.[14] IFSA is a global professional association which was created in 1966 'to serve the needs and interests of airline and railway personnel, inflight and rail caterers and suppliers responsible for providing onboard services on regularly scheduled travel routes'.[15] It has a particular focus on onboard food safety.

## REGIONAL REGULATORY BODIES

There are a number of regulatory bodies based in Europe which work to harmonise European aviation governance and to support ICAO. The European Civil Aviation Conference (ECAC) was founded in 1955 with a mission to promote 'the continued development of a safe, efficient and sustainable European air transport system'.[16] As an intergovernmental organisation of 44 European member states, ECAC issues guidelines, policy recommendations and resolutions. The European Organisation for the Safety of Air Navigation (EUROCONTROL) was founded in 1960 and provides technical expertise in relation to air traffic management across Europe.[17]

The European Union (EU) established a single aviation market for Europe in 1992. This European 'open skies policy' is probably unique in the world and has provided much commercial benefit, particularly for low-cost European airlines. A development from this cross-border integration was the establishment of Joint Aviation Authorities (JAA) which evolved into the European Aviation Safety Agency (EASA) in 2002.[18] As with NCAAs, EASA can recommend changes to existing regulations or the introduction of new regulations, but these are enacted by the EU and EASA's role is in oversight and enforcement. EASA is becoming an increasingly important regulatory actor in the European region. Notable EU legislation has included Regulation 2111/2005 which introduced a 'blacklist' of carriers banned from

12 ACI, 'About ACI'.
13 ACI website.
14 ACI, *ACI Policy Handbook* 9th edn (ACI 2018) i–ii.
15 IFSA, 'About'.
16 ECAC, 'About ECAC'.
17 EUROCONTROL website.
18 Regulation (EC) No 1592/2002 of 15 July 2002 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency.

operating within EU air space.[19] Further conformity within EU air space came with Regulation (EC) No 216/2008 of 20 February 2008 on common rules in the field of civil aviation. EASA explicitly aims for compatibility with ICAO annex 19 on safety management.[20] EU regulations are enforceable within member states, making EASA an important source of international aviation law.

In Asia, the area of fastest growth in aviation, the Single Aviation Market (SAM) was established in 2015, an initiative of the Association of South-East Asian Nations (ASEAN). At present this is a commercial arrangement and any attempt to introduce harmonised public health standards in aviation for Asia would be very challenging given the diverse national contexts within ASEAN and the enormous size of the Asian aviation market.

Much aviation governance is created by consensus of these groups. However, only ICAO and EASA have legislative power over member states: ICAO at international level, EASA at regional level. Even for ICAO and EASA there are limits of enforceability, which usually takes the form of penalisation of members.

Mention should also be made of the Federal Aviation Administration (FAA) which is an agency within the United States (US) Department of Transportation and the regulatory authority for aviation in the US, replacing the Civil Aeronautics Administration (CAA) in 1958. FAA rules are set out in the Federal Aviation Regulations (FARs), also known as Title 14 Code of Federal Regulations (CFR), which are binding and enforceable and are intended to ensure aviation safety in the US. Although a national agency, the positions taken by FAA on regulatory issues are highly influential but have also received repeated criticism for allegedly being too heavily influenced by the US airline industry.[21, 22]

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19 Regulation (EC) No 2111/2005 of the European Parliament and of the Council of 14 December 2005 on the establishment of a Community list of air carriers subject to an operating ban within the Community and on informing air transport passengers of the identity of the operating air carrier, and repealing Article 9 of Directive 2004/36/EC.

20 EASA, 'SMS – EASA Rules'.

21 David B Carmichael, Mary N Kutz and Dovie M Brown, 'FAA "captured?" is the Federal Aviation Administration subject to "capture" by the aviation industry?' (2003) 21(1) Collegiate Aviation Review International.

22 Stephen Mihm, 'The FAA has always been cozy with the aviation industry. That's why we need to empower the NTSB' *Los Angeles Times* (22 March 2019).

## CURRENT INTERNATIONAL LEGAL FRAMEWORK: KEY GOVERNANCE FOR PUBLIC HEALTH PROTECTION IN AVIATION

The IHR (2005) are the pre-eminent legal instrument for global public health, and 196 sovereign states[23] have committed to be legally bound by their terms. At the time of their creation, Fidler argued that the IHR represented 'a significant shift in international health cooperation',[24] which represented 'a conceptual breakthrough in global governance. Instead of commercial interests defining the scope and purpose of the IHR, public health considerations now take priority.'[25] Some years later, Gostin noted that:

> Finding ways to balance public health and economic activity has become an enduring feature of global governance ... The revised IHR sought to promote greater state compliance. Yet the regulations grant the WHO few, if any, explicit powers to monitor state performance, impose sanctions, or provide incentives ... Instead, the IHR rely on global norms and transparency, as civil society and the international community hold states accountable for evidence-based decisions.[26]

While intended to be binding, as Gostin points out, there is no enforcement mechanism to the IHR, and it is therefore soft law. Member states retain the sovereign right to legislate in accordance with their own health policies, but are expected to uphold the regulations[27] and much regional and national public health regulation incorporates its terms either implicitly or explicitly. The IHR include a number of terms which apply to air transport and aviation, including part IV – 'Points of entry' – and part V – 'Public health measures'. For example, part V, chapter II, article 24, 1(c) requires states to 'take all practicable measures' to 'permanently keep conveyances for which they are responsible free of sources of infection or contamination, including vectors and reservoirs. The application of measures to control sources of infection or contamination may be required if evidence is found.'[28] More specific provisions are set out in annexes 4 and 5 of the IHR, and the WHO regularly produces guidance developed by world experts in public health, and generally in collaboration with the aviation industry. The IHR are a critical foundation of public health in aviation, but their terms are general and unenforceable due to the sovereignty

23 194 WHO member states, Liechtenstein and the Holy See.

24 David Fidler, 'From international sanitary conventions to global health security: the new International Health Regulations' (2005) 4(2) Chinese Journal of International Law 325–392.

25 Ibid.

26 Lawrence Gostin, *Global Health Law* (Harvard University Press 2014) 183, 197.

27 IHR (2005), pt II, *Art 3 Principles*, para 4.

28 Ibid, pt V, ch II, art 24 'Conveyance operators', 1(c).

of member states. A recent report by WHO on the functioning of the IHR during the current COVID pandemic found that 'in the context of a pandemic, countries that in 2005 approved the IHR, in 2020 only applied the Regulations in part, were not sufficiently aware of them, or deliberately ignored them'.[29]

Apart from the IHR, the most significant international treaties specifically for health protection in aviation are the Warsaw Convention 1929,[30] the Chicago Convention 1944[31] and the Montreal Convention 1999.[32] The Warsaw Convention was important for being the first international agreement which imposed a strict (if limited) liability on commercial airlines for any event causing injury or death to passengers. The Chicago Convention was transformative for its establishment of ICAO at a critical time politically and in terms of the technological development of aircraft. The Montreal Convention in 1999 largely replaced the Warsaw Convention in its expansion of rights for passengers.

ICAO regulations (19 annexes to the Convention) cover a broad spectrum of aviation safety issues. For example, annex 1 concerns personnel licensing, and annex 8, 'Airworthiness of aircraft', is specifically concerned with mechanical safety. Yet, compared to the precise, binding laws in annexes 1 and 8, regulations for public health protection in aviation are permissive rather than mandatory.

Annexes which might have public health implications are annex 6 ('Operation of aircraft'), annex 9 ('Facilitation'), annex 11 ('Air traffic services') and annex 14 ('Aerodromes'). The first edition of annex 9 ('Facilitation'), published in 1953, includes chapter 8 ('Sanitation, medical services and agricultural quarantine') and says that contracted states should comply with the provisions of the International Sanitary Regulations (WHO Regulations No 2), accept WHO International Certificates of Vaccination and Revaccination, and should accept public health information in the form provided in the General Declaration. However, this is a recommendation, not a standard. ICAO has been transferring common safety elements from these annexes to a new annex 19 for 'Safety management'. The SARPs in annex 19 'shall be

29 WHO, 'Report of the Review Committee on the Functioning of the International Health Regulations (2005) during the COVID-19 response' (WHO 30 April 2021) 7.

30 Convention for the Unification of Certain Rules Relating to International Transport by Air 1929.

31 Convention on International Civil Aviation 1944.

32 Convention on the Unification of Certain Rules for International Carriage by Air 1999.

applicable to safety management functions related to, or in direct support of, the safe operation of aircraft'.[33]

The SARS outbreak of 2003 led to increased cooperation between IATA, ICAO and WHO.[34] This collaboration later included ACI and has been vitally important during major incidents. But there is far less clarity on the best response to a range of less visible public health risks on international flights, or identifying which authority has ultimate responsibility for coordinating this response. While WHO is the coordinating body for responses to Public Health Emergencies of International Concern (PHEICs), with its mandate based on the IHR (2005), its remit is the protection of *global* public health. The commercial aviation industry, through ICAO and other member bodies, has instead focused on *passenger* safety. WHO has only limited oversight regarding air transportation and already faces major challenges relating to the effectiveness of the IHR because of the need to support weak health systems in low-income countries. Thus, although WHO coordinates with aviation and state regulators, a greater rule-making role in civil aviation would almost certainly be beyond WHO's capacity, mandate or acceptability to stakeholders.

## PUBLIC HEALTH RISKS IN AVIATION

As aviation technology developed throughout the twentieth century, the focus was on achieving mechanical safety. Since the early days of commercial flights, accidents have become rare events – testament to the success of these measures. Recent years have witnessed huge changes in commercial aviation, with rapidly increasing passenger numbers, longer flights and extended flight networks to previously isolated regions. The current aviation industry, with a multitude of short-haul low-cost airlines, and at the other extreme, ultra-long-haul flights (lasting 16 hours or longer),[35] would be unrecognisable to the early aviation pioneers, or even to the delegates at the Chicago Convention in 1944. Prior to the COVID-19 outbreak, the commercial aviation industry was projected to expand rapidly in the coming decades, with the fastest growth in Asia and developing countries. Annual international passenger numbers stood at 1.467 billion in 1998, had grown to 3.979 billion by 2017 and with an annual growth rate of

33 ICAO, Annex 19 to the Convention on International Civil Aviation, Safety Management, 2nd edn, July 2016, ch 2 'Applicability'.

34 Cuinn and Switzer (n 1 above).

35 Ultra-long range operations (ULRs) are 'flight operations involving any sector between a specific city pair in which the planned flight time exceeds 16 hours, taking into account mean wind conditions and seasonal changes' (ICAO 2012).

3.5 per cent were forecast to reach 8.2 billion by 2037.[36] More fuel-efficient aircraft, low oil prices and customer demand made ultra-long-haul flights more common.[37] Whether this growth trajectory recovers post-COVID-19, or alternatively, the industry suffers long-term loss of public confidence, the need for robust, evidence-based, yet adaptable regulatory mechanisms is greater than ever.

The constant transport of large numbers of people across the globe brings public health risks for passengers, aircrew and the populations in destination countries. Prevention and response to public health threats require different, sometimes highly complex measures. For many of these threats there are inadequate data (partly due to a lack of monitoring) and no scientific consensus. While an impressive global conformity was achieved in technical safety standards, the same cannot be said for public health protection. Although the governance bodies described above have frequently collaborated with each other to develop guidelines, including sections of the IHR (2005), these carry less weight than the SARPS and are unenforceable. With the notable exception of environmental regulations, to date, neither ICAO nor EASA has introduced any binding international law for public health protection. Many individual countries have introduced relevant national legislation but, since these are not internationally harmonised and are sometimes based on differing scientific evidence, they may result in conflict of laws.

Aircrew are trained to be first responders and all commercial flights should carry a supply of emergency medical kit. Medically trained passengers are often asked to help out and there is also increasing reliance on medical advisors on the ground. However, there is no universally agreed kit and legal requirements vary across countries. In 2016 the FAA granted exemptions to 50 airlines from carrying a range of emergency medications.[38] Furthermore, a comparative study of American, European, Indian, Indonesian, Emirati and Canadian civil aviation regulations for carriage of first-aid and emergency medical kits found a lack of transparency, variation in criteria and exemptions.[39]

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36 IATA Press Release No 62, 'IATA forecast predicts 8.2 billion air travelers in 2037' (24 October 2018).

37 Graphic Detail, 'The rise of the ultra-long-haul flight' (*The Economist* 27 March 2018).

38 Federal Aviation Administration Exemption Number: 10690E 29 January 2016.

39 Wilfredo Rodriguez-Jimenez, 'First aid kit and emergency medical kit onboard commercial aircraft: a comparative study of American, European, Indian, Indonesian, Emirati and Canadian Civil Aviation Regulations' (MPH, University of Texas Medical Branch 2017).

## Vulnerable passengers

Passenger demographics have changed, with increased travel by the elderly, disabled and those with chronic illnesses.[40] Silverman and Gendreau[41] noted how passengers differ in vulnerability, and the pool of highly susceptible individuals is likely to increase. The UK Government reported that requests for special assistance at UK airports 'are increasing at a rate of around double that of general growth in passenger numbers'.[42] While not a direct public health threat in itself, this may create a greater potential for inflight incidents related to a susceptible condition. It may also mean an increase in workload for cabin crew. With any illness or medical condition, the risk of an inflight medical emergency increases, which in turn can impact flight safety (eg by diverting to alternate airports). The majority of inflight emergencies were due to exacerbation of pre-existing medical problems (65 per cent)[43] and ultra-long-haul flights put particular stress on such passengers. Syncope (temporary loss of consciousness) is the most common inflight medical emergency, accounting for 91 per cent of new inflight emergencies, and is considered likely related to a prolonged period of sitting.[44] The rarity of syncope during long-distance bus or rail travel suggests that air cabin pressure or air quality might be contributory factors.[45] A greater distance travelled is a significant contributing risk factor for pulmonary embolism associated with air travel[46] and Lapostelle considers that the incidence of pulmonary embolism and deep venous thrombosis after long-distance air travel is likely underestimated.[47]

## The airport and cabin environment

Airports are an integral aspect of public health protection. Health inspection and sanitation at many airports is the responsibility of local

40 House of Lords Science and Technology Committee on Air Travel and Health, An Update: 1st Report (Session 2007–08) HL Paper 7, 47

41 Danielle Silverman and Mark Gendreau, 'Medical issues associated with commercial flights' (2009) 373 (9680) The Lancet 2067.

42 HM Government, 'Aviation 2050. The future of UK aviation. A consultation' (HM Government Cm 9714 December 2018) 111, para 5.7, citing Civil Aviation Authority, *Airport Accessibility Report 2017/18* (2018).

43 A Qureshi and K M Porter, 'Emergencies in the air' (2005) 22(9) Emergency Medicine Journal 658.

44 Ibid.

45 J A Low and D K Chan, 'Air travel in older people' (2002) 31(1) Age and Ageing 17.

46 Frédéric Lapostolle et al, 'Severe Pulmonary embolism associated with air travel' (2001) 345(11) New England Journal of Medicine 779.

47 Ibid.

public health authorities rather than airport operators.[48] This will inevitably result in very variable local conditions, likely to be poorer in low-resource countries.

The cabin environment itself may represent a public health hazard. The modes of transmission of infectious diseases on board aircraft may be almost identical to those of other indoor environments or enclosed spaces but the aircraft cabin environment facilitates methods of disease transmission. The confined aircraft space, with many common surfaces and limited airflow, provides a favourable environment for infectious disease transmission[49] and airlines are free to set their own rate of air recirculation.[50]

Thornley et al highlight the potential of disease transmission for cabin crew through their work in the cabin, where transmission can recur from the same source over multiple flight sectors: 'infected flight attendants, whether symptomatic or asymptomatic, may have been an ongoing source of contamination of the airplane cabin or of person-to-person transmission to colleagues during their flight sectors'.[51] While other public transportation conveyances will have similar sources, aircraft environments are different given the high surface-to-volume ratios and the relatively small volume-to-passenger ratios.[52]

The limited galley space affects hand-washing practices[53, 54] and the nature of the galley design (compromised space) is affecting safe food-handling practices.[55] Confined spaces inhibit the circulation of workers, which may impair adherence to hygiene standards during food-handling processes and increase the risk of food safety lapses.[56]

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48 ACI (n 14 above) ch 8, 'Emergency medical services, hygiene and sanitation at airports' 146–148.

49 Hossam Elmaghraby et al, 'Ventilation strategies and air quality management in passenger aircraft cabins: a review of experimental approaches and numerical simulations' (2018) 24(2) Science and Technology for the Built Environment 160.

50 Carol Boyd, *Human Resource Management and Occupational Health and Safety* (Routledge 2004).

51 Craig Thornley et al, 'Recurring norovirus transmission on an airplane' (2011) 53(6) Clinical Infectious Diseases 515.

52 National Research Council, *The Airliner Cabin Environment and the Health of Passengers and Crew* (National Academies Press 2002).

53 Aimee Pragle et al, 'Food workers' perspectives on handwashing behaviors and barriers in the restaurant environment' (2007) 69(10) Journal of Environmental Health 27.

54 Deborah A Clayton and Christopher J Griffith, 'Efficacy of an extended theory of planned behaviour model for predicting caterers' hand hygiene practices' (2008) 18(2) International Journal of Environmental Health Research 83.

55 Ibid.

56 Ilija Djekic et al, 'Food hygiene practices in different food establishments' (2014) 39 Food Control 34.

There is no international, coordinated monitoring body for inflight/onboard hygiene measures. Most airlines set their own cleaning standards although there are minimal regulations through agencies such as the FAA and Occupational Safety and Health Administration (OSHA) in the US.[57] Boyd notes how

> survey findings suggest that airlines have overlooked a number of key areas that are vital to good health and safety practice, and that cabin crew are denied basic rights such as good hygiene, rest breaks and good air quality. Over half of respondents rated hygiene standards on the aircraft as 'poor', and many of their comments blamed short turnaround times, which prevent thorough cleaning of the aircraft.[58]

Food contamination hazards are associated with both food preparation processes on-ground and cabin crew serving meals on aircraft. Foodborne illness issues arise owing to the complexity and confined space, as well as limited sanitary facilities on aircraft.[59]

There are few clear standards for the cleanliness of commercial aircraft cabins. Airlines generally establish their own set of standards, which cleaning companies then follow. Vlagenov detected particularly high viral and bacterial counts on sink faucet handles, worktops or washroom door handles and argued that to minimise the risks for pathogen transmission, cleaning protocols need to be improved and follow strict rules.[60]

With input from industry experts, WHO has produced a *Guide to Hygiene and Sanitation in Aviation* which 'addresses water, food, waste disposal, cleaning and disinfection of facilities, vector control and cargo safety'.[61] This also makes reference to the need for harmonisation with the IHR which requires public health measures at airports and

> the use of scientific principles to prevent, detect, reduce or eliminate the sources of infection and contamination, to improve sanitation in and around international ports, airports and ground crossings, to prevent the international dissemination of vectors and to mandate national and international actions to prevent the international spread of disease.[62]

While these guidelines are helpful, and include sensible recommendations for routine cleaning programmes, training,

57 Scott McCartney, 'The trouble with keeping commercial flights clean' (*Wall Street Journal* 17 September 2014).

58 Boyd (n 50 above).

59 Maija Hatakka, 'Hygienic quality of foods served on aircraft' (Dissertation, University of Helsinki 2000).

60 Kiril Vaglenov, 'Survival and transmission of selected pathogens on airplane cabin surfaces and selection of phages specific for *Campylobacter Jejuni*' (PhD thesis, Auburn University 2014).

61 WHO, *Guide to Hygiene and Sanitation in Aviation* 3rd edn (WHO 2009) 2.

62 Ibid 5–6.

disinfection after an event and the use of protective equipment, they are advisory only. There are no regulations for either the number or size of toilets or washing facilities such as wash basins on an aircraft. Cabin design is not down to aircraft type, but to airline demands and choice. For example, a Boeing 737 is typically configured with three lavatories, but it can also be configured with two or four.[63, 64] Adequate disinfection may be challenging or impossible given the confined space and limited time available. Monitoring of cabin hygiene is not standard practice on many flights. Since the outbreak of COVID-19 many airlines have hastened to announce new and enhanced cabin-cleaning systems[65] and increased passenger seating space. However, this is not an option for budget airlines which follow a business model requiring a high passenger 'load number'. The director general of IATA has argued that social distancing on airlines would mean an end to cheap air travel.[66] There is scepticism that improved hygiene and distancing measures will be adopted long term.[67]

The confined space on an aircraft may also represent a hazard for vulnerable passengers. The average body size of passengers is increasing[68] at the same time that aircraft design has been under pressure to fit in as many passengers as possible to maximise income. Concerns have been raised that this confinement increases the risk for passengers of a deep vein thrombosis (DVT). The WHO WRIGHT project[69] concluded that the risk of developing a venous thromboembolism (which can manifest as a DVT or a pulmonary embolism) doubles after travel lasting four hours or more. Although low, the risk is greater in passengers with predisposing factors such as overweight, use of oral contraceptives, age over 40 years or chronic disease. Vulnerable passengers are estimated to face a two to fourfold risk of DVT on flights of eight hours or longer.[70]

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63 Collins Aerospace. '737 advanced lavatory'.

64 Dan Reed, 'American airlines' tiny new bathrooms test limits of what US Passengers will put up with' (*Forbes* 30 May 2018).

65 Laura Begley Bloom, 'COVID report: the best and worst airlines during coronavirus' (*Forbes* 27 July 2020).

66 Julia Kollewe, 'Physical distancing will end era of cheap air travel, industry warns' *The Guardian* (London, 21 April 2020).

67 Will Horton, 'New airline seat designs? They won't ever fly on airplanes' (*Forbes* 25 April 2020)

68 Johan Molenbroek, Thomas J Albin and Peter Vink, 'Thirty years of anthropometric changes relevant to the width and depth of transportation seating spaces, present and future' (2017) 65 Applied Ergonomics 130.

69 WHO, *WHO Research into Global Hazards of Travel (WRIGHT) Project: Final Report of Phase 1* (WHO 2007).

70 Roger W Byard, 'Deep venous thrombosis, pulmonary embolism and long-distance flights' (2019) 15(1) Forensic Science, Medicine and Pathology 122.

The risk of DVT is not aviation specific and is almost entirely due to the period of immobility. Those at increased risk are those who have risk factors that apply generally, regardless of the environment. However, no other means of transport are comparable to aircraft with regards to travel time (now up to 18/19 hours), confined seats and restricted movement (particularly those seated in middle rows). It may be a weak risk factor in shorter flights but the risk is likely to increase in long-haul flights.

There are no international regulations concerning the distance between seats (referred to as 'seat pitch') provided to passengers on commercial aircraft, and there may be considerable differences between airlines. Seat pitch has been decreasing since deregulation of the airline industry in the 1970s from around 89 cm to 71–79 cm, depending on the airline and fare class purchased.[71, 72]

There are concerns that insufficient seat pitch will make it difficult for passengers to assume an adequate brace position or evacuate the plane quickly in an emergency.[73] Part of the regulations for certification of any aircraft type/configuration is a requirement for formal testing of the time taken for evacuation of the aircraft and FAA regulations require that commercial aircraft must be evacuated within 90 seconds or less.[74] However, there is criticism that these tests fail to include all members of the population, such as the elderly. Lijmbach et al found that the elderly take significantly more time than younger people during an evacuation.[75] Airlines argue that reductions in seat pitch are necessary to compete with low-cost carriers[76] and Mendoza acknowledged the trade-offs between health risks, price, and airline seat size regulation.[77]

## Food contamination

Reports of food contamination are relatively rare, but present a uniquely hazardous event in flight, with potential to incapacitate aircrew as well

71 Scott R Winter, 'Government seat pitch regulation of commercial airlines: a multi-study of consumer perceptions' (2019) 37(2) Collegiate Aviation Review International.

72 Elaine Glusac, 'FAA declines to regulate airplane seat size' *New York Times* (6 July 2018).

73 Claire Quigley et al, 'Anthropometric study to update minimum aircraft seating standards' (Joint Aviation Authorities 2001).

74 Winter (n 71 above).

75 Willem Lijmbach, Peter Miehlke and Peter Vink, 'Aircraft seat in- and egress differences between elderly and young adults' (2014) 58 Proceedings of the Human Factors and Ergonomics Society Annual Meeting.

76 McCartney (n 57 above).

77 Roger Lee Mendoza, 'Health risk, price efficiency, and airline seat size regulation' (2018) 11(2) International Journal of Healthcare Management 122.

as passengers. Most inflight meals are prepared on the ground and then reheated on board. On-ground food hygiene rules are generally strict, governed by national public health laws and in alignment with food preparation regulations in public eating establishments such as restaurants and cafés. Airlines may need to comply with food hygiene regulations from the country where the food is supplied, the country of the airline affiliation, and possibly also public health regulations in the destination country.[78] Apart from the complexity of ensuring compliance, these rules may conflict. Also, while flight catering kitchens are in fact more stringently hygiene-controlled than other on-ground food establishments, facilities to ensure hygiene in food service are limited. The problematic time span is the point where food leaves the catering truck until the aircraft reaches its destination (termed by Sheward as the 'missing link')[79] with little oversight such as audits or compliance controls. Also, airlines rely on local catering companies, with different country standards of food safety.[80] Airline galleys are typically extremely small, and as stated above there are no rules for the size, number or accessibility of hand-washing facilities, such as wash basins.

Cabin crew are classed as professional food handlers,[81] yet research has identified poor aircrew training in food handling[82] and there is little transparency of training programmes for individual airlines.[83] Crew may be interrupted in food preparation by other service demands, for example, if a passenger is unwell and requires attention, yet cabin crew are typically not considered as a vehicle for disease transmission.[84] Food may be left standing or require reheating and maintaining a cold chain may be challenging on ultra-long-haul flights. All of these factors may compromise food hygiene and result in food contamination. There are recorded inflight incidents of food poisoning from agents including salmonella, *Staphylococcus aureus* and *E coli*.[85] However, evidence is limited due to passengers frequently not becoming symptomatic until after arrival in the destination country. Uneaten food is thrown

78 Lauren Solar, 'Food safety takes off: regulations, logistics and the challenges of airline catering' *Global Food Safety Resource*.

79 Erica Sheward, *Aviation Food Safety* (Blackwell 2006).

80 Solar (n 78 above).

81 Ayman Abdelhakim, 'Cabin crew food safety training: an exploratory study' (PhD thesis, Cardiff Metropolitan University 2016).

82 Ayman Abdelhakim et al, 'Cabin crew food safety training: a qualitative study' (2019) 96 Food Control 151.

83 Sheward (n 79 above).

84 Alexandra Mangili and Mark A Gendreau, 'Transmission of infectious diseases during commercial air travel' (2005) 365(9463) The Lancet 989.

85 R McMullan et al, 'Food-poisoning and commercial air travel' (2007) 5(5) Travel Medicine and Infectious Disease 276.

away at the end of a flight and is unlikely to be available for analysis. While there is considerable quality control for on-ground catering kitchens, there is no comparable monitoring of food hygiene inflight. For these reasons, quantifying the incidence of inflight food poisoning is difficult. Furthermore, proving liability is likely to be challenging, except when there has been a mass event where numerous passengers become ill. In economy class the meals are likely to be pre-packaged and pre-prepared (and therefore with less risk of contamination), but this may not be the case in first or business class.

Abdelhakim made an in-depth investigation into cabin crew food safety training and found 'numerous complaints related to food safety and in-flight service ... However, most of these complaints are not available due to the airlines' operations policy.'[86] Long departure delays, length of flight time, and appropriate storage of food at safe temperature zones are all important factors to achieve a true picture of the microbiological quality of food throughout the flight.[87] Incidents of foodborne illnesses among airline passengers are typically investigated in the countries where they occur and by an airline's own quality management team. Health authorities across national borders may neither publish nor monitor foodborne illness rates among passengers.

In the EU, food hygiene is regulated by EC Regulation No 852/2004 although this does not contain any specific reference to aviation. In the UK the Civil Aviation Authority provides a good practice guide.[88] UK-registered aircraft are also required to have a nominated environmental health officer and airlines must also have created a food safety management system.

Outside Europe, national public health regulations will usually be applicable, but there are no harmonised international laws for food safety. The IFSA, in collaboration with WHO, has produced 'World Food Safety Guidelines for Airline Catering', which are based on the Hazard Analysis and Critical Control Point (HACCP) system. HACCP is a science-based system for identifying and responding to specific hazards in food safety. IFSA also plays a role in the audit of flight kitchens (in addition to local authority/national government requirements) on behalf of airlines, to ensure that standards are applied and breaches investigated.

IATA's 'Cabin Operations Safety Best Practices Guide' also provides guidelines on food safety. Both guidelines contain sensible recommendations, but, without robust monitoring, it is difficult to

86 Abdelhakim (n 81 above).

87 McMullan (n 85 above).

88 Civil Aviation Authority, *CAP 757 Occupational Health and Safety On-board Aircraft* (CAA 2012).

ascertain incidence of food contamination, compliance with guidelines or how effective the guidelines have been in reducing risk.

## Air quality in the cabin

During the course of a flight the cabin air supply is recycled and filtered regularly using a high efficiency particle air (HEPA) filter, making a complete air change 20 to 30 times per hour. The highest efficiency filters available are comparable to those in hospital operating theatres, catching more than 99 per cent of airborne microbes.[89] However, while airlines generally maintain industry standards and comply with inflight safety regulations, it is not mandated and air quality and circulation rates are susceptible to cost-saving measures in terms of (1) reducing the fresh air provision rate and (2) failing to properly maintain the air-conditioning system.[90]

A currently highly contentious topic is allegations of aircrew becoming ill due to poor air quality in the cabin. These relate to what are known as 'fume incidents', namely, any event in which there is an unusual odour, fume or vapour (other than fire). There are many potential causes and a small proportion may be due to bleed air contamination, that is, the leak of engine oil or hydraulic fluid into the cabin air supply as a result of overfilling or oil seal failure. These fluids contain organophosphates which may become toxic to humans in sufficient quantities. Incidence has been estimated at 0.02 per cent[91] to 0.05 per cent[92] of flights although the seriousness may range from a strong smell to thick smoke.[93] The frequency of these events and causal link with ill effects on passengers and aircrew is strongly disputed.

There have been reports of pilot incapacitation[94] and allegations of ill health resulting in aircrew taking early retirement. In 2010, a flight attendant was successful in the Australian High Court in her claim for

89 IATA, *Briefing Paper: Cabin Air Quality – Risk Of Communicable Diseases Transmission* (IATA Corporate Communications January 2018).

90 Boyd (n 50 above).

91 Maher Shehadi, Byron Jones and Mohammad Hosni, 'Characterization of the frequency and nature of bleed air contamination events in commercial aircraft' (2016) 26(3) Indoor Air 478.

92 Committee on Toxicity of Chemicals in Food Consumer Products and the Environment, 'Statement on the review of the cabin air environment, ill health in air crews and the possible relationship to smoke/fume events in aircraft' (2007).

93 Virginia Harrison and Sarah J Mackenzie Ross, 'An emerging concern: toxic fumes in airplane cabins' (2016) 74 Cortex 297.

94 Sally Evans and Sally-Ann Radcliffe, 'The annual incapacitation rate of commercial pilots' (2012) 83(1) Aviation, Space, and Environmental Medicine 42.

compensation for injury suffered because of contaminated air.[95] Yet, despite many legal claims on behalf of aircrew, proving a causal link is often difficult. Research by EASA in 2017 found that 'cabin/cockpit air quality is similar or better than what is observed in normal indoor environments' and that there was no evidence of a causal link between contaminants and reported ill health.[96] However, Michaelis found that 'a clear cause and effect relationship has been identified linking the symptoms, diagnoses and findings to the occupational environment. Recognition of this new occupational disorder and a clear medical investigation protocol are urgently needed.'[97] The condition was named 'aerotoxic syndrome'. In March 2019 the BBC reported that 51 cases were brought by pilots and cabin crew for ill health arising from exposure to frequent 'fume events'.[98] Defossez argues that if causation can be proven this would 'open the floodgates for litigation' from aircrew[99] who may be repeatedly exposed to contaminated air over their career in the air industry. Passengers would be in an easier position as they could bring a compensation claim for bodily injury from a single incident under article 17 of the Montreal Convention. The aviation industry disputes that air quality is even a public health risk in aviation and 'aerotoxic syndrome' is not recognised in medicine.

The controversy remains ongoing. There is no constant monitoring of cabin air quality so it is difficult to get an accurate estimate of incidence in exposure to contaminants. If the lower statistic of 0.02 per cent incidence is taken, this would mean an incident approximately every 2000 flights, but most studies have used much smaller sample sizes.[100] As reports and legal claims mount there is likely to be increasing pressure for conclusive scientific evidence. If causation can be proven, there will clearly need to be urgent technical innovation to limit this health risk, supported by enforceable regulation. EASA is currently funding further research,[101] and it is to be hoped that the issue can be finally resolved soon.

95 *East West Airlines Ltd v Turner* [2010] HCATrans 238.

96 EASA, 'EASA publishes two studies on cabin air quality' (EASA 23 March 2017).

97 Susan Michaelis et al, 'Aerotoxic syndrome: a new occupational disease?' (2017) 3(02) Public Health Panorama 198.

98 'Airlines face lawsuits over "toxic" cabin air' (*BBC News* 28 March 2019).

99 Delphine Defossez, 'Contaminated air: is the "but for" test saving air carriers?' (2019) 44(2) Air and Space Law 185.

100 Ibid.

101 EASA Tender: EASA.2020.HVP.17: Cabin Air Quality Assessment of Long-Term Effects of Contaminants.

## Carriage of disease vectors

Several highly virulent vector-borne diseases have been spread by the carriage of insect vectors on international commercial flights including malaria,[102] West Nile virus[103] and Zika.[104] WHO reported that 'insect vectors may transmit infection to people in places served by aircraft (eg "airport malaria")'. West Nile virus first appeared in the US as a group of cases of patients who lived next to La Guardia airport in New York.[105] The spread of Zika virus to Brazil was attributed to flights from French Polynesia to Brazil during 2013–2014.[106] The problem is being exacerbated by the warmer weather brought by climate change. A major concern is that a new vector may be introduced in an area where it does not currently exist but where the environmental conditions are suitable for the establishment of a breeding population. If aircraft and airports can be kept free of vectors, then the risk of local disease transmission is mitigated.

Annex 5 of the IHR sets specific requirements for vector control:

> 2. Every conveyance leaving a point of entry situated in an area where vector control is recommended should be disinsected and kept free from vectors.

The primary defence against vectors such as mosquitoes is 'disinsection', the use of insecticide sprays inside the aircraft cabin. WHO has produced a list of approved insecticides and guidelines for disinsection procedures,[107] although the use of such insecticides is left to national policy.[108] ICAO similarly leaves the use of insecticides to the discretion of member states, stating only that they should follow WHO recommendations as to the method and procedure to be followed.[109] Disinsection is controversial due to alleged inefficacy and

102 WHO, 'Aircraft disinsection methods and procedures' 25 February 2021.

103 Eleanor B E Brown et al, 'Assessing the risks of West Nile virus-infected mosquitoes from transatlantic aircraft: implications for disease emergence in the United Kingdom' (2012) 12(4) Vector-Borne and Zoonotic Diseases 310.

104 Norman G Gratz, Robert Steffen and William Cocksedge, 'Why aircraft disinsection?' (2000) 78 Bulletin of the World Health Organization 995.

105 Doug Struck, 'Climate change drives disease to new territory' *Washington Post* (5 May 2006).

106 Eduardo Massad et al, 'On the origin and timing of Zika virus introduction in Brazil' (2017) 145(11) Epidemiology and Infection 2303.

107 WHO (n 102 above).

108 Ibid.

109 ICAO, *International Standards and Recommended Practices* 15th edn (October 2017) annex 9 'Facilitation', ch 2, D 2.25.

also potential adverse impacts on aircrew due to constant exposure.[110] Alternative, non-chemical measures have been proposed, such as the use of air curtains, but their effectiveness is still unproven and there is currently no scientific consensus on optimal measures. There is also questionable vector control around airports which is critical to supplement disinsection. Vector control around airports should be implemented both in the airport in the country of departure and in the destination airport where the environmental conditions are sufficiently favourable to enable the establishment of a new population of the vector. Yet vector control at airports is governed (if at all) by local or national regulation. Any measures would need resources and the active cooperation of the departure country, many of which are in low-income settings.

The lack of harmonisation or international consensus has led to some direct conflict of laws. For example, national laws in Australia and New Zealand mandate the use of pyrethroid insecticide on incoming aircraft, while the same insecticide is banned for use in public health in the US,[111] at least partly due to concerns about adverse impacts on the health of aircrew.[112] To our knowledge there has not been any litigation for transmission of insect vectors from an endemic to a non-endemic country, and evidentially this would be difficult to prove against a specific airline, notwithstanding the transmission routes proven by modelling.

## Outside environment

Although the present article focuses on public health threats arising within the aircraft cabin, aircraft fuel emissions, noise and waste management are also a public health concern and have been acknowledged as a contributor to climate change.[113] Regulatory bodies have been proactive about this issue. ICAO's annex 16 sets environmental standards to regulate aircraft noise and engine emissions. It established the Committee on Aviation Environmental Protection (CAEP) in 1983 and this now has 'more than 600

110 Binnian Wei, Krishnan R Mohan and Clifford P Weisel, 'Exposure of flight attendants to pyrethroid insecticides on commercial flights: urinary metabolite levels and implications' (2012) 215(4) International Journal of Hygiene and Environmental Health 465.

111 Andrea Grout et al, 'Guidelines, law, and governance: disconnects in the global control of airline-associated infectious diseases' (2017) 17(4) The Lancet Infectious Diseases 118.

112 United States, 'Agenda Item 6: International Health Regulations (IHRs). Non-Pesticidal Disinsection of Aircraft', *ICAO, Facilitation (FAL) Division – Twelfth Session* (Cairo 2004).

113 David S Lee et al, 'Aviation and global climate change in the 21st century' (2009) 43 (22–23) Atmospheric Environment 3520.

internationally recognised experts, in areas such as noise, air quality, climate change but also aircraft end-of-life and recycling and climate change adaptation'.[114] ICAO also developed the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) which has a self-imposed target to cut net emissions from aviation fuel by half by 2050 (from its 2005 baseline). The EU has created numerous environmental regulations, including the Environmental Noise Directive,[115] which monitors aircraft noise. Working with ICAO, the EU requires all member states to submit action plans to reduce carbon emissions.[116] IATA has also created a Sustainability and Environment Advisory Council (SEAC),[117] an Environmental Policy[118] and has established programmes to work with airlines to improve their environmental impact.[119]

Although the results are still to be seen, these initiatives represent a responsible and positive response from the aviation industry to international concerns. It would be hugely beneficial if it could take a similar approach to public health threats within the cabin environment itself.

## Carriage of infected passengers

While each of the public health risks discussed above merit attention, they are dwarfed by the threat to global health of commercial flights bringing infected persons, whether passengers or aircrew, to non-endemic countries, potentially creating or exacerbating a disease outbreak at local or international level. The threat was realised in February 2003 when the SARS virus was brought by an infected passenger on a flight from Hong Kong to Toronto, Canada, infecting hundreds of individuals, including hospital patients and healthcare workers in that city. The outbreak continued in Canada until June 2003 by which time it had resulted in 438 probable or suspect cases and 43 deaths.[120]

The COVID-19 pandemic has demonstrated the size of the challenge as never before. For Cassar, the growth in aviation traffic made it almost inevitable:

114 ICAO Environment, Environmental Report WHO Aircraft Disinsection.

115 Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise.

116 EASA, EEA and EUROCONTROL, 'European Aviation Environmental Report' (2016) 24.

117 IATA Sustainability and Environment Advisory Council.

118 IATA Aviation and Environment Policy.

119 IATA, 'Our actions for the environment'.

120 Bjug Borgundvaag et al, 'SARS outbreak in the Greater Toronto area: the emergency department experience' (2004) 171 Canadian Medical Association Journal.

> Considering the unprecedented volume of travel, specifically by air, and the unprecedented scale of globalization, it comes as no surprise that COVID-19, which has the innate ability of being transmitted easily from one person to another, infected such a large number of people in so many different locations in relatively no time at all.[121]

There are no easy control measures. Passenger screening is of doubtful efficacy, raises difficult ethical questions and is costly in time and resources. Self-reporting is unreliable and passengers may be asymptomatic in the early stages of disease, particularly for diseases with long incubation periods, so are unaware of their infection. It is also difficult for ground crew to spot disease cases and to enforce measures such as denial of boarding. There can be problems if a passenger becomes ill mid-flight due to a lack of space for isolation or quarantine.

Inaccurate pre-departure screening readings, such as temperature, PCR and LFTs, come with substantial consequences at the personal, health system, and societal levels. These include potential virus transmission from an undetected positive case, unjustified cancellation of travel in the case of a false positive result, or even misdirection of policies regarding quarantine and lockdowns.[122] Exit screening may be useful in some instances and was used during the Ebola outbreak of 2014, but will not catch all cases as demonstrated by incidents of aid workers who travelled on commercial flights home to the US and UK and were not diagnosed until after travelling on to their homes. This led to widespread concern, and political questioning of the wisdom of sending aid workers to assist in humanitarian disasters (or at least allowing them to return to their home countries).[123, 124] During the COVID-19 pandemic, passengers on flights from affected areas have been required to enter into 14-day quarantine on arrival and such measures may be of value where there is a known risk, although it remains to be seen what impact this has had on the spread of the virus. It is also still unclear how COVID-19-related quarantine

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121 Cassar R, 'Evolution or devolution: aviation law and practice after COVID-19' (2020) 45 (Special Issue) Air and Space Law.

122 E Surkova, V Nikolayevskyy and F Drobniewski, 'False-positive COVID-19 results: hidden problems and costs' (2020) 8(12) The Lancet Respiratory Medicine 1167–1168.

123 Stephanie Gee and Morten Skovdal, 'Public discourses of Ebola contagion and courtesy stigma: the real risk to international health workers returning home from the West Africa Ebola outbreak?' (2018) 28(9) Qualitative Health Research 1499.

124 Jenn Selby, 'Donald Trump says Ebola doctors "must suffer the consequences"' *The Independent* (London, 4 August 2014).

and isolation in aviation have collectively affected health equity and human rights.[125]

Airlines and national authorities have the right to refuse passage to persons carrying infectious disease,[126] although in many countries there are also protections against discrimination. For example, in the US it is illegal to refuse to carry a passenger just because they have AIDS.[127] (Although not a public health risk in the context of aviation, HIV/AIDS is still an infectious disease and 'infectious and contagious diseases' are listed under the medical contraindications to flying.) However, unlike AIDS, the greatest public health risks are likely to be from highly contagious diseases spread by droplet or airborne transmission, such as measles and influenza.

IATA guidance recommends that a person onboard who has a suspected communicable disease should be isolated if possible and, if suffering from vomiting and/or diarrhoea, seated near a toilet which should be restricted for use by the ill person(s). However, there may not be adequate space to isolate an ill passenger, especially in the context of higher overall passenger numbers and higher occupancy on each flight. As discussed, sanitary facilities are often limited and will depend on the class and aircraft type, but economy class washrooms are likely to be especially cramped. A passenger who has vomited, perhaps in their seat or in the toilet, may create a public health hazard which cannot be adequately cleaned for several hours, whether because the flight is part-way through a long-haul journey, or because of the pressure for a rapid change over on short flights. Spilt body fluids (blood, vomit etc) must be cleaned up during a turn-round and, if an area cannot be adequately cleaned, for example if fluid has soaked into the fabric of a seat, the area – usually the seat row – should be isolated until such time as this can be adequately dealt with. Many long-haul aircraft will have 'spill kits' for precisely this purpose but the carriage of spill kits is not mandatory and the use of these or any other cleaning practices is neither monitored nor subject to enforceable international regulations.

Pilots are required by annex 9 of the IHR to file a General Declaration at the end of a flight giving notification of any person who has been ill on board and may be suffering from a communicable disease. This will be of limited value if the person has been asymptomatic on board or if the pilot is not fully informed of the person's condition (and therefore

125 WHO 2021, Annexes to Weekly Epidemiological Record (WER). Evidence Review. Public health measures in the aviation sector in the context of COVID 19: Quarantine and Isolation (21 May 2021).

126 Jürgen Graf, Uwe Stüben and Stefan Pump, 'In-flight medical emergencies' [2012] Deutsches Aerzteblatt Online.

127 Federal Aviation Administration, 14CFR Nondiscrimination on the Basis of Disability in Air Travel; Final Rule, 382.21(b)(2).

may not have ensured adequate quarantine or safe transport on arrival for example). A passenger who is infected by a fellow passenger could potentially litigate against an airline (or directly against the fellow passenger), but it could be very challenging evidentially where the ill person is asymptomatic at the point of departure.

As with carriage of vector-borne disease, the lack of scientific consensus over effective control measures undermines and limits any possibility of harmonised regulation.

## LIABILITY

Air carriers should owe a duty of care to passengers, aircrew and to populations in destination countries but sometimes these duties may conflict, and current aviation governance is focused on passenger safety. Since the Warsaw Convention of 1929, airlines have owed a legal duty to passengers who have suffered loss, injury or death during an international flight. This is strict but limited liability. This means that, unless there is evidence of contributory negligence, the passenger does not need to prove fault on the part of the airline and therefore takes away the burden of evidential proof. However, damages are limited to 113,100 SDRs (Special Drawing Rights: a currency rate established by the International Monetary Fund).

This legal right was strengthened by article 17 of the Montreal Convention of 1999 which removed the limit on damages, provided an onboard accident causing death or bodily injury can be proven.[128] There has been considerable litigation regarding the meaning of the term 'accident'[129] and it has become defined as 'an unexpected or unusual event or happening that is external to the passenger'.[130] However, airlines can escape liability if they can prove the fault was that of a third party. Along with this duty of care, the Montreal Convention provides that a litigant has a choice of five alternative forums within which to bring a claim.[131]

Aircrew may also bring compensation claims under national legislation for occupational injury suffered during their work. As explained above, compensation has been sought for ill health

128 Montreal Convention 1999, ch III 'Liability of the carrier and extent of compensation for damage'.

129 Ronald I C Bartsch, *International Aviation Law: A Practical Guide* (Routledge 2016) 203.

130 *Air France v Saks* [1985] 470 US 392.

131 Domicile of the carrier; principal place of business of the carrier; country where the contract of carriage was made; destination country; the state of the passenger's principal place of residence (provided the carrier operates, directly or indirectly, to that state).

allegedly sustained through poor cabin air quality and overexposure to insecticides.[132] It might also conceivably be brought for, say, exposure to an infected passenger resulting in crew illness. Aircraft do not carry medical staff as standard practice and aircrew are expected to be 'first responders', perhaps responsible for dealing with a passenger who is vomiting, bleeding or suffers incontinence. Anyone acting in a first-aid role – which is an inherent part of the cabin crew role – is given adequate and appropriate training commensurate with the risk, but there is little insight (if any) into whether or to what extent airline-internal training curricula cover infectious diseases.

Even with the strict, no-fault liability under the Warsaw Convention, for many incidents it will not be possible to show that a passenger or air crew became ill because of a particular journey. Due to long incubation periods, an infectious passenger may be asymptomatic and fellow passengers may not become ill until after arrival and dispersal in the destination country. Although limited damages might be payable under the no-fault terms of the Warsaw Convention, to obtain the more generous compensation under the Montreal Agreement, a passenger would need to prove that this was due to the fault of the airline. Evidential difficulties might arise in trying to prove that a particular illness was contracted due to the condition of the cabin interior, say, due to dirty toilets, food trays or tray tables.[133]

However rare an event, carriage of disease vectors has brought highly dangerous diseases across the world. The risk might be reduced by effective disinsection and improved environmental controls at airports. Yet, despite WHO guidelines, current measures for disinsection are often haphazardly executed and of doubtful efficacy[134] and environmental control of vectors at airports is challenging in many high-risk endemic countries due to limited public health capacity. There is unlikely to be successful legal action against either airlines for allowing vectors on board (due to the virtual impossibility of proving that a particular vector was carried on a particular aircraft) or against national authorities for the same difficult evidential reasons.

## DISCUSSION

While the right to legal recourse for injury is important, the priority should be on prevention and response to public health threats. The aviation industry has the advantage of an ethos and structures for strong international and multi-agency collaboration. This has already

132 'Qantas steward with Parkinson's to sue over pesticide link' *Bangkok Post* (9 December 2013).

133 Vaglenov (n 60 above).

134 Grout et al (n 111 above).

shown itself to be responsive to new environmental threats and a similar approach should now be taken to other public health threats in aviation. 'Harmonisation' should not be confused with 'uniformity' of laws since it allows for national sovereignty in interpretation, but there need to be baseline, enforceable common standards. The benefits of harmonised laws may seem self-evident but are worth repeating. International aviation, by definition, crosses national borders, so public health threats are cross-border health threats affecting several countries. Harmonisation of laws means that the rules to deal with these threats will be the same across all jurisdictions, thereby reducing administrative complexity and avoiding conflict of laws where countries may have conflicting rules, for example on food handling or the use of insecticides. It ensures consistency and allows for greater collaboration between member states and industry stakeholders in the creating of these laws. It should be an opportunity to create high standards which follow the best scientific evidence and respect human rights. The latter aspect is important because some of these regulations will have ethical aspects – for example on isolating passengers, or refusing to carry them on aircraft. Above all, aviation is a global industry like none other for its potential to damage global health, and this demands the highest possible international standards.

So how might a robust, effective and harmonised regulatory regime be created to improve public health protection in aviation? Is it even possible to achieve the same hygiene standards as are enforced on the ground? Commercial pressures and lack of national capacity are likely to be obstacles, but those have been successfully overcome in the past in order to achieve a high level of mechanical safety.

Without scientific consensus it will be very difficult to require countries to introduce new measures and comply with harmonised standards. The greatest threats to public health – carriage of vectors infected with human pathogens or infectious passengers – are also the most challenging to resolve. Nevertheless, COVID-19 may provide the impetus and research investment that is needed. There are also less intractable problems which might be addressed more quickly and easily. Poor hygiene and poor sanitation are clearly public health issues. Onboard cleaning largely depends on airline-internal protocol and most airlines set their own cleaning standards. There is only minimal regulation through agencies such as the FAA and OSHA[135] and no monitoring bodies.

Regulations for toilets and perhaps improved, ergonomic design to make cleaning easier should be possible. The cost of providing adequate space for isolation of an ill passenger might be a difficult

135 McCartney (n 57 above).

barrier, given the low number of incidents but better aircrew training should be possible. Following the example of hospitals, hand sanitisers might be provided throughout the cabin for the use of passengers as well as crew. This is justifiable in light of the unique form of transport, confined space conditions, and the fact that people from all over the world share this space.

There needs to be better identification of the types of food most at risk of contamination, examination of behaviours for food preparation and service, monitoring and enforceable regulations to bring standards into line with those on the ground.

The SARS outbreak led to closer cooperation between WHO, ICAO, IATA and subsequently ACI. SARS was also a catalyst to the 2005 revision of the IHR which incorporated numerous references to aviation. Similarly, ICAO updated its SARPS to recommend greater preparedness at airports and the need for member states to develop national health plans to deal with public health emergencies.[136] It also led directly to ICAO establishing the Collaborative Arrangement for the Prevention and Management of Public Health Events in Civil Aviation (CAPSCA), a collaboration of regulatory bodies to review the spread of communicable diseases which has declared that:

> Coordinating the international aviation response to public health risks, such as pandemics, is a key role for the International Civil Aviation Organization. By means of international, regional, national and local organizations are brought together to combine efforts and develop a coordinated approach.[137]

While encouraging and valuable, these remain matters of guidance only, and are not prescriptive.

Cuinn and Switzer argue that public health emergencies such as SARS and Ebola have led to a more coherent governance framework, pointing to the joint development of a Passenger Locator Form in 2007 and the Traveller Public Health Declaration Form during the Ebola outbreak, both self-reporting forms which are used to improve surveillance and tracing of potentially infected passengers. However, they accept that there remained 'something of a "gap" when it came to governing a crucial component of the aviation sector – the interior of the cabin and infected passengers'.[138] They also found that:

> the aircraft is a site of legal contestation. Tensions were revealed between the intersections of legal systems. These were particularly prevalent when it came to the collection and handling of passenger data and

136 Cuinn and Switzer (n 1 above)

137 CAPSCA Collaborative Arrangement for the Prevention and Management of Public Health Events in Civil Aviation.

138 Cuinn and Switzer (n 1 above).

> were only partly resolved by the bridging work performed between the regimes. This reveals a legal plurality within the constitutive assemblage of global health security; a finding which has significant implications for the development of international responses to infectious disease.[139]

It may be argued that ICAO's remit is primarily passenger safety and that public health is a matter for public health authorities – and at international level this means the WHO. It would certainly need a major realignment of responsibilities for aviation regulators to take the lead on this, going beyond their current role of collaboration with public health authorities on public health risks linked to aviation. Yet the evidence that aviation has facilitated the spread of successive global outbreaks, leading to the global catastrophe that is COVID-19, surely now demands a debate on responsibilities.

An alternative regulatory actor, at least at regional level, might be the EU. EASA's 'European Plan for Aviation Safety (EPAS) 2019–2023' has a goal to 'achieve constant safety improvement within a growing aviation industry'. This policy document includes proposals to address environmental factors such as aircraft emissions and aircraft noise. EASA's research on cabin air quality shows that it is willing to investigate cabin safety issues, even if that particular public health threat remains unresolved. With political will, adequate funding and legislative authority over 27 EU member states and four European Free Trade Area states,[140] EASA has the potential to make a significant impact on public health protection in aviation. Either ICAO or EASA might expand the mandates of their environmental bodies to include the cabin environment.

## CONCLUSION

Due to a scarcity of available data, the present article can only provide an outline of the legal framework for aviation, examples of some key regulations and a snapshot of a few identified public health risks. Until COVID-19, the aviation industry was growing exponentially, with vulnerability increasing in tandem and disease incidents becoming more frequent – SARS, Zika, and now COVID-19. Existing governance structures require a radical rethink and overhaul to ensure they can adequately manage these vulnerabilities.

Above all else, there is a need for a comprehensive and reliable quantification of risks. This would require far more data than are currently collected, including detailed monitoring of the cabin

139 Ibid.

140 Switzerland, Norway, Iceland, Leichtenstein. As a result of Brexit, the UK is no longer a member of EASA.

environment and passenger demographics. There will be cost and feasibility implications but, at minimum, they should include better access to passenger data, including greater access to incident and accident data. Such information would enable more reliable risk analyses, allowing problems to be prioritised and informing approaches to tackling them. A full systematic review of the legal landscape and mapping of responsibilities is also required along with collaboration to agree responsibilities at international level.

For decades the aviation industry has been a model to others for its collaborative approach to regulation, enabling aviation to become one of the safest forms of transport. It now needs to draw on that strength to tackle the enormous challenges ahead of it. The devastating impact of the COVID-19 pandemic calls for a fundamental reassessment of the roles of the WHO and ICAO in managing public health risks in aviation.