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Supporting document 1

Risk assessment – Application A1314

Permitting small dogs and cats in aircraft cabins

Executive summary

This microbiological risk assessment outlines the common zoonotic pathogens potentially associated with companion dogs and cats in Australia, their common modes of transmission, the likelihood these pathogens are transmitted to humans through a foodborne route and the food safety risk posed to consumers in aircraft cabins if companion dogs and cats were allowed to be present.

Aircraft cabins present unique challenges for infection control due to their enclosed environment, limited ventilation and close proximity of passengers. These factors may amplify the risk of disease transmission, particularly when companion animals are not properly managed or are carrying pathogens. Additionally, the presence of animals in proximity to food service areas poses potential contamination hazards that could contribute to foodborne illness among passengers and crew.

Zoonotic pathogens potentially carried by dogs and cats include bacteria, fungi, parasites, protozoa and viruses. The majority of foodborne zoonotic pathogens are transferred between companion animals and humans via a faecal-oral route. Other routes of infection include ingesting saliva, urine, faeces, bodily fluid or a vector such as a flea or tick from the animal.

The public perception of the risk of disease transmission onboard aircraft is greater than the actual risk. Although aircraft cabins are enclosed spaces, their environmental control system regulates cabin pressure, temperature, ventilation and air filtration. The system aims to maintain air quality and restricts the spread of pathogens in the air (thereby also restricting contamination of surfaces and food by aerosolised pathogens). In addition, the food and beverages served in-flight are predominantly pre-packaged. The food safety risk onboard an aircraft is thus greatly reduced compared to other food consumption areas, such as cafes or restaurants.

Reported foodborne illness outbreaks on aircraft are rare. Approximately 47 in-flight foodborne outbreaks resulting in 11 deaths were documented world-wide between 1947 and 2011. In January 2025 the first foodborne illness incident in 14 years was reported. The current low incidence of foodborne illness outbreaks is likely attributable to greater use of pre-packaged meals and improved food handling practices. It could also represent under-reporting by passengers or reporting bias.

Introducing companion dogs and cats into aircraft cabins potentially increases food safety risks. Zoonotic pathogens originating from companion dogs and cats are a potential foodborne disease risk to consumers dining in these settings in Australia. This risk may be slightly higher for young children and immunocompromised individuals. Food safety risks from companion dogs and cats onboard can be addressed through hygiene and containment measures. These include:

- requiring animals to be in pet carriers that are leak-proof and secure
- serving only pre-packaged food and beverages
- designating animal-free zones
- ensuring proper hand hygiene practices among passengers and crew
- cleaning and disinfecting surfaces after exposure to companion dogs and cats.

Virgin Australia proposed a series of preventative measures effectively mitigating food safety risk. Their risk management centres on eliminating contact between companion animals and food handlers (i.e. crew), as well as contact with the food or beverage itself. This is achieved through mandating the animals be kept in secure containment throughout the journey and prohibiting aircraft crew's contact with the animals.

The overall level of food safety risk from the presence of companion dogs and cats in aircraft cabins is expected to be low when appropriate mitigation controls (listed above) are in place.

Contents

1 Scope of the assessment

This microbiological risk assessment presents an outline of the common zoonotic pathogens[1] potentially associated with companion dogs and cats in Australia; their common modes of transmission; the likelihood these pathogens are transmitted to humans through a foodborne route; and the food safety risk posed to consumers in aircraft cabins if companion dogs and cats were permitted to be present. Non-food risks from cats and dogs and animal welfare aspects are not within FSANZ's remit and were not examined.

2 Introduction

Including companion animals (especially dogs and cats not classified as 'assistance animals') in many aspects of human life has become increasingly common, including in air travel. While this trend reflects a growing recognition of the role animals play in people's lives, it also potentially introduces public health risks.

This risk assessment examines increased risks to public health associated with allowing companion dogs and cats onboard aircraft cabins. The focus is on potential transmission of zoonotic disease and is twofold: (1) transmission from animals directly contacting food, and (2) transmission due to indirect contamination — through animal contact with food handlers, food preparation or consumption areas, or through aerosolised foodborne pathogens released by the animal (e.g. faecal or saliva droplets) contaminating surfaces or food.

Air travel is a common activity during which food is served. In 2022-2023 there were 595,118 Australian domestic flights transporting 55,294,455 passengers (BITRE, 2023). Aircraft cabins present unique challenges for infection control due to their enclosed environment, limited ventilation and close proximity of passengers. These factors may amplify the risk of disease transmission via food contamination, particularly if companion animals are carriers of pathogens and/or are not properly managed. Additionally, the presence of animals close to food service areas poses potential contamination hazards that could contribute to foodborne illness among passengers and crew.

As of 2022, Australia is home to approximately 5.3 million companion cats and 6.4 million companion dogs (AMA, 2022). Companion animals can be colonised or infected with a wide variety of viruses, bacteria, parasites and fungi that are pathogenic to animals and people. Companion animal-associated zoonoses represent a relatively neglected area of study. There is a general lack of data on pathogen prevalence in the relevant animal population and on the incidence of human infections attributable to companion animals. The close contact between companion animals and people provides favourable conditions for pathogen transmission by direct contact (e.g. petting, licking or physical injuries) or indirectly through contamination of food and domestic environments (Damborg et al., 2016).

Airlines serve hundreds of millions of meals to passengers each year (Grout and Speakman, 2020). Serving food onboard commercial aircraft has unique risk factors to be managed to ensure good hygiene. Most countries have well-established, detailed and enforceable food hygiene regulations for on-ground food settings, such as ensuring food handlers have access to toilets and handwashing basins. However, adapting these regulations to food handling in flight and in space-limited aircraft cabins presents a challenge. There are operational constraints, such as limited space for sanitary facilities, and also time constraints, such as having to comply with internal protocols about serving food within a short time and sometimes in a hurried manner. Despite the difference with routines and protocols in on-

[1] Zoonotic pathogens refers to pathogens that can be transmitted (sometimes via a vector) to humans through non-human animals, both domestic and wild.

ground food settings, food safety is governed by the same fundamental principles of hygiene, food science and public health.

An incidence of food poisoning among crew can directly affect flight safety. For example, a common cause of pilot incapacitation is gastrointestinal illness (Newman, 2007). Food safety is paramount, so any new potential risk (such as introducing companion animals) must be appropriately managed.

3 Zoonotic pathogens potentially carried by companion dogs and cats

Zoonotic pathogens potentially carried by dogs and cats include bacteria, fungi, parasites, protozoa and viruses. Pathogens shown to be foodborne transmissible to humans from companion dogs and cats in Australia are summarised in Table 1. Other pathogens transferable from cats or dogs to humans via pathways other than ingestion (e.g. bites and scratches) are not being considered by FSANZ in this assessment.

Table 1. Summary of zoonotic pathogens potentially carried by companion animals (dogs and cats)

Zoonotic disease	Causative pathogens	Companion animal reservoir	Route of infection
Bacteria			
Antimicrobial resistant infections	Methicillin-resistant *Staphylococcus* Extended-spectrum β-lactamase (ESBL)-producing bacteria Multidrug resistant (MDR) bacteria	Cats/Dogs	Direct contact, ingestion
Brucellosis	*Brucella canis* *Brucella suis* *Brucella melitensis* *Brucella abortus*	Dogs	Bodily fluids
Campylobacteriosis	*Campylobacter jejuni* *Campylobacter coli*	Cats/Dogs	Faecal–oral ingestion
Capnocytophaga infections	*Capnocytophaga canimorsus* *Capnocytophaga cynodegmi* *Capnocytophaga canis* *Capnocytophaga stomatis* *Capnocytophaga felis*	Cats/Dogs	Saliva ingestion
Clostridial infection	*Clostridium difficile* *Clostridium perfringens*	Cats/Dogs	Faecal–oral ingestion
Escherichia coli infections	Enteropathogenic *E. coli* (EPEC) Shiga toxin-producing *E. coli* (STEC)	Cats/Dogs	Faecal–oral ingestion
Listeriosis	*Listeria monocytogenes*	Cats/Dogs	Ingestion
Leptospirosis	*Leptospira* spp	Cats/Dogs	Urine ingestion

Mycobacteriosis (inc Tuberculosis)	*Mycobacterium* spp Mycobacterium avium-intracellulare complex *Mycobacterium bovis* *Mycobacterium tuberculosis*	Cats/Dogs	Ingestion, inhalation, waterborne
Mycoplasma infections	*Mycoplasma haemofelis* *Candidatus* Mycoplasma haemominutum *Candidatus* Mycoplasma turicensis	Cats	Vector-borne, bodily fluids
Q fever (Query fever)	*Coxiella burnetii*	Cats/Dogs	Bodily fluids, vector-borne
Salmonellosis	*Salmonella* spp.	Cats/Dogs	Faecal–oral ingestion
Tularemia	*Francisella tularensis*	Cats	Ingestion, inhalation
Yersiniosis	*Yersinia pseudotuberculosis* *Yersinia enterocolitica*	Cats/Dogs	Faecal–oral ingestion
Viruses			
Norovirus infection	Norovirus	Dogs	Faecal–oral ingestion
Rotavirus infection	Rotavirus	Dogs	Faecal–oral ingestion
Parasites			
Cryptosporidiosis	*Cryptosporidium parvum* *Cryptosporidium canis* *Cryptosporidium felis* *Cryptosporidium meleagridis* *Cryptosporidium cuniculus* *Cryptosporidium andersoni* *Cryptosporidium suis* *Cryptosporidium viatorum* *Cryptosporidium muris*	Cats/Dogs	Faecal–oral ingestion
Giardiasis	*Giardia intestinalis* *Giardia duodenalis* (formerly *Giardia lamblia*)	Cats/Dogs	Faecal–oral ingestion
Microsporidiosis	*Enterocytozoon bieneusi* *Encephalitozoon cuniculi* *Encephalitozoon intestinalis* *Encephalitozoon hellem*	Cats/Dogs	Faecal–oral ingestion
Toxoplasmosis	*Toxoplasma gondii*	Cats	Faecal–oral ingestion
Cestodes (Tapeworms)			
Coenuriasis	*Taenia multiceps* *Taenia serialis*	Dogs	Faecal–oral ingestion
Dipylidiasis	*Dipylidium caninum*	Cats/Dogs	Vector ingestion
Echinococcosis (hydatid disease)	*Echinococcus granulosus* sensu lato complex *Echinococcus granulosus* sensu stricto *Echinococcus canadensis* *Echinococcus ortleppiare*	Cats/Dogs	Faecal–oral ingestion

Nematodes (Hookworms and Roundworms)			
Hookworms infection	*Ancylostoma* spp. *Uncinaria* spp.	Cats/Dogs	Faecal–oral ingestion
Roundworms infection (Toxocariasis)	*Toxocara canis* *Toxocara cati* *Toxascaris leonina*	Cats/Dogs	Faecal–oral ingestion

The introduction of companion dogs and cats onto aeroplane flights could increase the risk of foodborne illnesses, due to potential contamination of food or surfaces by zoonotic pathogens carried by these animals. The disease characteristics, prevalence, transmission and preventative measures for key foodborne zoonoses transmissible by companion animals are summarised below. This is not an exhaustive list of all possible pathogens and not all prevalence data is Australia-specific.

3.1 Bacteria

3.1.1 Antimicrobial resistant bacteria

Antimicrobial resistant bacteria are included among the selected zoonoses in view of the increasing evidence that companion animals are a source of infection of multidrug-resistant (MDR) bacteria of zoonotic potential, including methicillin-resistant *Staphylococcus aureus* (MRSA) and extended-spectrum β-lactamase (ESBL)-producing *Escherichia coli* (Damborg et al., 2016; Wieler et al., 2011). Various genetic similarities have been observed between MDR isolates from human infections and from companion animals (Damborg et al., 2016). This indicates companion animals are a reservoir of resistant strains and contact with companion animals is a risk factor for transmitting resistant bacteria and/or their genes to humans (Bhat, 2021; Damborg et al., 2016).

Exposure to companion animals has been identified by two separate studies as a risk factor for ESBL carriage in people (Meyer et al., 2012, Leistner et al., 2013). MRSA colonisation (and perhaps infection) is a recognised occupational risk in veterinary staff and various studies have identified the same MRSA strains in people and companion animals sharing the same household (Weese, 2010).

Recently, Kenney et al. (2025) identified 55 different antimicrobial resistance genes in dog-associated *Salmonella enterica* clinical (human) isolates in the United States. They concluded although antibiotics are not typically prescribed for diarrhoeal *Salmonella* infections diagnosed in dogs, there is little regulation regarding the use of antimicrobials in companion animals (Kenney et al., 2025). A similar study from Thailand found 34% of *Salmonella* isolates obtained from healthy companion dogs and cats were multidrug-resistant (Chantharothaiphaichit et al., 2022).

3.1.2 *Brucella*

Brucellosis is one of the most prevalent zoonoses globally, imposing a heavy burden on national health services. Various types of *Brucella* spp. have been recognised; those resulting in human brucellosis include *B. melitensis, B. abortus, B. suis* and *B. canis*. Human transmission predominantly occurs through exposure to body fluids of dogs. Brucellosis may be asymptomatic or present serious clinical symptoms, especially fever, night sweats and back pain (Ghasemzadeh and Namazi, 2015). In the last decade, there has been an increase in the detection of *B. suis* in dogs, particularly in Australia and the United States (Kneipp et al., 2023). For example, one study found nearly one in ten (9.3%) dogs in eastern Australia exposed to feral pigs or their meat products are seropositive *for B. suis* (Kneipp et al., 2023).

3.1.3 *Capnocytophaga*

Zoonotic species of *Capnocytophaga* occur in the oral microbiota of dogs and cats. They may cause serious human infections with a high mortality rate, especially in immunocompromised individuals (Beauruelle et al., 2022). Though transmission to humans commonly occurs through animal bites, direct animal contact is not required and food contaminated with saliva from a carrier dog or cat can cause disease (Beauruelle et al., 2022). Typically, these infections are characterised by sepsis, which can be complicated by septic shock or disseminated intravascular coagulation (abnormal blood clotting), meningitis, endocarditis and less frequently osteoarticular infections have also been described (Beauruelle et al., 2022; Fernández Vecilla et al., 2022).

3.1.4 Common gastrointestinal pathogens: *Campylobacter* spp., *Escherichia coli, Listeria monocytogenes, Salmonella* spp.

The major risk factors for *Campylobacter, E. coli, L. monocytogenes*, and *Salmonella* transmission are direct or indirect contact with animal faeces, contaminated pet food, or surfaces touched by animals (Acke, 2018; Finley et al., 2006; Finley et al., 2008). Recent studies have shown dogs fed with raw meat or pig-ear treats were more likely to shed *Salmonella* and *Campylobacter* in the environment and be a source of human contamination (Chomel, 2014). Contaminated fur, saliva, or paws can transfer the bacteria to surfaces, utensils, or food items. Prevention of salmonellosis relies on avoiding direct or indirect exposure to animal faeces. As such, the main preventive measures include proper handling of the faeces and litter box, removal of faeces from public areas, and hand hygiene after contact with companion animals and animal-contaminated items (Leonard et al., 2011).

***Campylobacter* spp.**
Campylobacteriosis is predominantly a foodborne disease but there is clear evidence of zoonotic transmission occurring from companion animals. Current evidence suggests transmission from companion animals accounts for only a minority of human cases**.** *Campylobacter* is commonly found in the gastrointestinal tracts of dogs and cats, especially young animals or those consuming raw diets. Carriage rates may reach figures up to 50% in healthy dogs and cats, with relatively higher rates in puppies, kittens and stray and kennel populations (Baker et al., 1999, Wieland et al., 2005). Infected animals often do not show signs of disease, although cases of diarrhoea in young animals under one year old have been associated with the presence of *Campylobacter*.

Campylobacteriosis is a leading cause of human gastroenteritis in industrialised countries (Humphrey et al., 2007). The most common symptom is diarrhoea, which in 0.15% of cases develops into septicaemia (Damborg et al., 2016). The general prevalence of pathogenic *Campylobacter* spp. in dogs has been reported to be in the range of 2.4 to 47% (Lenz et al. 2009, McKill et al. 2009, Workman et al. 2005). Young animals are more likely to shed the pathogen. Stafford et al. (2008) estimated that about 3% of human cases of campylobacteriosis could be attributed to owning a puppy and Buettner et al. (2010) estimated 8% of human cases might be due to contact with dogs and cats.

Escherichia coli
E. coli are part of the normal intestinal microflora, but can cause gastroenteritis when local or systemic immunity does not function properly (Kantere et al., 2014). Enteropathogenic strains of *E. coli* (EPEC) have been found in people and dogs living in the same household (Kantere et al., 2014). Morato et al. (2008) collected faeces from 70 cats with diarrhoea and 230 without diarrhoea and isolated 15 and 14 EPEC strains respectively. Those isolated strains included serotypes known as human pathogens (Morato et al., 2008). This shows that asymptomatic animals can still carry human pathogenic strains. Pathogenic *E. coli* infection

in humans can cause diarrhoea, stomach pains and cramps, low fever, bloody urine and dehydration.

Companion animals can also be reservoirs of Shiga toxin-producing *E. coli* (STEC) strains. STEC is a foodborne pathogen causing diarrhoeal diseases, sometimes followed by haemolytic uremic syndrome (HUS), a systemic complication that could lead to death. Although companion animals shed STEC belonging to diverse serotypes in their faeces, Bentancor et al. (2012) characterised a set of STEC strains from dogs and cats that contributed to human infection. The Argentinian study showed dogs and cats can serve as a vehicle for bovine strains in the cycle of human infection and found STEC present in 15.5% or dogs and 8.7% of cats tested (Bentancor et al., 2012).

Listeria monocytogenes
L. monocytogenes has reportedly been isolated from 1.3% of faecal samples from healthy dogs and from 0.4% of faecal samples of healthy cats (Weber et al., 1995). Listeriosis disease more commonly affects susceptible sub-populations (the elderly, pregnant women, immunocompromised individuals, neonates and children under the age of 5 years, organ transplantation patients, cancer patients, and HIV carriers) (Chlebicz and Śliżewska, 2018). Infections associated with *L. monocytogenes* are characterised by a long incubation period of up to 70 days. *L. monocytogenes* are intracellular pathogens, which means for infection of the host, bacteria have to not only penetrate intestinal cells, but also cells of the host's spleen, liver, brain, heart and placenta (Chlebicz and Śliżewska, 2018). Listeriosis symptoms include joint pain, headache and stomach ache, diarrhoea, nausea, vomiting, lack of appetite, weariness, and somnolence (drowsiness). In pregnant women, infection with *L. monocytogenes* may lead to miscarriage. In very young children, the infection may lead to sepsis, pneumonia, or meningitis.

***Salmonella* spp.**
There is not much data on the occurrence of *Salmonella* in companion animals. General prevalences ranging from 0 to 9% and 0 to 4% have been reported in dogs and cats, respectively (Marks et al., 2011). Other studies found pathogenic *Salmonella* spp. in the range of 14% to 44% in dog populations (Joffe and Schlesinger 2002; Finley et al. 2007; Lenz et al. 2009). Higher prevalences may be found in stray or shelter cats/dogs as well as dogs fed raw food diets (Marks et al., 2011). Dogs and cats are typically asymptomatic but infections ranging from mild (e.g. fever of unknown origin) to potential, fatal gastroenteritis and septicaemia can occur (Marks et al., 2011). Managing stress in companion animals is considered likely to reduce *Salmonella* shedding (Verbrugghe et al., 2012).

Most people infected with *Salmonella* spp. develop symptoms of gastroenteritis. Depending on the age or immune status of the patient and serovar involved, salmonellosis may evolve to septicaemia, miscarriage and even death (Damborg et al., 2016). One case–control study reported cat exposure to be a risk factor for childhood salmonellosis (Younus et al., 2010).

3.1.5 *Clostridium*

Clostridium difficile and *Clostridium perfringens* are found in intestines of both animals and humans. *C. perfringens* prevalence in dogs is reportedly 80% while in cats it appears to be lower at 43-63% (Marks et al., 2011). The prevalence of *C. difficile* in dogs and cats is lower than *C. perfringens,* with general ranges from 0-58% and 0-21% respectively (Marks et al., 2011). *Clostridium* shedding can occur during times of stress or illness. Clostridial infection can occur through faecal contamination of food service areas or food products, exacerbated by improper cleaning (Marks et al., 2011). The spore-forming ability of *Clostridium* spp. increase their environmental survivability compared to other bacterial pathogens. Infection symptoms include diarrhoea, abdominal cramping, fever and nausea.

3.1.6 *Leptospira*

Leptospira is a diverse group of gram-negative bacteria that can survive for long periods in warm, wet environments. Virtually any domestic animal species can be infected, and different serovars may be involved depending on the animal species. Human exposure to *Leptospira* spp. has traditionally been associated with direct or indirect contact with wildlife. However, the re-emergence of *Leptospira* spp. in companion animal populations and the potential severity of infection, are reasons for concern (Damborg et al., 2016). Feral pigs are known carriers of *Leptospira* and pig hunting using dogs has led to human leptospirosis illness emerging in Queensland communities (Orr et al., 2022).

Risk factors for seropositivity or disease in dogs include exposure to wildlife, being a working dog, being older than 5 years of age and living in semi-urban or urban areas (Orr et al., 2022; Pham and Tran, 2022). However, the changing incidence has also been accompanied by anecdotal changes in at-risk populations and risk factors in some regions, with increases in disease concentrated in urban dogs, potentially due to changes in urban wildlife numbers and infection rates. While much less common, leptospirosis can occur in cats, particularly stray cats (Millán et al., 2009).

Animals are often silent carriers of *Leptospira*, but mild to severe infection may develop, most commonly in the urinary tract. Transmission occurs through ingestion or contact of *Leptospira* with mucous membranes or broken skin (Levett, 2001). The bacteria are shed in urine and most infections are acquired from urine-contaminated environmental sources, particularly water and/or food.

The reported incidence of human infection in most countries is low. Most human infections are mild (e.g. rash, headache and lymphadenopathy) or asymptomatic, but severe cases of hepatic or renal failure (Weil's disease) have been reported, especially in vulnerable groups (i.e. young, old, pregnant and immunocompromised) (Damborg et al., 2016).

This is an emerging pathogen and there are uncertainties on the likelihood of human transmission. The real rate of leptospirosis in Australia is likely under-reported, and increased detection and reporting of identified serovars would assist with epidemiologic modelling, particularly in a changing climate (Orr et al., 2022; Pham and Tran, 2022).

3.1.7 Mycobacteria

Mycobacterial infections pose a particular threat to immunocompromised people and act as opportunistic pathogens in healthy people. Tuberculosis is an infectious zoonotic disease caused by *Mycobacterium tuberculosis* and *Mycobacterium* avium-intracellulare complex. It is usually a chronic, debilitating disease in humans. Other diseases thought to be linked to *Mycobacterium* include Crohn’s disease, inflammatory bowel disease, ulcerative colitis, sarcoidosis and diabetes mellitus (Eslami et al., 2019).

Dogs infected with *M. tuberculosis*, *M. bovis*, and *M. microti* are rarely documented worldwide. However, dogs are considered a spillover host for mycobacterial pathogens, meaning although the pathogen is not maintained within the canine population, transmission can occur when dogs come in contact with a primary host (Ghielmetti and Giger, 2020). Transmission of *Mycobacterium* commonly occurs via inhalation of infected droplets. However, the bacteria can also be ingested, particularly via contaminated water or food (Eslami et al., 2019; Ghielmetti and Giger, 2020).

3.1.8 *Mycoplasma*

Hemotropic mycoplasma are small, cell-wall-free bacteria that can infect various mammalian species. They are located on the surface of red blood cells and can induce haemolytic anaemia (Baumann et al., 2013). Three different haemotropic mycoplasma species are known in domestic cats: *Mycoplasma haemofelis*, *Candidatus* Mycoplasma haemominutum and *Candidatus* Mycoplasma turicensis. In the United Kingdom, *Candidatus* Mycoplasma haemominutum infection has been detected in 7.0% and 8.7% and *M. haemofelis* detected in 2.3% and 0.2% of healthy and ill cats, respectively (Willi et al., 2006). An Australian study found 23.1% of ill cats were positive for *Candidatus* Mycoplasma haemominutum and 4.1% were positive for *M. haemofelis* with 0.7% positive for both species (Tasker et al., 2004). Mycoplasma have been detected in the saliva and blood of infected cats (Museux et al., 2009). Transmission to humans is thought to occur through bodily fluids or via a vector such as fleas (Steer et al., 2011). Human infection commonly results in haemolytic anaemia, fever and enlarged spleen (Hattori et al., 2020).

3.1.9 *Coxiella burnetii*

Q fever in humans is caused by the bacterium *Coxiella burnetii*. The pathogen normally infects individuals via aerosol and direct contact with body fluids of infected animals (Ghasemzadeh and Namazi, 2015). There has been an increase in Q fever cases in Australia (Ma et al., 2020). Australian serological surveys in 2011 reported the number of infected dogs with *C. burnetii* had increased to nearly 22% (Cooper et al., 2011). The prevalence in Australian cats is more uncertain, with one study reporting 1% of companion cats were seropositive (Shapiro et al., 2015). Transmission from dogs and cats is enhanced during their periparturient window (Ma et al., 2020): this includes the time of parturition (whelping or kittening) and a few weeks before and after. Many people with Q fever have no symptoms or only a mild illness. People who do become sick often have a severe flu-like illness (NSW Health, 2024).

3.1.10 *Francisella tularensis*

Tularaemia is a rare disease in Australia, caused by *Francisella tularensis* bacteria. *F. tularensis* is one of the most virulent microorganisms currently known to cause fatal disease in humans and animals (Carvalho et al., 2014). Infections usually occur through handling of infected animals, bites of an infected ticks, consumption of contaminated food, or contact with contaminated water (NSW Health, 2020). Domestic dogs and cats can also transmit tularaemia to humans after contact with an infected animal, environment or infected ticks (Carvalho et al., 2014). Tularaemia has been reported to occur in any age group and has an acute onset, with fever, chills, fatigue, generalised myalgia and headaches, resembling a flu-like syndrome that is potentially fatal (Carvalho et al., 2014).

3.1.11 *Yersinia*

Yersinia pseudotuberculosis and *Yersinia enterocolitica* can cause tuberculosis-like symptoms, including localised tissue necrosis and granulomas in the spleen, liver and lymph nodes. These bacteria are found in the gastrointestinal tract of animals, particularly if they consume raw or undercooked meats. Transmission risk factors include faecal contamination of surfaces, leading to cross-contamination of foods or utensils (Shoaib et al., 2019). Human infection may be asymptomatic in early stage and when the pathogen invades the mucosal surface of the intestine, watery or bloody diarrhoea may be present (Shoaib et al., 2019). *Y. enterocolitica* can also cause the development of Peyer's patches and appendicitis-like symptoms (Ghasemzadeh and Namazi, 2015).

3.2 Viruses

3.2.1 Norovirus

Noroviruses are a heterogeneous single strand RNA virus belonging to the Caliciviridae family. Noroviruses are the main cause of sporadic and epidemic gastroenteritis in humans (Ghasemzadeh and Namazi, 2015). This virus can affect humans of all ages. Human norovirus sequences were recently detected in faecal samples from companion dogs that had been in direct contact with humans with norovirus gastroenteritis, suggesting human norovirus can at least survive in the gastrointestinal tract of dogs (Chomel, 2014). While not directly carried by companion animals, contamination of surfaces by animal faeces or saliva could facilitate the spread of norovirus, which is highly infectious and common in closed environments like aeroplanes (Vega and Barclay, 2014).

Canine noroviruses have also been identified and reports suggest a role of companion dogs in spreading noroviruses (Chomel, 2014). Canine norovirus may have the ability to infect humans. A study looking at small-animal veterinarians found antibodies to canine norovirus in 22.3% of 373 veterinarians and 5.8% of 120 control individuals (Chomel, 2014).

3.2.2 Rotavirus

Rotavirus is primarily transmitted through the faecal-oral route, typically via contaminated hands, objects or food. In humans, rotavirus primarily targets the gastrointestinal tract, causing gastroenteritis and related symptoms such as diarrhoea and vomiting (Dóró et al., 2015). Studies indicate rotavirus infections in dogs and cats are usually caused by species-specific strains (Cook et al., 2004; Malik et al., 2020). Young children are more susceptible to being infected by a canine or feline rotavirus strain. A rotavirus group A G3 strain isolated from a child with a companion cat was identical to a feline rotavirus strain (Cook et al., 2004). A 3-week old baby in an Israeli household with a young dog (6 months old) was infected with a canine rotavirus group A G3 strain (Cook et al., 2004). In rare cases, dogs and cats have been found to carry human rotavirus strains (Malik et al., 2020). This cross-species transmission can happen when a dog ingests rotavirus-contaminated materials or comes into close contact with an infected individual's faeces. When carrying human rotavirus, transmission from the companion animal to a human is more likely to occur than with a species-specific rotavirus.

3.3 Protozoan parasites

3.3.1 *Cryptosporidium* spp. and *Giardia* spp.

Cryptosporidium and *Giardia* are major causes of diarrhoeal disease in humans, worldwide and are major causes of protozoan waterborne diseases (Smith et al., 2007). Dogs and cats, especially those exposed to contaminated water or environments, can carry these parasites. Animals' shedding of infectious cysts in faeces can lead to the contamination of surfaces or water used in food preparation (Bowman and Lucio-Forster, 2010). Ingestion of infectious cysts by humans usually causes gastrointestinal disease commonly with acute diarrhoeal; however, chronic infections can occur in immunocompromised individuals (Monis and Thompson, 2003).

3.3.2 Microsporidia

Microsporidia are a diverse group of unicellular obligate intracellular parasites including *Enterocytozoon bieneusi, Encephalitozoon cuniculi, Encephalitozoon intestinalis, and Encephalitozoon hellem* (Han et al., 2021). Microsporidia produce distinctive unicellular spores that are environmentally resistant and can survive for months outside a host (CDC, 2019c). Microsporidia can be transmitted by food and water and are likely zoonotic, as they parasitise a wide range of invertebrate and vertebrate hosts, including cats and dogs (Han et al., 2021). Mature spores of intestinal-localising species may be shed in faeces, although the route of transmission remains uncertain for many species (CDC, 2019c). Infection in humans occurs in both healthy and immunodeficient individuals, with symptoms including diarrhoea, lung problems, kidney failure and eye inflammation (Han et al., 2021).

3.3.3 *Toxoplasma gondii*

Cats are the definitive host for *T. gondii*, shedding oocysts in their faeces. *T. gondii* can be transmitted through contamination of surfaces or hands that then come into contact with food (Dubey, 1998). This is of concern for vulnerable populations such as pregnant women or immunocompromised individuals (Dubey, 1998). Toxoplasmosis is the leading cause of death from foodborne illness in the United States. Clinical signs of infection include flu-like symptoms, such as fever, swollen lymph nodes, headache, and muscle aches (CDC, 2024). Severe toxoplasmosis can cause damage to the brain, eyes, or other organs. The parasite occurs worldwide and can survive for long periods (up to a lifetime) in human bodies (and other animals).

3.4 Parasitic worms

3.4.1 Tapeworms

Companion dogs are definitive hosts for *Echinococcus granulosus* and may harbour thousands of adult tapeworms without being symptomatic. *E. granulosus* is widespread through Australia. Dogs accompanying individuals are often suspected of being an intermediary in the cycle of transmission to humans (Victoria Health, 2022). Human infection occurs by hand-to-mouth transfer of viable tapeworm eggs from dog faeces. This may occur by patting a dog then touching your mouth, kissing a dog, through contact with contaminated soil or through consuming food or water contaminated with dog faeces containing tapeworm eggs (Queensland Health, 2017a; Victoria Health, 2022).

Human infection with *E. granulosus* leads to the development of one or more hydatid cysts located most often in the liver and lungs, and less frequently in the bones, kidneys, spleen, muscles and central nervous system (WHO, 2021). Abdominal pain, nausea and vomiting are commonly seen when hydatids occur in the liver. If the lung is affected, clinical signs include chronic cough, chest pain and shortness of breath (WHO, 2021). Young children are particularly at risk of becoming infected with the tapeworm eggs, but symptoms may not appear for many years (Queensland Health, 2017a).

Coenurosis is infection with the metacestode larval stage of coenurus (cyst)-forming *Taenia* species. Coenurus-forming *Taenia* species include *T multiceps*, *T. serialis*, *T. brauni*, and *T. glomeratus*. Humans do not support the maturation of these tapeworms in the intestine and only experience tissue infections with coenuri (CDC, 2019a). Human infection occurs via ingestion of embryonated eggs shed by infected animals. Clinical symptoms of infection in humans include coenuri development in various tissues (commonly the brain, eyes and subcutaneous tissues) (CDC, 2019a). Depending on their location, coenurosis symptoms include seizures, headaches, vomiting, tenderness, visual impairment and difficulty moving and swallowing (CDC, 2019a).

Dipylidium caninum is a common tapeworm of dogs and cats, but is occasionally found in humans. Its common names include “flea tapeworm”, “cucumber tapeworm”, and “double-pored tapeworm”. The intermediate host is usually the larval stages of the dog or cat flea (*Ctenocephalides* spp.) and occasionally *Trichodectes canis* (the dog louse) (CDC, 2019b). Transmission to humans usually occurs through ingestion of infected fleas harboured by cats and dogs (CDC, 2019b). Most infections with *Dipylidium caninum* are asymptomatic, but mild gastrointestinal disturbances may occur (CDC, 2019b).

3.4.2 Hookworms

Hookworms are parasitic nematodes primarily infecting the intestines of their hosts. The genera of most concern for zoonotic transmission to humans are *Ancylostoma* and *Uncinaria*. Hookworms are common infections of dogs and cats, particularly young animals (Traub et al., 2021). These hookworms can infect humans through ingestion of larvae shed in the faeces of infected animals. Symptoms include cutaneous larva migrans (larva migration under the skin), gastrointestinal issues and anaemia (Traub et al., 2021).

3.4.3 Roundworms

Toxocariasis is a human infection with nematode ascarid larvae of the genus *Toxocara*. The parasite is common to dogs and cats. Human cases of toxocariasis are uncommon in Australia with human transmission occurring via ingesting eggs passed in faeces of infected animals (Queensland Health, 2017b). Symptoms include fever, anorexia, rash, pneumonitis, hepatosplenomegaly, asthma, or visual impairment (Marie and Petri, 2025).

4 The aircraft cabin environment

Air travel presents food safety hazards arising from the unique nature of aircraft cabin environments and potential ease of foodborne pathogen transmission. Characteristics of cabin airflow, food preparation and sanitation facilities, and crew skills and knowledge that can impact food safety are outlined below.

4.1 Airflow

During flight, the aircraft cabin is a ventilated, enclosed environment exposing passengers to hypobaric hypoxia (low blood oxygen due to reduced air pressure), low humidity and close proximity to fellow passengers (Bagshaw and Illig, 2019; Zubair et al., 2014). This space is regulated by an environmental system controlling pressure, temperature, ventilation and air filtration on the aircraft (Bagshaw and Illig, 2019; Mangili and Gendreau, 2005; Zhang et al., 2017; Zubair et al., 2014).

During flight, fresh air is supplied into the cabin from the engines where the air is heated, compressed, cooled and passed into the cabin and circulated by the ventilation system (Zhang et al., 2017). Outside air is assumed to be sterile at typical cruising altitudes (Mangili and Gendreau, 2005). Air circulation patterns onboard standard commercial aircraft are laminar (smooth and even) with air entering the cabin from overhead, circulating across the cabin and exiting near the floor (see Figure 1) (Freeman, 2020). The exact nature of air flow depends on the plane's size and seat configuration (Figure 2). Minimal front-to-back (longitudinal) airflow occurs in the cabin (Mangili and Gendreau, 2005; Shehadi et al., 2018). This air circulation pattern divides the air flow into sections within the cabin, thereby limiting the spread of airborne particles throughout the passenger area (Shehadi et al., 2018).

Most commercial aircraft recirculate 50% of the air delivered to the cabin for improved control of air circulation, humidity and fuel efficiency. This recirculated air usually passes through high efficiency particulate air (HEPA) filters before being delivered into the cabin. In general, HEPA filters used on commercial airlines have a particle-removing efficiency of 99·97% at 0·3 microns (Bagshaw and Illig, 2019). These filters remove dust, vapours, bacteria and fungi. HEPA filters also effectively capture viral particles because viruses usually spread by droplets. Normal airline cabin air exchange rates range from 15 to 20 air changes per hour

(Mangili and Gendreau, 2005). Virgin Australia report in their application their cabin air is refreshed 20-30 times an hour.

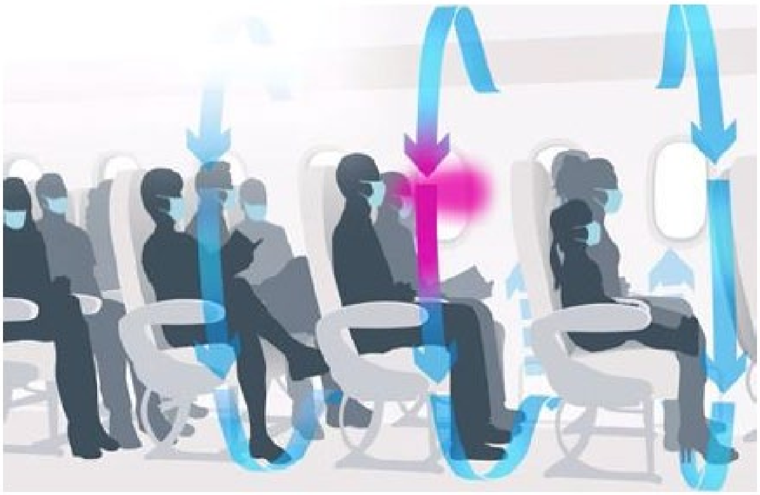

Figure 1. Cabin air flow schematic *(source: Freeman, 2020)*

In general, proper ventilation in any confined space reduces the concentration of airborne organisms logarithmically, and one air exchange removes 63% of airborne organisms suspended in that particular space (Mangili and Gendreau, 2005; Zubair et al., 2014). The main laminar flow pattern in the aircraft cabin, with frequent air exchanges and use of HEPA filters, limits transmission of contagions. These contagions could include aerosolised foodborne pathogens. Ventilation is a crucial determinant of disease transmission risk, and efforts to increase ventilation will reduce that risk. Widespread transmission can occur when ventilation is ineffective, as shown by an influenza outbreak when passengers were kept onboard a grounded aircraft with an inoperative ventilation system (Mangili and Gendreau, 2005).

There is reported public concern that airborne particles are distributed through the entire cabin by the ventilation system. However, no peer-reviewed scientific work links cabin air quality and aircraft ventilation rates to greater health risks compared with other modes of transport or with office buildings (Mangili and Gendreau, 2005).

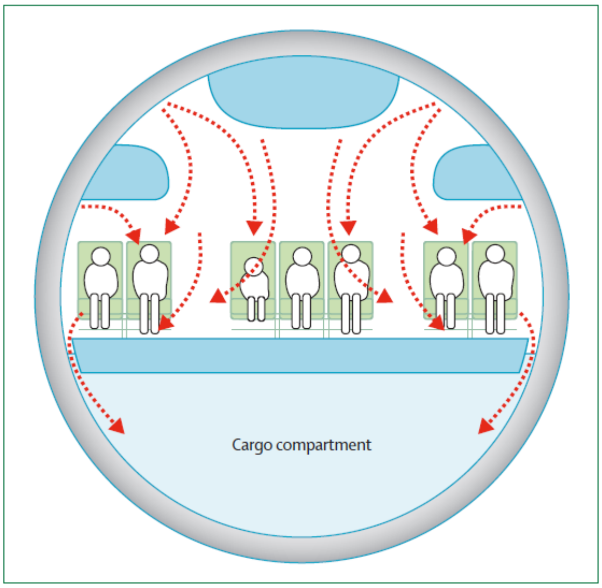

Figure 2. Air circulation pattern in typical airline passenger cabin. *Arrows show air currents (source: Mangili and Gendreau, 2005)*

The risk of disease transmission within the confined space of the aircraft cabin is difficult to determine. Insufficient data prohibits meta-analysis, which would enable estimates of the likelihood of disease transmission for each respective pathogen. Many of the available epidemiological studies are compromised by reporting bias caused by incomplete passenger manifests, complicating risk assessment. Despite these limitations, data suggest risk of disease transmission from one passenger to another is associated with sitting within two rows of a contagious passenger for a flight time of more than 8 hours (Bagshaw and Illig, 2019; Mangili and Gendreau, 2005). Deterministic modelling with data from an in-flight tuberculosis investigation showed doubling the ventilation rate in the cabin halved the infection risk (Ko et al., 2004). Risk also reduced exponentially to almost zero in passengers seated 15 seats from the infectious source (Ko et al., 2004). While this association is mainly derived from airborne transmission of tuberculosis (a respiratory illness), it is also relevant to aerosolised foodborne pathogens and allergens (Masotti et al., 2019). By managing airborne particles, effective ventilation can help minimise contamination of surfaces and food by foodborne pathogens.

4.2 Plane configuration, facilities and surfaces

Food safety hazards in aircraft include large numbers of people in a confined space and shared sanitary facilities (Zhao et al., 2019). Inherent factors affecting the risk of in-flight foodborne illness include the types of foods served and susceptibility of people consuming the food. Most food is pre-prepared by airline catering and their food safety management is critical. Once food is on the plane, food contamination can arise from unhygienic practices in the food preparation area and during food handling.

Evidence suggests foodborne pathogens, including *E. coli*, *S. aureus*, *Campylobacter* and Norovirus, can survive for hours to months on various surfaces and spread to other individuals by direct or indirect contact (Vaglenov, 2014). This persistence has been identified in aircraft cabins on tray tables, worktops, sink faucets and washroom door handles (Vaglenov, 2014). Larger aircraft built for longer distances and increased passenger capacity will present even greater challenges to food hygiene. Few standards exist specifically dealing with hygiene requirements in aircraft cabins, and airlines generally establish their own cleaning standards. While poor hand hygiene is often at the root of major foodborne illness outbreaks, there are no requirements for a minimum number of washrooms, such as a toilet/passenger ratio, similar to an emergency door/flight attendant/passenger ratio, and no requirements for designated crew toilets or handwashing sinks in galleys (Grout and Speakman, 2020).

Evidence suggests one in every five cases of foodborne illness is caused by the hands of a contaminated food handler. When considered in the context of confined aircraft cabins, not only may contaminated hands play a key role in transmitting foodborne illness, the galley design also impacts safe food handling practices. Similar to the way constricted space for food handlers in small restaurants impedes adherence to good hygiene practice, the constraints of the aircraft galley, too, increase the risk of food safety lapses (Grout and Speakman, 2020). In addition, most sinks in aircraft galleys are not designed for optimal handwashing, as the tap design requires one hand to operate the tap handle.

The WHO, the International Flight Services Agency (IFSA), and the International Air Transport Association (IATA) all provide guidance on best practices for in-flight food safety and hygiene practices (IATA 2019, IFSA 2022, WHO 2009). IFSA's guidance is based on a HACCP (Hazard Analysis and Critical Control Point) system, which is widely used in the food industry and involves identifying specific hazards and measures for their control. Although the IATA notes cabin crew should follow the same code of practice as on-ground food handlers, there are real barriers for crew members to adhere to the same stringent hand hygiene practices required for most on-ground food settings (IATA 2019).

4.3 Cabin crew skills and knowledge

The potential for disease transmission by cabin crew has been demonstrated in past foodborne outbreaks onboard aircraft, where transmission can recur from the same source over multiple flight sectors (Thornley et al., 2011). As cabin crew handle and serve food, they meet the definition of a food handler under the Australia New Zealand Food Standards Code (the Code), Standard 3.2.2 - Food Safety Practices and General Requirements. Under Standard 3.2.2, aircraft operators and staff must be equipped to ensure safe handling of food. Clause 3 in Standard 3.2.2 stipulates food handlers must have skills and knowledge in food safety and food hygiene matters commensurate with their duties. Cabin crew must be able to identify and act on potential food safety issues to prevent transmission of foodborne illness. They must be able to do this in a work environment that is often space- and time-limited.

Outbreaks resulting from indirect transmission through exposure to contaminated surfaces occurring days after the contamination incident have been reported in other contexts (Evans et al., 2002). The type and sequence of work activity also determines risk of contamination. For example, failing to wash hands after touching soiled workplace surfaces is likely to be riskier than failing to wash hands after touching one's uniform.

With the introduction of companion dogs and cats onboard, the cabin crew should minimise, if not eliminate, contact with these animals to prevent disease transmission. Crew knowledge and skills should be reviewed to ensure any potential food contamination from the animals is identified and appropriately managed.

5 History of foodborne illness on aircraft

Aircraft environments have the potential to rapidly spread pathogens that can result in significant outbreaks and this has been borne out by reported outbreaks. The most commonly reported diseases transmitted on aircraft have been spread by the faecal-oral route via contaminated food. There is no reported data looking specifically at food safety on planes where animals are in the cabin. However, as discussed in Section 3, cats and dogs are known carriers of foodborne pathogens that can cause human illness.

Approximately 47 in-flight foodborne outbreaks resulting in 11 deaths were documented between 1947 and 2011 (Grout and Speakman, 2020; Mangili and Gendreau, 2005). *Salmonella* is the most usually reported foodborne pathogen spread by a commercial airline, with 15 documented outbreaks in 1947-2011 affecting nearly 4000 passengers and resulting in seven deaths. In one case, a *Salmonella* outbreak linked to contaminated crème anglaise on an Australian flight in 1998 resulted in 500 cases of illness (McMullan et al., 2007). Eight foodborne illness outbreaks caused by *Staphylococcus* and one associated death were reported between 1947 and 2011. There were five Norovirus outbreaks between 1991 and 2009. These include an Australian incident in 1991 where Norovirus-contaminated orange juice was linked to over 3000 illness cases including 30 passengers (Lester et al., 1991). There have been a few reported cases of passengers becoming ill from consuming food or water contaminated with *Vibrio cholerae* during international air travel. The first documented in-flight outbreak was in 1972 on a flight from London to Sydney via Singapore. Of the 47 people who developed cholera, which was attributed to a cold appetiser served during the flight, one person died (Sutton, 1974).

Between 2012 and 2024, no foodborne outbreaks associated with aircraft were reported. This is probably attributable to greater use of pre-packaged meals and improved food handling protocols, but might represent under-reporting by passengers or reporting bias (Grout and Speakman, 2020). In most instances, identification of epidemiological links between cases is extremely challenging. Illness often occurs after passengers and crew have dispersed to different public health jurisdictions. Potential in-flight contamination and resulting outbreaks are difficult to differentiate from disease cases attributable to pre-flight exposure. Outbreak investigation is further limited by ill people not seeking health care, delayed reporting, limited testing of specimens, or lack of cooperation between airlines and health authorities regarding passenger data.

In January 2025, the first reported foodborne illness incident in 14 years was reported by the Department of Health in Hong Kong (Whitworth, 2025). Beetroot salad contaminated with *S. aureus* was identified as the likely source of illness onboard two flights from Nepal (Whitworth, 2025). The incident caused 43 passengers to become ill on the flights.

6 Public health risk mitigation

Hygiene and containment measures to minimise the potential for foodborne pathogen transmission from companion dogs and cats in aircraft cabins include:

- requiring animals to be in pet carriers that are leak-proof and secure
- serving only pre-packaged food and beverages
- designating animal-free zones
- ensuring proper hand hygiene practices among passengers and crew
- cleaning and disinfecting surfaces after exposure to companion dogs and cats.

Effectively evaluating food safety risks and implementing controls should safeguard passenger and crew health in pet-friendly air travel environments.

6.1 Enforcing proper animal containment

Companion animals should be transported in secure, leak-proof and well-ventilated carriers. These carriers should remain closed throughout the flight. Proper containment minimises direct contact between animals and food handlers, surfaces, or food areas (Raymundo et al., 2021).

6.2 Restricting animals from food preparation areas

Animal-free zones should be designated, particularly near food service areas or galley kitchens, to reduce the risk of food contamination. Proximity to food handling areas increases the risk of cross-contamination of food and surfaces (FDA, 2023).

6.3 Dedicated location for companion animals

Companion animals should be located in designated rows and seats. This allows for better control over the public health risk. Consideration should be given to selecting row location distanced from galley areas. Window seats would also provide the greatest distance from food carts. Under-seat storage takes advantage of the airflow mechanics in aircraft (see Section 4.1 Airflow) where air is drawn out of the plane at floor level. This means fresh and filtered air (50/50) enters from the roof of the cabin and reaches passengers' breathing space and any food present before it reaches the floor space where the companion animal is located (Mangili and Gendreau, 2005).

6.4 Maintaining the use of pre-packaged food

Airlines allowing companion animals on-board should exclusively use pre-packaged foods and beverages in areas where animals are kept. Pre-packaged and low-risk foods decrease food safety risks onboard aircraft compared to conventional cafes and restaurants. Serving meals on plates, such as in first or business class, presents a higher food safety risk if companion animals are onboard.

6.5 Implementing cleaning and disinfection protocols

Proper sanitation reduces environmental contamination with pathogens (WHO, 2018). Standard 3.2.2 already requires food businesses to maintain hygiene of premises, equipment and handlers. Permitting companion animals onboard requires the airline to further consider their cleaning and disinfection procedures during and after flights to ensure cabins are effectively cleaned. Disinfectants should be validated as effective against zoonotic pathogens.

6.6 Requiring veterinary health certifications

Ensuring the health of companion animals flying would reduce potential transfer of zoonosis from a sick animal. Companion animals traveling in aircraft cabins should have an up-to-date health certificate from licensed veterinarians, including proof of vaccination. This measure ensures companion animals are healthy and reduces the likelihood of pathogen carriage (AVMA, 2020).

6.7 Training airline staff on handling and hygiene in case of contact with the animal

Direct contact between the airline staff and the companion animals should be prevented to minimise risk of contaminating any food served to passengers. However, if contact does occur, staff must be aware of the risks involved and how to mitigate them. Airline crew members should be trained on proper handling, waste management and hygiene protocols if any contact with an animal is made. This increases the ability of staff to identify and manage risks associated with companion animals onboard (OSHA, 2013).

6.8 Limiting the number of companion animals on board

Restricting the number of companion animals per flight reduces the cumulative risk of contamination and conflict. A small number of companion animals on a single flight decreases the likelihood of incidents and enables crew to monitor compliance of the animal and owner with requirements while onboard (Singh and Shukla, 2019).

6.9 Providing passenger education

Passengers should adhere to proper hygiene practices, such as handwashing after contact with animals, and should keep their animals contained in carriers during flights. Informed passengers are less likely to engage in behaviours that increase contamination risks (Flight Safety Foundation, 2020).

6.10 Monitoring and surveillance for zoonotic disease outbreaks

Airlines should implement reporting systems for monitoring, identifying and responding to potential zoonotic disease outbreaks linked to air travel involving companion animals. Early detection and response can prevent widespread transmission (Jones et al., 2008).

6.11 Behavioural screening of companion animals

Airlines should consider screening companion animals for aggressive or disruptive behaviour to prevent incidents that could lead to increased stress and contamination events. Stressful environments can exacerbate shedding of pathogens in animals (Overall, 2013).

6.12 Conclusion

The above mitigations can significantly reduce food safety risks associated with allowing companion animals into aircraft cabins. These measures should be incorporated into airline policies to ensure the safety and well-being of passengers, crew and animals.

7 Virgin Australia's proposed controls

Virgin Australia has carried assistance animals onboard for several years and advised they had not received any customer complaints about food safety arising from their presence in the cabin. Virgin Australia advised assistance animals are onboard on approximately 3% of domestic flights. The proposed permission for companion animals onboard could lead to an increase in flights with animals onboard. To manage any potential increased food safety risk from companion dogs and cats in their aircraft cabins, Virgin Australia proposed the below control mechanisms to ensure the food safety risk onboard remains at its current level.

7.1 Required health of companion animals

The requirements for companion animals to travel in the cabin will be similar to animals travelling in the aircraft hold/cargo. Virgin Australia will continue to comply with International Air Transport Association (IATA) Live Animals Regulations (LAR). These regulations require companion animals to be fully vaccinated and in a healthy state to travel, and not carrying any infectious disease. In some cases a veterinary 'fit to fly certificate' will also be required[2]. Virgin Australia can refuse travel for companion animals for, among other reasons, signs of poor health, if the animal and/or its carrier is odorous or if the animal is released from its carrier.

7.2 Limits on number of animals

Virgin Australia proposes to limit the maximum number of companion animal containers/carriers per flight to four, with rare exceptions. Virgin Australia noted this is lower than another airlines operating in other countries. To ensure passengers can keep control of their companion animals throughout the journey, the number of animals per passenger will be limited. Setting animal limits per flight and per person is intended to reduce potential food-related risk exposure and allow efficient management and implementation of controls.

7.3 Animal containment

Companion animals will be required to stay secured inside their carriers for the duration of the journey. Virgin Australia will require the animal carrier to: be suitable to keep the animal inside at all times; have a leak-proof base and be lined with absorbent bedding material; be clean and odour free; and have a secure and functional latching system to prevent accidental opening or escape by the animal. Pet carriers will be assessed by staff at the time of check-in and passengers must agree to their animal remaining in the carrier and under the seat in front of them while on the aircraft. The animal is not allowed to be removed from the carrier

[2] See https://www.virginaustralia.com/us/en/travel-info/specific-travel/pets/

while inside the aircraft. Maintaining containment of the animal at all times minimises additional food safety risks posed by introducing companion animals in aircraft cabins.

7.4 Companion animal boarding procedure

Companion animals will be required to enter and leave the aircraft via the forward door and must be secured in their carrier during embarking and disembarking. During boarding, the animal will briefly pass the aircraft's forward galley; however, this will occur at a time when food items have already been stowed away in the galley. Virgin Australia proposes to pre-board passengers with companion animals, ensuring a swift boarding process and reducing the duration of proximity between the animal and the galley area.

7.5 Designated seating assignment

Virgin Australia will assign designated window seats to passengers traveling with companion animals, with the animal in its carrier to be placed under the seat in front. Assigning window seats provides the maximum distance between the location of the stowed pet carrier and the food service carts that may pass in the aisle. Stowing the carrier under a window seat also takes advantage of the airflow dynamics in the plane, where air is drawn out via the floor space where the animal is located. This helps minimise the amount of circulating air that has come in contact with the animal. Designated rows for companion animal travel maximise the distance between the animals and the galley areas on the plane.

7.6 Airline food handling processes

Virgin Australia's food is delivered to the aircraft in security-sealed catering carts or metal boxes. While in flight, 'buy on board' food and beverage service occurs in economy class – where the companion animals are proposed to be located. This food is all pre-packaged and remains packaged when provided to customers. The only exceptions are tea, coffee and water served in disposable cups, and instant noodle/pasta products that are partially opened and have boiling water added before being served. Food items that are heated, such as a toasted sandwich or bakery item, are heated inside their packaging and served while still fully packaged. Only serving pre-packaged foods and beverages, which are served to passengers in their fully packaged form, reduces potential for food contamination. These food and beverage practices decrease the food safety risks onboard the aircraft when compared to conventional cafes and restaurants. While meals are served on plates in business class, these meals also arrive onboard pre-packaged before being served. Virgin Australia has currently proposed to permit companion animals only in economy class.

Cabin crew meet the definition of food handlers under Standard 3.2.2 and must be equipped to ensure safe handling of food. Virgin Australia proposes a new policy to prevent cabin crew from physically interacting with companion animals to further reduce the possibility of food contamination. Cabin crew will be not be able to provide veterinary assistance to animals nor to refrigerate or heat any food or veterinary items for a companion animal. Virgin Australia note the carrier is not permitted to be opened while onboard the aircraft, even for the purpose of providing food or medicine.

7.7 Aircraft cleaning

All Virgin Australia aircraft are thoroughly cleaned overnight by specialist contractors. Cabin crew also tidy the aircraft cabin between flight sectors. Virgin Australia use chemical disinfectants to clean cabins on a scheduled basis and in compliance with airline cleaning standards. All contact surfaces (in both galleys and passenger areas) are treated with an industrial cleaning agent used in hospital and aviation environments. The cleaner used by

Virgin Australia is safe to use on hard and soft surfaces, can eliminate viruses, bacteria and mould on contact and remains effective for up to 48 hours. To manage the unlikely event of a biological hazard (such as animal defaecation), Virgin Australia has biohazard kits stowed onboard each aircraft. Cabin crew follow procedures in using the kit to eliminate biological hazards.

Virgin Australia's application noted the presence of antimicrobial coatings applied to surfaces of their aircraft. Virgin Australia clarified this feature is currently not present on the Virgin Australia Boeing fleet.

7.8 Other considerations

Virgin Australia proposed to carry companion animals in cabins only on selected routes, where originating and destination airports have designated animal relief areas available. This reduces the likelihood of companion animals relieving themselves during a flight. Virgin Australia will recommend passengers ensure their companion animal uses these relief areas before boarding any flight.

Virgin Australia considered the need of passengers to be relocated onboard if seated in proximity to companion animals. Those passengers may be moved with sufficient separation from designated companion animal rows. FSANZ notes its assessment focuses on food safety; airborne allergies to dogs and cats are out of scope. Interested parties can seek further information directly from Virgin Australia on its considerations of other safety matters.

8 Data gaps

Australia-specific data is generally lacking on pathogen prevalence in companion dog or cat populations or on the incidence of human infections attributable to companion animals. However, combining international studies with available Australian data provided a solid base of scientific evidence for our risk assessment.

The following actions could address gaps in knowledge: (1) coordinated surveillance of zoonotic pathogens and antimicrobial resistance in companion animals, (2) studies to estimate the burden of human disease attributable to companion animals and to identify risk behaviours facilitating transmission, and (3) education of those in charge of companion animals, animal caretakers, veterinarians and human medical healthcare practitioners on the potential zoonotic risks associated with exposure to companion animals (Damborg et al., 2016).

9 Conclusions

Commercial aircraft can be an environment facilitating the spread of foodborne pathogens carried by passengers, crew and/or food. Foodborne transmission of infectious diseases in aircraft cabins is likely under-reported (as is the case with most cases of foodborne illness). A significant factor in under-reporting is that most diseases have a longer incubation period than the air travel time and passengers may be in a different country once ill.

The public perception of the risk of disease transmission onboard aircraft is greater than the actual risk. Although aircraft cabins are enclosed spaces, their environmental control system regulates cabin pressure, temperature, ventilation and air filtration. The system aims to maintain air quality and restricts the spread of pathogens in the air (thereby also restricting contamination of surfaces and food by aerosolised pathogens). When compared to other food consumption areas, such as cafes or restaurants, the food safety risk onboard an aircraft, where predominantly pre-packaged foods and beverages are used, is greatly decreased. Reported foodborne illness outbreaks on aircraft are rare.

Introducing companion dogs and cats into the aircraft cabin increases the potential public health safety risk on board from foodborne illnesses. Risk mitigations can maintain the overall level of risk to be the same as before companion animals were allowed into the cabin. Virgin Australia has proposed a series of effective preventative measures unique to aircraft cabins that mitigate food safety risks. These centre on eliminating contact between companion animals and food handlers, as well as contact with the food or beverage itself. This is achieved through maintaining animals in secure containment throughout the journey and prohibiting aircraft crew contact with animals. The probability of contamination of food is reduced by these measures and the public health risk remains low. The likelihood of direct contact of food or food preparation areas with companion dogs and cats or their faeces or saliva is very low as the animals stay contained. Acquiring diseases through indirect foodborne transmission routes (i.e. from animals to food via an intermediate vector, such as a food handler), is very low as cabin crew must not make contact with animals.

Zoonotic pathogens originating from companion dogs and cats present in aircraft cabins represent a foodborne disease risk to consumers dining in these settings in Australia. This risk may be slightly higher for young children and immunocompromised individuals. However, the overall level of food safety risk arising from the presence of companion dogs and cats in such settings is expected to be low when appropriate mitigation controls are in place. Keeping the animals in secure containers throughout their journey, prohibiting food handler contact with the animals, adhering to good hygienic practices in food preparation and service, maintaining cleanliness, and using predominantly pre-packaged foods should contribute to minimising any potential risk of foodborne transmission of pathogens potentially carried by companion dogs and cats in aircraft cabin environments.

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