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Over one billion people fly on commercial aeroplanes each year, and taking young children abroad on holiday is an expected part of modern life in the United Kingdom. This article considers the issue of whether it is safe for infants and young children to fly, and reviews the hazards. It principally focuses on issues of hypoxia and respiratory disease but also reviews other areas (box 1). The British Thoracic Society 2004 guidelines[1] suggest that "it is prudent to wait for 1 week after birth before allowing infants to fly to ensure they are healthy", which is similar to the international Aerospace Medical Association, which suggests waiting 1 to 2 weeks after birth.[2]

HYPOXIA DURING AIR FLIGHT

The greatest concern is the effect of hypobaric hypoxia (hypoxia caused by a lowered oxygen pressure at altitude). Commercial aeroplanes fly at an altitude of 30–40 000 ft (9144–12 192 m), which would result in an equivalent fraction of inspired oxygen (FiO_2) of only 0.04 (as opposed to 0.21 at sea level). To counteract this, aircraft cabins are pressurised so that the passengers are at the equivalent of 5–8000 ft (1525–2438 m); at this level the air has an equivalent FiO_2 of 0.15–0.17. US Federal Aviation Regulations stipulate that cabins must not be pressurised to above 8000 feet (around 560 mm Hg), and if the cabin altitude rises above this, emergency oxygen masks are deployed automatically. It is theoretically possible for aircraft to be maintained at a sea-level pressure (760 mm Hg), but this would be less energy- and no doubt less cost-efficient; it would also reduce the working life of the aluminium airframes.[3]

Box 1 Issues and conditions reviewed

1. **Hypoxia especially related to ex-premature babies with chronic neonatal lung disease**
2. **Other respiratory conditions**
   - Asthma
   - Cystic fibrosis
   - Recent pneumothorax
   - Cystic lung conditions
   - Non-invasive ventilation
3. **Non-respiratory conditions**
   - Infection
   - Cardiac disease
   - Diabetes mellitus
   - Sickle cell disease
   - Middle ear barotrauma
   - Acute mountain sickness
   - Behavioural problems and jet lag

Serious effects of altitude hypoxia do not usually arise until the atmospheric pressure drops to the equivalent of 10–12 000 feet (3048–3658 m).[4] Although Mount Everest at 29 035 feet (8850 m) has been climbed without supplemental oxygen, there is no time for acclimatisation during air flight. Breathing air containing 15–17% O_2 can cause hypoxia in predisposed individuals. Eighty healthy children aged 6 months to 14 years were studied during 8–10 h flights between Hawaii and Taiwan.[5] At sea level, their mean oxygen saturation (SaO_2) was 98.5% and mean heart rate was 105 beats per min; after 3 h of flight it was 95.7% and 105 beats per min, and after 7 h of flight 94.4% and 108 beats per min. The SaO_2 results were marginally higher in the children under 2 years of age. No acclimatisation occurred and SaO_2 was lower when the children were asleep (mean 93.4% versus 94.8% at the 7 hour measurement). A further study measured oxygen saturation using pulse oximetry on the ground and then during a flight in 84 passengers, ten of whom were aged 10 years or younger.[6] The mean (range) SaO_2 was 97% (93–100%) at ground level, which fell to a mean of 93% (85–98%). Over half the passengers had SaO_2 of 94% or less during the flight, and there was no difference between short- and long-haul flights.

SUSCEPTIBILITY OF INFANTS TO HYPOXIA

A study of 67 healthy full-term infants aged 29–54 days showed their baseline SaO_2 (measured by pulse oximetry) ranged from 97–100% (median 99.8%).[7] Eighty-one percent of infants had episodes of desaturation to 80% or less (occurring at a median of almost 1 per h); they were short, however, with a median duration of 1.2 sec, and 97% were less than 4 sec. The baseline SaO_2 of preterm babies measured at term is similar to babies born at term, but oxygen desaturations were more frequent (median 5.4 per h) and longer (median 1.5 sec) than the term infants.[8] Newborns and infants below 1 year of age have an increased tendency to ventilation–perfusion mismatch, making them particularly susceptible to hypoxaemic episodes, especially if they are ill or in the presence of airway hypoxia.[4] There are a number of factors that contribute to this greater risk of developing hypoxia: the presence of fetal haemoglobin (with the oxygen-dissociation curve shifted to the left); tendency to pulmonary vasoconstriction in the presence of airway hypoxia; tendency to bronchoconstriction in the presence of airway hypoxia; relatively fewer alveoli; compliant rib cage; and smaller airway diameter.[4] In addition, in the first two months of life, infants may show a

paradoxical inhibition of the respiratory drive causing apnoea/hypoventilation in response to hypoxia or infection.[4]

DOES A PERIOD OF HYPOXIA MATTER?

Although the effects of chronic hypoxia and living at altitude are well established (reviewed by Samuels[4]), the effect on infants of short periods of hypoxia (eg, during air flight) is less well known. It is known, though, that hypoxia can cause apnoea and hypoventilation, so the greatest concern is whether a period of hypoxia can lead to an acute life-threatening event (ALTE) or actual sudden infant death (SID). There have been rare case reports of sudden death following air flights.[9] However, the confidential enquiry into stillbirths and deaths in infancy (CESDI) sudden unexpected deaths in infancy (SUDI) case-controlled study 1993–96 found none of the 456 cases of SID had flown (or been at high altitude) in the month prior to death, compared with two of the control infants who had flown.[10] In the correspondence following publication of their study, Professor Southall reported that they had since received letters from parents and doctors that identified ten infants who had died within a few days of an airline flight, and four infants who had an ALTE during a flight, one of whom died shortly after landing.[11] Nevertheless, it is generally believed that flying is safe for healthy children in the first year of life.[12] In practical terms, many millions of infants must have flown and not suffered either short- or long-term adverse effects from their periods of reduced SaO_2. If a significant problem existed, it is likely that we would know about it (although without conclusive data that is not necessarily the case).

Nevertheless, to learn more about the effects of the aircraft level of hypoxia on healthy infants, Parkins *et al* studied 34 healthy infants (born at term) at a mean age of 3 months (range 1–6 months) by exposing them to 15% oxygen for a mean of 6.3 h.[9] The exposure was discontinued if the saturations dropped to <80% for 1 min or more. The median baseline SaO_2 fell from 97.6% to 92.8% (median fall 4.9%), and this was accompanied by a significant tachycardia. The individual response was unpredictable as the baseline SaO_2 in room air did not correlate with the size of the subsequent fall. There was a reduction in the proportion of time spent with a regular breathing pattern, and a 3.5-fold increase in the time spent in periodic apnoea. Four out of 34 infants had a significant desaturation to <80% for 1 min or more (remaining asleep) and were withdrawn from the study at 1.9–5.2 h; one required supplemental oxygen for the next hour to maintain SaO_2 above 94%. Somewhat controversially, the authors concluded that air travel may be harmful to some infants.

PRE-FLIGHT TESTING: THE "FITNESS-TO-FLY" TEST

Since SaO_2 at sea level is a poor indicator of SaO_2 during air flight,[13] a test has been developed where the inspired oxygen concentration is set at the level expected during flight in a controlled safe manner. The closest simulation would be to sit in a hypobaric chamber, as this would reproduce both the reduction in atmospheric pressure and inspired oxygen; however, these chambers are not readily available. Dilliard *et al* confirmed the reliability of the hypoxia inhalation test (breathing 15.1% oxygen through a mouthpiece for 15 min) by comparing it to a hypobaric chamber (set at 8000 ft) in adults.[14]

Infants can not use a mouthpiece, and rather than wearing a facemask, which many children find unacceptable, an alternative method is to have the child sit on their parents/carer's lap inside a sealed body plethysmograph (fig 1). The FiO_2 is then reduced to 15% by adding nitrogen into the chamber over 5 min.[15] A pulse oximeter is used to measure the SaO_2 and heart rate, and the patient is observed throughout the test. Carbon-dioxide levels in the "box" do not exceed 0.5% and do not need to be monitored.[16] If the patient's SaO_2 drops to 85%, or below, oxygen is administered immediately and titrated until the SaO_2 is normal (which indicates how much oxygen will be required during the flight). This method is the one recommended by the British Thoracic Society guidelines.[1] Its successful use has been reported in 20 children aged 2–54 months with a history of a variety of chronic pulmonary conditions in early infancy, who were due to fly.[16] Eight children desaturated below 90% and all children had normal SaO_2 at the baseline. Nine of the children were ex-preterm (gestational age 23–34 weeks, median 27 weeks) and were tested at a median age of 6 months (range 3–19 months). Eight of the nine had chronic neonatal lung disease, and all desaturated (median from 99 to 92%) but in only one was oxygen recommended for the flight.

However, many centres do not have access to a plethysmograph, therefore, the hypoxia inhalation test has also been carried out on infants using a facemask.[13 17] It is important to ensure the mask is tight enough, otherwise room air entrainment occurs, which increases the oxygen concentration delivered. A department in Perth, Australia, have reported their experience on 47 ex-preterm infants (23–36 weeks gestation, median 27 weeks) who had pre-flight testing (using this facemask method) at a median corrected age of 1.4 months.[13] They all had a history of neonatal lung disease, 32 out of 47 had chronic neonatal lung disease (CNLD) but none was receiving supplemental oxygen. All infants had a baseline SaO_2>95% at sea level but despite this 81% of the infants desaturated to less than 85% and were recommended to have supplemental oxygen on the plane. Median time for the SaO_2 to fall to 85% in those

Figure 1 Body box plethysmograph used for pre-flight testing. Informed consent was obtained for publication of this figure.

failing the test was two minutes. Baseline saturation did not predict outcome, however, age at testing was an important predictive factor with the younger children more prone to significant desaturation. The authors suggested that all children with a history of neonatal lung disease and a corrected age under 3 months would require in-flight oxygen, and that testing was indicated in all infants under 1 year corrected age. This does not necessarily apply to ex-preterm babies who had no respiratory problems.

Subsequent to this, the Perth group has published a study in which they performed their hypoxia challenge in 46 premature babies who were being transferred back to local hospitals at a corrected gestational age of 33–43 weeks (median 36).[18] None required supplemental oxygen, and 76% passed the test (with an 85% cut-off level for SaO_2). However, 12 out of 35 (34%) babies who passed the test required oxygen on the flight and seven out 11 who failed the test did not require oxygen. This led the authors to conclude that the hypoxia challenge with a facemask was not accurate at identifying who would require oxygen during airflight, at least in ex-premature babies who were still relatively young (only 11% were over 37 weeks corrected gestational age). Given their earlier work,[13] the surprise was that so many infants had passed the test in the first place, given 59% had a history of neonatal lung disease and they were all under 3 months.

Since the Udomittpong study,[13] a new protocol at the Neonatal Unit at Chelsea and Westminster Hospital has been devised. Now, fitness-to-fly tests are performed in all ex-preterm babies with a history of CNLD and a corrected age <1 year, whose parents were planning to fly with them. In the past year, we have tested 16 ex-preterm infants (gestational age range 24–35 weeks), nine patients failed and required in-flight oxygen. Comparing those who failed with those who passed, there was no difference in gestational age (median 28 weeks for both groups), although those who failed tended to be younger at the time of testing (median 5 versus 7 months). There was no difference in the baseline SaO_2 (median 98 verus 99%), and while all desaturated significantly, obviously it was greater in the failed patients (median 84 versus 92%).

BRITISH THORACIC SOCIETY 2004 GUIDELINES

The BTS 2004 guidelines (table 1) suggest that any oxygen-dependent infant who must fly should have their oxygen requirements titrated in advance with a fitness-to-fly test. The BTS also suggests that if an infant has had neonatal respiratory problems, a hypoxic challenge should be considered, and they recommend the "body box" method as described above.[15] They recommend supplemental oxygen be given if the SaO_2 falls below 90%. They also recommend that ex-preterm infants who have a current respiratory infection should probably not fly if they are still under the age of 6 months post expected date of delivery. This latter recommendation is because of the increased risk of apnoeic episodes with respiratory infections.

The 2004 BTS recommendation that desaturating below 90% during a fitness-to-fly test be the cut-off for requirement of supplemental oxygen is not evidence-based, but an arbitrary consensus view. In fact, in their initial 2002 guideline they took 85% as the cut off. The critical question that remains is whether it matters if the SaO_2 falls below 90% or even 85%. As discussed above, apart from the potential risk of ALTE,[9] there seems to be little evidence to suggest that SaO_2 of 85–90% for a few hours is harmful. Chronic or intermittent hypoxia has been shown to adversely affect cognitive and behavioural outcomes, particularly in some children with congenital cyanotic heart disease and sleep-disordered breathing;[19] and certainly animal work has demonstrated harm from short intermittent periods of hypoxia. Nevertheless, for the majority (if not all), it is unlikely air travel has a similar adverse effect because of the relatively short periods involved and generally minor reduction in oxygen levels. It is possible though, that some children are more susceptible to mild levels of oxygen desaturation, similarly to how some people may be genetically susceptible to altitude-related illness.[20] Identifying these adverse responders would be important if it became feasible.

In a recent study, a hypoxia test (14% oxygen for 20 min via a facemask) was performed in 34 healthy children and 35 children with a history of CNLD (<5 years old).[21] In children under 2 years old, a cut-off of 90% meant that 12 out of 24 healthy children and 14 out of 23 with CNLD "failed" the test and would be recommended to have in-flight oxygen (all children >2 years passed). Using 85% as a cut-off, only one out of the 24 healthy children and six out of 23 with CNLD failed. This would suggest that the BTS-recommended 90% cut-off may be too high, otherwise half of all healthy children would need extra oxygen in planes. Clearly this cannot be right, as there is a huge global experience showing that for many decades many infants have flown without encountering respiratory difficulties. This discrepancy may have arisen because in the study the babies were breathing through a facemask, which increases the dead space and may effect the minute volume.

GETTING SUPPLEMENTAL OXYGEN ON BOARD THE PLANE

Many airlines will not allow passengers to take their own oxygen supply on-board, but with advance notice, most will provide oxygen cylinders for the flight, although often they will not allow its use during take-off and landing. However, some airlines refuse use of supplemental oxygen, and many can only cope with one passenger per flight having it. The flow rate is usually fixed, at either 2 or 4 l per min. In addition, many airlines charge the passenger, and the amount can be variable (eg, British Airways charge £100 each way while Virgin Airlines do not charge). A list has been compiled on the web sites of the Grown Up Congenital Heart Patients Association (www.guch.org.uk) and US National Home Oxygen Patients Association (www.homeoxygen.org) that gives advice on each airline. Airlines do not supply oxygen for use in the airport. Clearly parents should contact the relevant airline before booking a flight.

OTHER RESPIRATORY CONDITIONS

Asthma

Aside from someone with asthma having an acute exacerbation during the flight, there are no contraindications to flying. However, the patient should have all their medication (including spacer device) available in their hand luggage. It might be sensible for those with difficult asthma going on a long flight to have a supply of oral corticosteroids in their hand luggage as well. Battery-operated nebulisers can be used on board (with prior notification to the airline) but spacers are as effective anyway and certainly more convenient. Infants with chronic neonatal lung disease have an increased risk of airway reactivity and bronchoconstriction if exposed to a degree of hypoxia.

Cystic fibrosis

The air extracted from outside the plane at high altitude is extremely dry, so that the humidity inside the plane ranges from 10–20%, which can dehydrate airway secretions.[22] This

Table 1 Some principal recommendations from the British Thoracic Society 2004 guidelines[1]

Risk factor	Advice
Infants	Wait 1 week to ensure the infant is healthy
Ex-preterm baby	Should probably not fly under the age of 6 months post expected date of delivery if they have a respiratory-tract infection
Neonatal respiratory illness	Should have pre-flight assessment including hypoxic challenge testing
Oxygen dependent	Oxygen requirements should be titrated with a fitness-to-fly test
Cystic fibrosis	Assessment by the cystic fibrosis physician In-flight nebulised antibiotics should not be required Check with pharmacist whether medicines should be kept in hold
Previous pneumothorax	Patients should be able to fly 1 week after a chest radiograph confirms resolution or after 2 weeks for a traumatic pneumothorax
Chronic lung disease	If FEV_1<50% should undergo pre-flight assessment including hypoxic challenge testing
Infections	The following should not fly on commercial flights: ► Infectious TB patients until rendered non-infectious ► Those from an area with recent transmission of SARS and symptoms compatible with SARS

might be a particular problem for children with cystic fibrosis (CF), and this issue becomes even more important with an increased respiratory rate (compensatory hyperventilation) that can occur in the presence of relative hypoxia. The BTS guidelines state that children with CF should be assessed by a CF specialist prior to air flight.[1] Buchdahl *et al* performed a study whereby 87 children aged 7–19 years with CF had pre-flight testing prior to intercontinental flights and compared the results with in-flight pulse oximetry.[23] Ten children desaturated <90% at some point, but the pre-flight hypoxia test predicted this in only two of them, although spirometry (forced expiratory volume in one second (FEV_1) <50% predicted) was predictive in seven. The authors felt the study provided evidence that it is preferable to perform pre-flight testing on children with CF who have a FEV_1<50% predicted or who are already having supplemental oxygen. However, using FEV_1 alone as a criterion for testing will still miss some patients who are at risk of desaturation (30% in their study). Oades *et al*[24] also studied 22 children with CF prior to their holidays to the French Alps and eight children going to the United States. They performed a 15% hypoxic challenge, spirometry and pulse oximetry during the flight and at altitude in the mountains (1800 m). They found that all of the children showed significant desaturation with all hypoxic challenges. However, they found that the hypoxia inhalation test was a better predictor of desaturation (in either the aeroplane or at 1800 m in the Alps) than spirometry or SaO_2 at sea level.[24] They found that spirometry and baseline SaO_2 tended to underestimate the desaturation risk in some patients.

Recent pneumothorax

Clearly a patient with a current closed pneumothorax should not fly on a commercial flight.

Commercial airlines currently arbitrarily advise that there should be a 6-week interval between having a pneumothorax and travelling by air, but this is not based on any evidence.[1] The BTS guidelines on both the management of a spontaneous pneumothorax[25] and air travel [1] suggest that patients who have had a spontaneous pneumothorax not requiring active intervention should be cautioned against flying until a follow up chest radiograph (2 weeks later) confirms full resolution of the pneumothorax. It is also suggested that it is sensible to have a further short period of stability before flying (usually 1 week). In the case of a traumatic pneumothorax, the period should be 2 weeks after full radiographic resolution. They also state that while recurrence is unlikely during a flight, since the consequences may be serious, patients may wish to consider alternative transport for 1 year after the pneumothorax (after which the recurrence risk declines significantly). If a pneumothorax was treated surgically by pleurodesis, the recurrence rate is so low that it is suggested there should be no travel restrictions.[1]

Cystic lung conditions

If an intrapulmonary cyst is connected to an airway then there should be no problem as the air inside the cyst will equalise with the atmospheric pressure inside the air cabin. The issue is different for a completely encysted air space, such as is found with certain congenital thoracic malformations. Although many of these lesions are asymptomatic and go undetected, routine detailed antenatal ultrasounds are now picking up many of these lesions. The decision whether an asymptomatic lesion should be resected is not clear cut,[26] and even if surgery is planned, it is often delayed until the child is 2 years or older. The air would expand inside the lesion as the atmospheric pressure drops in the plane by about 38% at 8000 ft (2438 m);[1] although this could theoretically lead to rupture and subsequent pneumothorax, haemothorax or air embolism, it has not previously been considered to be a significant risk. It is also unlikely to become such a significant size as to cause compression of adjacent lung tissue or even shift the mediastinum. Nevertheless, a recent case report of a 17 year old highlighted the potential danger, describing a cerebral air embolus arising from a large congenital cystic adenomatoid malformation in the left upper lobe (and a smaller one in the left lower lobe), which presumably had ruptured.[27] The patient was unaware of the lesion and had flown four times previously. There has also been a report of a large bronchogenic cysts leading to fatal air embolism[28] and a report of a case of air embolisation from a large intrapulmonary bulla treated successfully with hyperbaric oxygen (both in adults).[29] It is hard to know what advice to offer parents of children with known congenital lesions after this latest case report, but perhaps they should be aware that there is a risk (albeit small) of a child with a large cyst flying, in which case they may opt for elective surgery.

NON-INVASIVE VENTILATION

There is no reason why children who require non-invasive ventilation cannot fly. Airlines do need prior warning and a dry-cell battery pack (wet-cell packs are prohibited) should be available. A potential problem is that some airlines require the ventilator to be turned off during take off and landing, which is obviously problematic if the child is completely ventilator dependent. The BTS guidelines[1] state that a medical escort must able to change the tubing, operate a suction machine and hand ventilate the patient if necessary, something parents of these children would be expected to do anyway.

NON-RESPIRATORY ISSUES

Infection

Airline passengers (both adults and children) and crew are subject to a higher risk of infectious diseases — some people always seem to catch a viral cold on long flights (personal

communication, C Wallis). This is thought to be secondary to the increased exposure time to others in a confined space, recirculation of air and limited ventilation.[30] There is evidence that these factors contributed to patients contracting tuberculosis, influenza, severe acute respiratory distress syndrome (SARS) and measles from an index case in close proximity. The risk is, however, small and the World Health Organisation states that the risk does not differ from that for passengers on a bus or train.[31] Measures are taken to reduce the spread of infection on aircraft during flying — these include the use of air exchange, which occurs 15 to 20 times per h in-flight (compared with five per h in most homes and 12 per h in some offices), and the use of particulate air filters to remove a large proportion of bacteria and viruses.[32] In addition, the air flow is from floor to ceiling rather than along the length of the aircraft. The BTS guidelines state that patients with infectious tuberculosis should not fly until they are rendered non-infectious.[1] Passengers from an area with recent transmission of SARS and symptoms compatible with SARS should not fly; and contacts of probable or confirmed SARS within the preceding 10 days should not fly.

Cardiac disease

There are currently no established guidelines on the safety of patients with congenital heart disease (CHD) flying. This is an area that needs to be studied; does it matter if a child with cyanotic CHD and a SaO_2 of 75% at sea level desaturates further? A small study of 12 adults with cyanotic CHD and acquired pulmonary hypertension found that when spending 1.5 and 7 h in a hypobaric chamber (with equivalent FiO_2 15%), their SaO_2 fell from a mean 86% (range 69–98%) to 78% (range 56–90%).[33] During a subsequent 2.5 h air flight, however, the mean SaO_2 was 83% (range 78–94%), and, importantly, there were no clinical problems encountered. It has been recommended that paediatric patients with uncontrolled hypertension, uncontrolled ventricular or supraventricular tachycardia, and Eisenmenger syndrome should not fly,[2] but there is little evidence to support this. In fact a survey of 53 adult patients with Eisenmenger syndrome and 48 with acyanotic congenital heart disease who had taken over 1100 flights between them found the patients with Eisenmenger flew safely with no major adverse events.[34]

There is currently no evidence that normal healthy children are at an increased risk of developing venous thromboembolism during airflight. However, children with significant thrombophilia, previous thromboembolism, malignancy and recent major surgery may be at a higher risk of thromboembolism and may require prophylaxis with low-molecular-weight heparin.[2] Advice from a paediatric haematologist should be sought.

Diabetes mellitus

Obviously all medication and equipment (including needles) must be carried in the hand luggage. Insulin in the hold may be subject to freezing and thus inactivated. Problems can be encountered flying across time zones in terms of altered mealtimes and insulin regulation. The meals themselves may be unsuitable and dehydration must be avoided.

Sickle cell disease

Children with sickle cell disease have a higher incidence of crises at higher altitude. In an old study performed by Mahony *et al*, 75 children with sickle cell anaemia were questioned about their experience when travelling in the mountains and flying.[35] They found that 20% with HbSC or HbS/beta thalassemia (but none with Hb SS) had experienced crises during airflight. There is no evidence that sickle cell trait confers any risk of crises with flying or altitude and this was also confirmed in this study. The UK Sickle Cell Society (www.sicklecellsociety.org) recommends affected people avoid dehydration on long flights, do not sit for too long and that some take an aspirin before the flight. On the other hand, British Airways suggest that those with sickle cell anaemia should travel with supplemental oxygen and should defer travel for 10 days following a sickling crisis (www.britishairways.com/health/docs/before/airtravel_guide.pdf).

Middle ear barotrauma

Otic barotrauma, which may occur during air travel, is caused by a failure to equilibrate the middle ear and atmospheric pressure difference and tends to occur more commonly during descent.[36] Children are particularly prone to this as they have narrower Eustachian tubes and are less able to regulate the pressure difference by performing a Valsalva manoeuvre. They are also more likely to have a viral cold, and adenoidal tissue can also obstruct the Eustachian tube orifice. Parents are therefore advised to encourage their children to drink, chew, suck and to blow their noses, especially during descent, to reduce barotraumas. Otalgia, ear fullness, deafness and rarely tympanic membrane perforation can all result from barotrauma. The risk is increased in children with previous ear pain or nasal congestion and the incidence is as high as 22%.[37] There has been a randomised controlled trial of the use of pseudoephedrine given pre-flight in children aged 6 months to 6 years, which did not find any reduction in ear pain.[38] A trial in adults, however, did find a significant reduction in symptoms of barotrauma.[39] Children who develop otitis media prior to flying should be clinically evaluated and it may be preferable for them to postpone flying for 2 weeks after the diagnosis.[32] However, a small study of children with otitis media who flew did not find an increase in symptomatology or complications after airflight.[40] This may be because the middle ear was filled with fluid rather than air.

Acute mountain sickness

Acute mountain sickness can occur in unacclimatised people who travel to high altitudes, and symptoms include headache, nausea, vomiting, anorexia, lethargy and sleep disturbance. The effective cabin altitude during air flight is high enough to potentially cause symptoms of acute mountain sickness. Muhm *et al* recently published a single-blind controlled hypobaric chamber study of adults looking at the effect of barometric pressures on SaO_2 and the occurrence of acute mountain sickness.[3] Adult volunteers were exposed to decreasing pressures in the chamber for 20 h. Their mean arterial SaO_2 decreased with increasing equivalent altitude, with a maximum decrease of 4.4% (95% confidence interval 3.9 to 4.9%) at 8000 ft (2400 m); differences became apparent after 3–9 h. Symptoms of acute mountain sickness occurred in 7.4% of people, and the frequency of reported discomfort increased with increasing altitude. Exercise reduced the prevalence of muscular discomfort but did not affect other outcomes. Acute mountain sickness may account for some of the common symptoms often blamed on jet lag after long flights. There is no reason that this study should not equally apply to children, as acute mountain sickness effects all ages; the problem is that it is harder to recognise the condition in young children.[41]

Behavioural problems and jet lag

Flying on an aeroplane can be a stressful experience for the whole family. Some passengers become very anxious about flying, and this may be worsened by travelling with young children. Jet lag with daytime sleepiness, sleeping difficulties and irritability is common, especially after long flights across multiple time zones, and it is worse flying in an eastern direction. Jet lag in children has not been extensively studied, but it is thought that children are probably less severely affected than adults due to the higher amounts of melatonin that they secrete compared with adults.[32] Melatonin is not recommended to treat jet lag in children as its side-effect profile is not well studied, besides which, a recent meta-analysis failed to show benefit of melatonin in adults.[42]

CONCLUSIONS

A huge number of infants have flown, and will continue to fly, with absolutely no health problems. However, a small number who have certain underlying conditions — particularly respiratory ones, may need an assessment to determine whether supplemental oxygen will be required on an aeroplane. This is more likely in infants with a history of neonatal respiratory problems (especially related to prematurity) who are under 1 year, and those under 3 months of age are most likely to require supplemental oxygen.

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Patient consent: Informed consent was obtained for publication of figure 1.

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