Air travel and children's health issues

Canadian Paediatric Society

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ABSTRACT

With more children travelling by air, health care professionals should become more familiar with some of the unique health issues associated with air travel. A thorough literature search involving a number of databases (1966 to 2006) revealed very few evidence-based papers on air travel and children. Many of the existing recommendations are based on descriptive evidence and expert opinion. The present statement will help physicians to inform families about the health-related issues concerning air travel and children, including otitis media, cardiopulmonary disorders, allergies, diabetes, infection and injury prevention. An accompanying document (Information for Parents and Caregivers) is also available in this issue of *Paediatrics & Child Health* (pages 51-52) to help answer common questions from parents.

Key Words: *Airline; Air travel; Barotitis; Child safety; Hypoxia*

INTRODUCTION

Air travel has become such a convenient and accessible form of transportation that each year, an estimated one billion people, many of them children, travel on domestic and international airlines (1). Air travel has some unique safety and health issues, especially for the infant. On Air Canada flights, medical incidents (per 100,000 passengers) ranged from 1.7 (1982) to 3.4 (1988) (2). On Air France flights between 1989 and 1999, medical advice was sought 380 times (3). For both airlines, some of these events involved children, although the medical reasons were not clarified. Physicians need to be aware of the health issues related to travelling, identify children at risk for health problems during flight, and provide appropriate anticipatory guidance. A letter should be offered to families travelling with children with known health problems, detailing their medical condition, any need for medication and supplies (including needles for insulin injection and EpiPen injectors [DEY, USA]), and a medical action plan in case of emergencies, including contact information of medical personnel. Any mode of travelling with children requires preparation and an awareness of potential safety and health issues. The present guidelines were developed to help inform physicians about some of the health issues of children travelling by air.

OBJECTIVES

The objectives of the present guidelines are to provide information on the risks of airline travel to children, determine which pre-existing health conditions may be complicated by airline flight, and offer preventative measures that can minimize potential risks to children during flight.

METHODS AND RESULTS OF DATA COLLECTION

A literature search using the keywords 'aviation medicine' or 'air travel' or 'aerospace medicine' was performed for the following databases: PubMed indexed for MEDLINE (1966 to February 2006), EMBASE (1988 to February 2006), Global Health (1973 to December 2005), Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, Cochrane Central Register of Controlled Trials and the ACP Journal Club. Before limits were placed on the search strategy, 14,087 articles were identified. Articles related to medical air transport, space medicine, flight phobia, pilot training, decompression sickness and pregnancy were excluded. Further limitations included articles related to humans, age younger than 18 years, and English-language studies. Fifty-five articles were identified with these search parameters. Other articles were identified through the reference list of papers retrieved with the original computer search. Experts were consulted in areas related to otolaryngology and pulmonary medicine.

TRANSMISSION OF INFECTIOUS DISEASES

Airborne illnesses

Secondary to exposure time, recirculated air and limited ventilation in a confined area, airline passengers and crew are potentially at higher risk of infectious diseases (4). These factors, along with proximity to an index case, have been implicated for aircraft transmission of tuberculosis (all exposed patients were asymptomatic, but a few had a positive converted tuberculin skin test) (5,6), influenza (no cases, however, since 1999), severe acute respiratory distress syndrome (7) and measles (8); the latter could become more important with increasing international air travel combined with incomplete immunizations. Although several people with symptomatic meningococcal disease have flown on commercial airlines, there have been no reports of transmission of disease to date. In such cases, the airline should work

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TABLE 1
Patients recommended for evaluation of potential hypoxemia before air travel*

Patients with known or suspected hypoxemia
Patients with known or suspected hypercapnia
Patients with known chronic obstructive lung disease or restrictive lung disease
Patients who already use supplemental oxygen
Patients with a history of previous difficulty during air travel
Patients with recent exacerbation of chronic lung disease
Patients with other chronic conditions that may be exacerbated by hypoxemia

**The present table lists adult patients who should be evaluated before air travel, as recommended by the Canadian Thoracic Society (33). Children with these same conditions should also be referred for further evaluation (arterial blood gas, pulmonary function tests) to ensure safe air travel and the potential need for in-flight oxygen*

with the federal health authority to contact passengers at risk and provide chemoprophylaxis (9).

Despite the above cases, the chance of acquiring a respiratory infection while onboard an aircraft is quite small. One report by the World Health Organization (10) suggested that because transmission of respiratory infections is usually by direct contact, the risk to the aircraft passenger is no different than to travellers on a bus or train.

High-efficiency particulate filters in pressurized cabins remove 99.9% of bacteria and viruses from the cabin air (4,8). Another factor that limits the spread of infection is air exchange. On a modern aircraft, air is exchanged at least 15 to 20 times per hour, compared with five exchanges per hour in most homes and 12 exchanges per hour in some office buildings (8). As well, airflow occurs from top to bottom with little front to back flow, further minimizing infection risk (4,8). Handwashing remains the best form of protection and, at present, the routine use of face masks on airlines is not recommended (7,8).

A passenger who has, or appears to have, a communicable disease may be denied boarding by the airline (10). However, it is impractical for airlines to systematically screen all of its passengers. Therefore, health care professionals need to educate their patients about travel safety and help to identify those who are unfit for air travel (8). Furthermore, health care providers should promptly report to public health authorities a communicable disease obtained by a child after a commercial flight (and within the relevant infectious/incubation time).

Intestinal and vector-borne illnesses

Improper handling and preparation of food has caused several (but relatively uncommon) outbreaks of foodborne illness on aircrafts, most commonly from *Salmonella*, *Staphylococcus*, *Shigella* and *Vibrio* species (11-14). Some aircraft originating from destinations that have disease spread by insects (ie, malaria) will have the interior of the aircraft treated by an insecticide. Occasionally, passengers are onboard during this process. At present, the World Health Organization has not found any evidence that these insecticides are harmful (10); however, the risk to children is, at present, unknown.

Cardiopulmonary diseases and flight

Most airlines reach a cruising altitude of 9150 m to 13,000 m, an altitude which, if uncompensated for, would lead to a lethal level of airway hypoxia. Cabins are therefore pressurized to an atmospheric pressure of 2440 m (8000 ft), equivalent to approximately only 15% oxygen at sea level (15). While physiological factors (infants with fetal hemoglobin [oxygen saturation curve shifted to the left, airways more prone to bronchoconstriction]) and anatomical factors (relatively fewer alveoli, compliant rib cage, smaller diameter airways) in theory may put healthy infants and children onboard an aircraft at risk for hypoxia (15), less is known about the clinical impact of the lowered partial pressure on healthy children. Eighty healthy children aged six months to 14 years had their oxygen saturation measured before and during a long-haul flight (longer than 8 h). Although none of the children were symptomatic, the saturations decreased from 98.5% at preflight to 95.7% at 3 h of flight, and to 94.4% at 7 h of flight. A slight, although statistically significant, increase in heart rate was also reported, which was noted more in children older than six years of age. Sleeping was associated with a lower saturation. The investigators concluded that while healthy children may be asymptomatic from lowered oxygen saturations incurred during prolonged flights (longer than 3 h), children with pre-existing cardiopulmonary conditions that predispose them to hypoxia may be at greater risk during flight (16), including those with cystic fibrosis (17). However, some patients with cystic fibrosis may tolerate the aircraft cabin environment without the need for supplemental oxygen (18,19). Preflight spirometry can help to determine which patients with cystic fibrosis will require supplementary oxygen during flight (20).

Although a normal oxygen saturation can be reassuring, the response to altitude-related hypoxia is not fully known. Some children may therefore need specialized pulmonary testing, including spirometry and hypoxic challenge tests (Table 1). Adults with an arterial partial pressure of oxygen less than 70 mmHg may need oxygen; when breathing a mixture of nitrogen (85%) and oxygen (15%) (accomplished by simulating the cabin environment using the hypoxia altitude simulation test [HAST]), an arterial partial pressure of oxygen less than 55 mmHg suggests the need for supplemental oxygen on an aircraft. How comparable these values are for children is not known; however, for children with risk factors (Table 1), the child's partial pressure of carbon dioxide should be checked because hypercapnia can suggest poor pulmonary reserve, which could potentially be problematic at higher altitudes (1). Infants with chronic lung disease are particularly at risk, although otherwise healthy infants, especially if born premature, are also at risk (15). Arrangements to provide oxygen and monitoring equipment need to be made in advance with the airline. Oxygen bottles onboard an aircraft can supply 2 L/min for 4 h 22 min, 4 L/min for 3 h 13 min, 6 L/min for 1 h 30 min, and 8 L/min for 1 h 12 min (2).

There are some cardiovascular diseases that are contraindications to commercial airline flight; those in particular for paediatric patients include uncontrolled hypertension, uncontrolled supraventricular tachycardia and Eisenmenger's syndrome (21).

Vascular disorders and flight thromboembolic disease

At present, there is no evidence that healthy children on a prolonged flight are at risk for deep vein thrombosis. The Cochrane Peripheral Vascular Diseases Group, however, has submitted a protocol that may assess this level of risk (22). Children with thrombophilia, previous thromboembolism, malignancy or major surgery within six weeks may be at high risk of developing deep vein thrombosis and may require prophylaxis with low-molecular-weight heparin or acetylsalicylic acid (1). Consultation with a thrombosis specialist may be indicated. At present, there is no evidence to support prophylactic acetylsalicylic acid use in healthy children; indeed, this could put children at risk for Reye's syndrome.

Sickle cell disease

Children with sickle cell trait have not been documented to have any medical problems during routine air travel. However, because of the reduced oxygen pressure in the cabin, people with sickle cell anemia are at risk for a crisis episode during flight. Medical oxygen should be available for these children during flight. Oxygen therapy on aircraft has been recommended at altitudes of over 2135 m (7600 ft) in people with sickle cell disease, especially if they have splenomegaly and relatively higher blood viscosity (15).

Otitis media and flight

Changes in ambient pressure can affect the pressure in the middle ear. Barotrauma, characterized by otalgia, is a consequence of the inability to equilibrate this pressure differential; this is often more severe during landing than takeoff. Most people, including older children, can equilibrate the pressure through yawning, swallowing, chewing or the Valsalva manoeuvre (pinching the nose and blowing is often the simplest form). Infants and young children, however, are often unable to deliberately perform these activities. Parents can assist their children by encouraging them to drink or chew; this may be more beneficial during descent than takeoff (23).

Barotitis media is an inflammatory change (acute or chronic) of the middle ear secondary to barotrauma. It is characterized by sudden ear pain, impaired hearing, and occasionally vertigo and rupture of the tympanic membrane. One study (24) found that 22% of children had a finding of barotitis after a flight, and previous ear pain and nasal congestion were associated factors. Barotitis may be prevented by teaching children how to perform a Valsalva manoeuvre, by tympanostomy tubes, or by treating nasal congestion or a sinus infection before a flight.

Physicians are frequently asked about the impact of flying on children's ears (pain and hearing), especially if there is a history of otitis media; despite this, there are very few published studies, and most of these are descriptive or based on expert opinion. At present, from the information available, children with recurrent otitis media and adenoidal hypertrophy have a harder time equilibrating the pressure of the middle ear. With the advice of a physician, a topical nasal decongestant can help if used at least 30 min before takeoff and landing (15). In a randomized, double-blind, placebo-controlled study, oral pseudoephedrine did not provide any symptomatic benefit for children with ear pain during flight, but it did increase drowsiness (25). In a prospective study, limited by a sample size of 14, children with otitis media with effusion did not experience an increase in symptomatology or complications because of air travel, perhaps because the eustachian tube was filled with fluid, rather than gas or air-fluid levels (26). Children adequately treated for acute otitis media (AOM) may be able to safely fly two weeks from diagnosis (27); this evidence, however, is limited to expert opinion. If possible, children with AOM should be clinically evaluated before air travel. If the diagnosis of AOM is made within 48 h of a flight that cannot be postponed, the child should be provided with appropriate analgesia.

Food allergies

Food allergies can be problematic to prevent on an aircraft. Peanut allergy is one of the most common and severe allergies in children. While many airlines no longer offer peanut snacks, they cannot prevent passengers from bringing their own food onboard. As such, there is always the potential for exposure to a food allergen. With advance notice, some airlines can try to provide a 'peanut-free zone' on the aircraft (28). However, the feasibility of creating a peanut-free zone on an aircraft may be problematic, and perhaps even provide a false sense of security, because peanut dust, which contains peanut protein, can potentially be distributed through the ventilation system; to cause an allergic reaction, at least 25 passengers may have to be eating peanuts (29). A telephone interview of the 3704 people registered in the United States Peanut and Tree Nut Allergy Registry revealed that 42 had a reaction on an airplane, with a mean age of 5.9 years. Of the 42 individuals, 35 had a reaction to peanuts, of which only 14 were from direct ingestion. The other reactions (some severe) were from skin contact and inhalation. Surprisingly, the flight crew was notified in only 33% of the reactions (29). While allergic reactions to inhaling peanut protein are very rare and require exposure to a large volume of peanut protein (ie, through many passengers opening peanut bags), parents should still alert the airline and crew that their child is allergic, and carry an EpiPen and antihistamines on the aircraft.

Managing type 1 diabetes and air travel

A child with type 1 diabetes may fly and travel safely, provided that adequate preparation is made, including speaking with their diabetic specialist and the airline. Insulin dosing may need to be adjusted if time zones are crossed during flight. When travelling east, the day is shortened and, if it is shortened by more than 2 h, it may be necessary to decrease the amount of intermediate- or long-acting insulin. Conversely, if the day is lengthened by more than 2 h (by travelling west), more units of insulin may be needed.

Seizures and flight

Provided that seizures are controlled with medication, epileptic children can travel by air. Parents, however, need to be aware that some aspects of air travel, jet lag, delayed meals, potential hypoxia and fatigue can lower the seizure threshold. As a precaution, parents should notify the flight attendants during boarding that their child has a seizure disorder. Antiepileptic medication should be readily available (ie, in carry-on luggage).

Air sickness

There are many potential causes of air sickness: air turbulence, seat position (increased movement at the rear of the aircraft), anxiety and history of motion sickness. Antiemetic compounds are more effective if given before the onset of nausea and vomiting. Dimenhydrinate is the most commonly used antiemetic compound. There are no data on the safety of other antiemetic compounds, such as transdermal scopolamine in children. While parents should be advised of the sedation side effect of dimenhydrinate, they should be cautioned against using the drug for this purpose. Excessive sedation, combined with the lower oxygen partial pressure in the cabin, can potentially be dangerous for some children. Alternatives to antiemetic drugs for air sickness include directing cool ventilated air to the face, gazing at the horizon, and selecting a seat away from the rear of the cabin (1).

Behavioural effects

A healthy child, let alone a child with a behavioural problem (ie, attention deficit hyperactivity disorder, autism or developmental delay), may find the experience of air travel stressful. Parents need to consider not just the in-flight experience of cramped seats, turbulence and restricted access to washrooms, but also the time and potential stress involved with crowds, waiting in line, security checks and unexpected delays or cancellations of flights (1).

To help prepare their child, before travelling, parents could show their children books about plane travel, explain the different steps needed (travelling to the airport, security checks, waiting in different lines), and take practice trips to the airport. If anxiety is a concern, the parents could practice a relaxation technique with their child. Because of potential side effects (oversedation and paradoxical irritability), medications such as dimenhydrinate, chloral hydrate and promethazine should not be used for behavioural control of children onboard an aircraft.

Jet lag

Jet lag refers to a group of symptoms (daytime fatigue, sleeping difficulties, irritability and decreased mental efficiency) that can occur when there is an imbalance between the body's internal clock and the external environment. Risk factors include crossing multiple time zones, especially in the eastward direction, and poor sleep. Presently, it is not known to what extent children experience jet lag, but it may differ because children express high amounts of melatonin, a hormone used as an effective treatment for adults with jet lag. Melatonin is not recommended for children with jet lag, however, because its side effect profile has not been well studied, and a recent meta-analysis (30) did not show any benefit for its use in children with secondary sleep disorders or jet lag.

Medical mechanical devices on aircraft

With changes in cabin pressure, gas expansion in some pneumatic components (ie, feeding tubes or urinary catheters) can introduce air into a hollow viscus. All feeding and infusion tubes should be capped off during takeoff and landing.

Orthopaediatric casts

Trapped gas beneath a cast may expand during a flight. For children with a recent fracture (48 h), a plaster or fiberglass cast should be bivalved to prevent pain and circulatory problems. Children should also be provided with adequate analgesia and instructions for proper limb elevation (the safety of the latter point should be reviewed with the airline crew, particularly during takeoff and landing). Pneumatic splints are not allowed on most airlines (21).

Injury on aircraft

Parents travelling on a commercial flight with children younger than two years of age can choose for their child to fly for free (providing they are held on the adult's lap as directed by the flight attendant). Alternatively, parents may purchase a ticket, often for a reduced price, and have the child occupy a passenger seat secured in a child car safety seat (purchased in Canada, complete with the national safety mark and labelling indicating certification for use on an aircraft). Some airlines do not allow the use of the base, when it is deemed as optional by the car seat manufacturer (Dr L Warda, personal communication). Parents should ensure that they have the car seat instructions onboard, which may have special instructions for installation and use on aircraft. Front infant carriers or slings should not be used for this purpose and must be removed during the flight (takeoff and landing). Although data are limited, unrestrained infants have a relatively higher mortality risk than restrained adult passengers (31). Child safety seats have provided protection for children in at least two airline crashes.

In 2001, the American Academy of Pediatrics published a policy statement recommending a mandatory federal requirement for restraint use for children on aircraft (31). Subsequently, a risk and economic analysis was performed to determine the impact of such legislation on child mortality.

TABLE 2
Levels of evidence and strength of recommendations*

Level of evidence	Description
I	Evidence obtained from at least one properly randomized trial.
II-1	Evidence obtained from well-designed controlled trials without randomization.
II-2	Evidence obtained from well-designed cohort or case-controlled analytic studies, preferably from more than one centre or research group.
II-3	Evidence obtained from comparisons between times and places, with or without the intervention. Dramatic results in uncontrolled experiments could also be included in this category.
III	Opinions of respected authorities, based on clinical experience, descriptive studies or reports of expert committees.
Grade	**Description**
A	There is good evidence to recommend the clinical preventive action.
B	There is fair evidence to recommend the clinical preventive action.
C	The existing evidence is conflicting and does not allow a recommendation to be made for or against use of the clinical preventive action; however, other factors may influence decision-making.
D	There is fair evidence to recommend against the clinical preventive action.
E	There is good evidence to recommend against the clinical preventive action.
F	There is insufficient evidence (in quantity or quality) to make a recommendation; however, other factors may influence decision-making.

**Table adapted from reference 34*

One study (32) estimated that child safety seats on airlines could prevent between 0.05 to 1.6 deaths per year. The investigators concluded that if child safety seats were mandated for children younger than two years of age, many parents may choose instead to travel by vehicle, which, in turn, could increase motor vehicle mortality (32). However, despite this conclusion, the United States Federal Aviation Administration still strongly recommends the use of child restraints on aircraft. Further research on child safety and injury prevention in aircraft needs to be conducted.

Physician assistance on aircraft

Flight attendants are trained in basic first aid and cardiopulmonary resuscitation. However, medical situations often arise on aircraft, prompting an announcement for medical assistance from a trained health care provider. Physicians should be aware that if they volunteer to assist on an aircraft, they are protected from liability by the 'Good Samaritan' provision of the Airline Passenger Safety Act (7). A basic first aid kit can be found on almost all commercial airlines, and for those with more than 100 passenger seats, a more complete emergency medical kit is available; this should include basic resuscitation medications and equipment, some of which may be appropriate for children. A detailed list of recommended equipment can be found in the Aerospace Medical Association's Medical Guidelines (1).

SUMMARY

There is little evidence-based research in medical aerospace studies, particularly involving children. As such, the following recommendations were based on case reports, cohort studies, review articles and expert opinion from specialists and the Community Paediatrics Committee of the Canadian Paediatric Society. These recommendations may change as more evidence on this topic is published. Corresponding levels of evidence and strength of recommendations can be found in Table 2.

RECOMMENDATIONS

- Holding an infant or child on a caregiver's lap is improper restraint and has the potential to contribute to injury on an aircraft, particularly in the event of turbulence (Level III, Grade C).
- If possible, children with AOM should wait two weeks before air travel. For AOM, a topical nasal decongestant can be used before takeoff and landing, as directed by a physician. Swallowing, sucking and the Valsalva manoeuvre are effective strategies to minimize discomfort during takeoff and landing. Children who fly with otitis media with effusion may not experience as much discomfort or complications compared with those with AOM (Level III, Grade B). Oral decongestants are not recommended to treat air travel-associated ear pain in children (Level I, Grade A).
- Some children with cardiopulmonary diseases and sickle cell disease may require oxygen during flight. Consultation with a physician before travel is recommended (Level III, Grade A).
- Physicians should be prepared to write a medical letter briefly describing the patient's medical status, and if necessary, the need for medical equipment (ie, oxygen or pumps), supplies (ie, needles and syringes) and medications (Level III, Grade A).

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