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CHRONIC LUNG DISEASE IN ADULTS AND AIR TRAVEL

ABSTRACT

The safety of travelling in patients suffering from chronic lung conditions is a frequently encountered problem amongst healthcare professionals. The objective of this paper is to review currently available literature, with the aim of clarifying such issues for doctors dealing with such concerns. The article will describe the effect of altitude on healthy and diseased lungs, assessment tools to be utilised when assessing patients with suspected or diagnosed chronic lung conditions and international guideline recommendations for chronic lung conditions.

ABBREVIATIONS

COPD - Chronic obstructive pulmonary disease
FEV_1 - Forced expiratory volume in one second
CPAP - Continuous positive airway pressure
CXR - Chest X-ray
SpO_2 - Peripheral capillary oxygen saturation
PaO_2 - Arterial partial pressure of oxygen
BTS - British Thoracic Society

INTRODUCTION

In recent years there has been a progressive rise in the number of people who travel by air.[1] The ease of travel as well as the increasing availability of lower cost travel makes journeys accessible to older or less financially advantaged travellers.[2] In addition, advances in the monitoring of many chronic respiratory diseases as well as the availability of medications have improved quality in the lifestyle of such patients, allowing chronically ill patients to consider the possibility of air travel. It has become common for people with lung disease to request to travel and in turn seek advice from their medical practitioners about related issues. Surprisingly, reports of serious incidents concerning travellers with lung disease are relatively rare. Since respiratory problems are estimated to make up about 11% of in-flight emergencies it is reasonable to assume that the burden of risk surrounding the flight itself, and later disruption of the journey, is significant.[3]

FIGHT ENVIRONMENT AND ALTITUDE EFFECTS

Commercial aircraft are pressurised to cabin altitudes of up to 8000 feet (2438m) although this ceiling may be exceeded in emergencies. Pressurization of the aircraft cabin is achieved using exterior air that is compressed and mixed with filtered and re-circulated cabin air. Up to 50% of the cabin air is not re-circulated and is expelled, to be replaced with exterior air, with 20–30 complete air exchanges occurring per hour.[4] At that altitude, the partial pressure of oxygen falls to the equivalent of breathing 15.1% oxygen at sea-level.

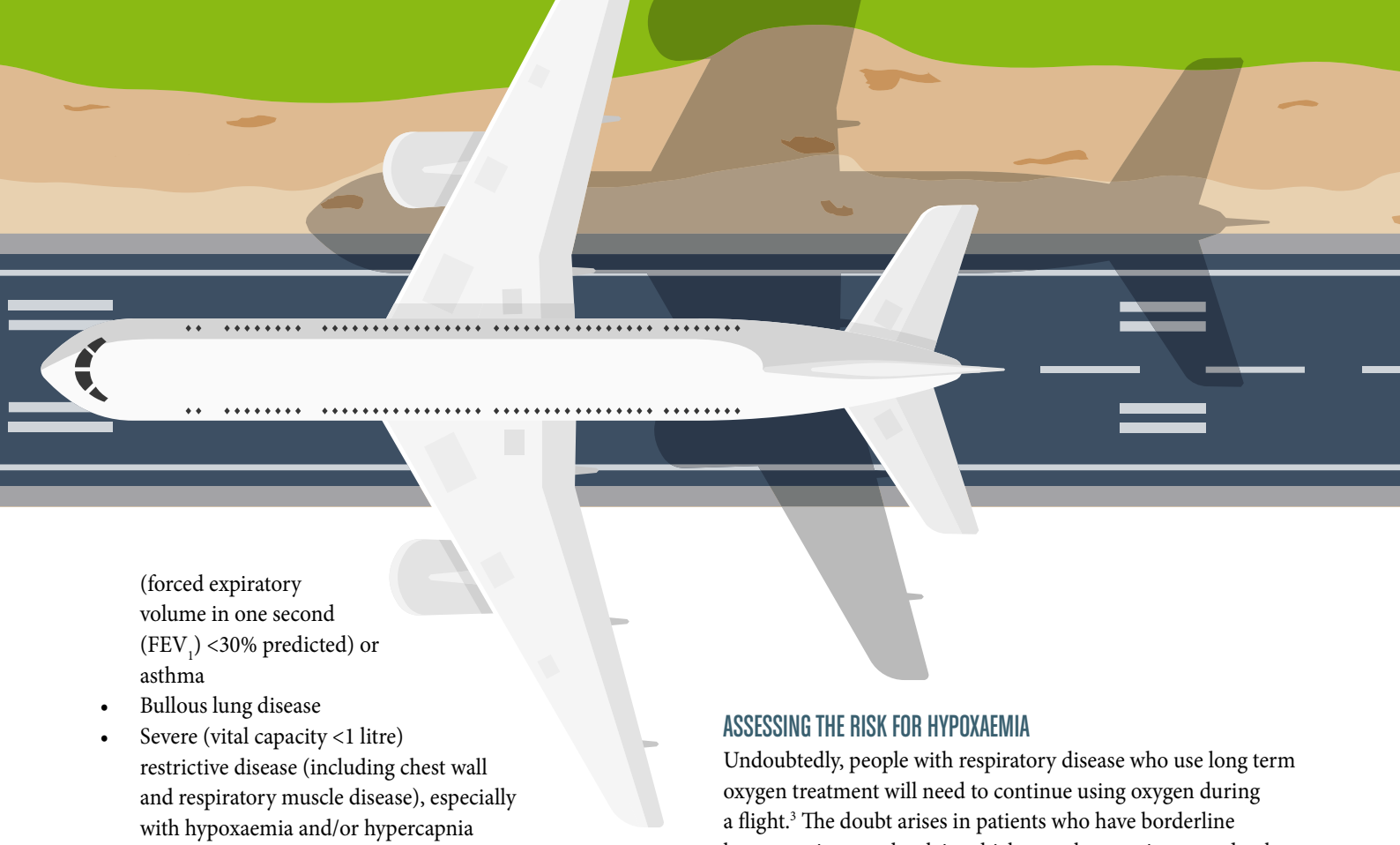
The rapid reduction in pressure associated with ascent is usually well tolerated by the healthy lung. At cabin altitude even normal people can occasionally desaturate but will generally compensate by increasing alveolar ventilation,[3] such that people with healthy lungs remain asymptomatic throughout the flight.

On the other hand, apart from the usual health risks of airline flight, the principal additional challenge for patients with chronic respiratory disease is exposure to hypobaric hypoxia. Patients suffering from chronic respiratory illness may have mild hypoxaemia, which may even go unrecognized at times. Altitude exposure may worsen hypoxaemia in pulmonary disease. Compensatory pulmonary mechanisms may be inadequate in patients with lung disease despite normal sea-level oxygen requirements. In addition, compensatory cardiovascular mechanisms may be less effective in some patients who are unable to increase cardiac output.[4] Such patients may be vulnerable to the relatively minor pressure changes, causing an enlargement of a pre-existing pneumothorax or rupture of an emphysematous bulla or other spaces containing air.[3] The physiological compensation for acute hypoxaemia is mild to moderate hyperventilation, limited by the fall in arterial carbon dioxide tension ($PaCO_2$) together with a moderate tachycardia.[2]

PRE-FLIGHT ASSESSMENT

If there is doubt about the patient's fitness to fly and if there are co-morbidities affecting fitness, assessment is advised. In general, the patient's respiratory condition should be stable and the patient must have recovered from any recent exacerbation before travel. It is recommended that those patients with the following conditions should be assessed with at least, a history and physical examination:

- Previous air travel intolerance with significant respiratory symptoms (dyspnoea, chest pain, confusion or syncope)
- Severe chronic obstructive pulmonary disease (COPD)



(forced expiratory volume in one second (FEV_1) <30% predicted) or asthma
- Bullous lung disease
- Severe (vital capacity <1 litre) restrictive disease (including chest wall and respiratory muscle disease), especially with hypoxaemia and/or hypercapnia
- Cystic fibrosis
- Co-morbidity with conditions worsened by hypoxaemia (cerebrovascular disease, cardiac disease or pulmonary hypertension)
- Pulmonary tuberculosis
- Within six weeks of hospital discharge for acute respiratory illness
- Recent pneumothorax
- Risk of or previous venous thrombo-embolism
- Pre-existing requirement for oxygen, continuous positive airway pressure (CPAP) or ventilator support.[2]

During such an assessment patients should have their condition optimised, where possible, thus decreasing the risk of complications and potentially reducing the severity of hypoxaemia.

PRE-FLIGHT SCREENING
HISTORY, PHYSICAL EXAMINATION, AND SPIROMETRY

As part of a pre-flight screening evaluation, a detailed history and physical examination should be performed. Any previous flying history should therefore be explored, as this may yield important information on the symptoms or complications that may have occurred during or after previous air travel. Physicians should also consider the flight duration, destination, as well as the control of the disease.

In the absence of any contraindication, the American Thoracic Society recommends that spirometry should be performed on patients with a history of acute or chronic lung disease or with symptoms suggestive of lung disease. Pulse oximetry at rest should also be done, with arterial blood gas confirmation in addition to this, if hypercapnia is suspected.[4]

ASSESSING THE RISK FOR HYPOXAEMIA

Undoubtedly, people with respiratory disease who use long term oxygen treatment will need to continue using oxygen during a flight.[3] The doubt arises in patients who have borderline hypoxaemia at sea level, in which case these patients need to be assessed thoroughly.

A number of methods of assessment for hypoxaemia risk during air travel are available. These include:
- Sea-level measurement of SpO_2 and PaO_2
- The use of equations to predict hypoxaemia at altitude
- Hypoxic challenge testing, performed under either normobaric or hypobaric conditions.

Measuring SpO_2 at sea level to risk-stratify patients has become recognized as a less reliable predictor of in-flight SpO_2 compared to other methods. In the 2002 British Thoracic Society (BTS) guidelines, an SpO_2 of 92–95% without risk factors or SpO_2 greater than 95% was used to indicate that no further testing was warranted.[5] However, in one study, 23% of patients having an SpO_2 greater than 96%, tested by hypoxic challenge testing, experienced significant hypoxaemia warranting in-flight oxygen supplementation.[6] In another study of 100 COPD patients, stratified on the basis of SpO_2 thresholds from the 2002 BTS algorithm, who underwent pulse oximetry and normobaric hypoxic challenge testing, the sensitivity and specificity for these SpO_2 thresholds were only 59% and 72%, respectively.[7] Despite this method being readily available, cheap, and not laborious, this tool is not considered sufficiently robust to screen patients.

Predictive equations have also been used to estimate the risk of hypoxaemia at high altitude; they incorporate sea-level measurements of PaO_2 and other parameters such as FEV_1 or anticipated cabin altitude.[8,9] Many of the equations consistently overestimated the need for supplemental oxygen, thus incurring unnecessary additional cost.[4] The novel non-linear predictive models represent a low cost option for the prediction of

significant hypoxia during flight and perform better than SpO2 in identifying those patients who require more formal assessment with hypoxic challenge testing.[10]

Hypoxic challenge testing, though costly and time-consuming, is now the preferred method to assess risk of hypoxaemia at altitude.[4] It uses a decreased (normobaric) fraction of inspired oxygen (FiO_2) to simulate the hypoxic conditions at altitude.[4] It is performed in a specialist lung function unit after referral to a respiratory specialist.[2] However, it is not available locally, rendering it difficult to advise our local patients accordingly, even in a hospital setting. The hypoxic challenge test is not a 'fitness to fly' test but is used to determine whether a patient needs in-flight oxygen; most importantly, even with in-flight oxygen and/or ventilator support, safety cannot be guaranteed.[2] In fact, in one particular study, *in PaO_2 hypoxic altitude simulation testing,* no difference was identified between COPD patients with and without respiratory symptoms.[11]

FEV_1 is also a useful marker of clinical severity. However, neither resting sea-level oxygen saturations nor FEV_1 appear to predict hypoxaemia or complications accurately during or after air travel in patients with respiratory disease.[2]

Based on the current literature, it can be concluded that air travel is safe for most patients. However, those at risk of hypoxia can benefit from supplemental in-flight oxygen.[12]

Further research is required to determine whether a symptom-based approach, for instance the Medical Research Council dyspnoea scale or clinical exercise testing might be more reliable for screening.[2]

CONTRAINDICATIONS TO COMMERCIAL AIR TRAVEL

Certain patients suffering from pulmonary disease should be advised to avoid flying, either because of high risk of deterioration of their pre-existing condition or else, because they pose a risk to others. These include:

- Ongoing pneumothorax with persistent air leak
- Major haemoptysis
- Infectious tuberculosis
- Usual oxygen requirement at sea level at a flow-rate exceeding 4L/min.[2,4]

CHRONIC LUNG DISEASES
OBSTRUCTIVE PULMONARY DISEASE (ASTHMA AND COPD)

Before travel, patients should have their condition optimised, with the least possible symptoms as well as minimal use of reliever medication. They should carry their inhalers, including spacer, at all times. A patient should also be treated and has recovered from an exacerbation before being advised to travel. A bronchodilator given via a spacer is as effective as a nebuliser. For acute exacerbations on board, the patient's own bronchodilator inhaler, ideally with a spacer, should be taken, and the dose repeated until symptomatic relief is obtained. According to BTS recommendations, it is advised that patients with severe or brittle asthma or severe COPD (FEV_1<30% predicted) should consult their respiratory specialist beforehand for optimisation of their condition and the patient may consider carrying an emergency supply of prednisolone in addition to their usual medication.[2] A recent study has suggested that hypoxic challenge testing should be performed for patients suffering from severe asthma.[13]

BRONCHIECTASIS

Positive sputum cultures should ideally be treated so as to optimize the patients' condition. Bronchodilators should be prescribed as necessary. Nebulised antibiotics or nebulised bronchodilators are not generally required.[2]

CANCER

Severe or symptomatic anaemia should be corrected beforehand, as should hyponatraemia, hypokalaemia and hypercalcaemia. Treatment (radiotherapy, chemotherapy and/or stenting) for major airway obstruction, including upper airways stridor, should be complete before travel and sufficient time passed to enable the physician/oncologist to confirm stability. Patients with lymphangitis carcinomatosa or superior vena cava obstruction should only fly if essential, and must have in-flight oxygen available. Pleural effusions should be drained as much as possible before travel. Patients with major haemoptysis should not fly.[2]

AIRBORNE INFECTIONS

Pre-flight assessment is advised for those with acute and chronic respiratory infections. Patients with infectious tuberculosis must not travel by public air transportation. World Health Organization guidelines state that 'physicians should inform all infectious and potentially infectious tuberculosis patients that they must not travel by air on any commercial flight of any duration until they are sputum smear-negative on at least two occasions'.[2]

INTERSTITIAL LUNG DISEASE

Patients should be carefully assessed. Supplemental oxygen should be considered if travelling at high altitude destinations. Carrying an emergency supply of antibiotics and prednisolone is recommended and medical advice on their usage should be given in the case of an exacerbation.[2,4]

NEUROMUSCULAR DISEASE AND CHEST WALL DISEASE

International guidelines recommend that all patients with conditions causing severe extra-pulmonary restriction, including those needing home ventilation, should undergo hypoxic challenge testing before travel, if available. The decision to recommend in-flight oxygen and/or non-invasive ventilation must be made on an individual clinical basis. [2,4]

CYSTIC LUNG DISEASE

In addition to hyperinflation within communicating airways, at an altitude of 8,000 feet, Boyle's law predicts there will be a 38% increase in the size of closed air-filled pockets within the body.[14] This gas expansion may be associated with an increased risk of pneumothorax in patients with bullous or cystic lung disease. In patients with chronic lung disease who are already at risk of hypoxaemia, the development of a pneumothorax in-flight could

be a significant challenge. A previous history of pneumothorax may be more relevant in patients with lung disease, as rapid changes in barometric pressure may precipitate recurrence.[4]

OBSTRUCTIVE SLEEP APNOEA SYNDROME

A doctor's letter is required outlining the diagnosis and necessary equipment, and patients should keep their CPAP machine in the cabin. Alcohol and sedatives should be avoided before and during travel.[2]

PNEUMOTHORAX

Patients with a closed pneumothorax should not travel on commercial flights (with the exception of the very rare case of a loculated or chronic localised air collection which has been very carefully evaluated). Patients who have had a pneumothorax must have a chest X-ray (CXR) to confirm resolution before a flight, and flying is not advised for at least seven days after confirmation of resolution. For patients who have suffered a traumatic pneumothorax, the delay after full radiographic resolution should ideally be two weeks. Prognosis is good for those who opt for surgical intervention as a treatment measure. The risk of recurrence is higher in those with coexisting lung disease and does not fall significantly for at least one year.[2,4] Alternative forms of transport might be considered for other patients.

THORACIC SURGERY

In patients who underwent thoracic surgery with drain insertion, chest radiography is required after drain removal to ensure full expansion of the lung. Patients who have a pneumothorax after drain removal should not travel on commercial flights until full re-expansion has been confirmed on CXR. If chest radiography after drain removal confirms full re-expansion, it is prudent to wait for seven days before air travel. Any symptoms or signs suggesting the possibility of a pneumothorax should prompt a further CXR before air travel.[2,4]

GENERAL ADVICE

Advance planning is of utmost importance. Our patients must be advised to seek medical attention before flying. Patients should be advised to carry around a list of their prescription medication, including oxygen, and to take an adequate supply to last the whole trip. For patients who make use of portable oxygen concentrators, they must check in advance to see if the airline allows this and notify them accordingly. If needed, one should book extra services with the airline in advance, such as in-flight oxygen or wheelchairs, and check with the airline regarding the carriage of nebuliser machines, ventilators or CPAP machines. Travellers must also ensure that proper arrangements are made for travel insurance. The physician might also consider prescribing an emergency supply of antibiotics, with or without prednisolone, to be used as required by the patient, in case of an exacerbation whilst abroad.

ADDITIONAL CONSIDERATIONS

When evaluating patients for air travel, it is important to highlight the following points:

1. Even at 35,000 feet, different types of commercial aircraft can have widely differing cabin altitudes, ranging from an equivalent of approximately 5,400 feet to 8,000 feet.[15] In addition, commercial aircraft may also vary their cruising altitude a number of times during the flight, which in turn can alter cabin pressure.[15,16]
2. Respiratory symptoms may occur despite having a pre-flight assessment. One study found 18% of patients with COPD developed respiratory symptoms despite having a pre-flight evaluation.[17]
3. Flight duration is another important factor to consider. Longer flight durations are associated with increased symptoms,[6] particularly when lasting over three hours.[18]
4. The levels of activity of the patient during the flight should also be considered. Patients with COPD, restrictive lung disease, and cystic fibrosis demonstrate significant worsening of hypoxaemia at simulated altitude with a workload equivalent to that of walking around the aircraft cabin.[19-21]

CONCLUSION

Being diagnosed with a chronic lung condition does not mean that the patient can no longer travel but there are a number of limitations and implications. Patients must be advised to carefully plan their travel and to seek medical advice accordingly.

International guidelines recommend that hypoxic challenge testing should be considered for patients with chronic lung diseases, since such patients are at risk of developing significant hypoxaemia and complications during air travel. In the absence of its availability locally, medical professionals must ensure that such patients have their respiratory status optimised, following a thorough assessment with the help of available tools, and that expert advice is sought when deemed necessary.

CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest.

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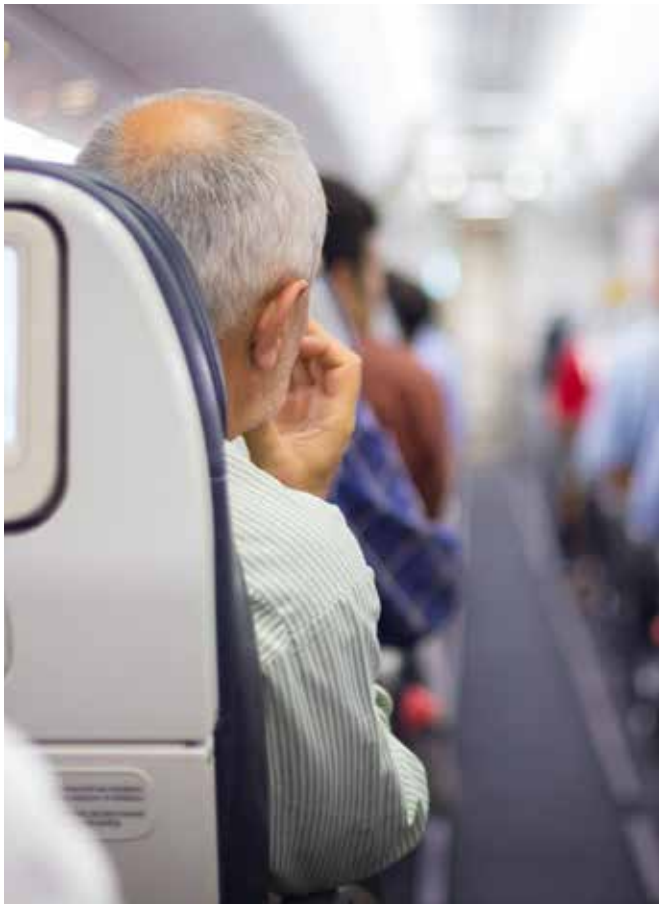

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CARDIAC ARRYTHMIAS

MIREILLE DEBONO

MPSA

The American Heart Association defines cardiac arrythmias as any change from the normal sequence of electrical impulses. Cardiac arrythmias can be the result of either an abnormality of impulse formation [which can lead to impulses that are too fast, too slow or irregular] or else an abnormality in impulse conduction [which can lead to heart block].

During a normal cardiac cycle the electric impulse originates in the sino-atrial node (SA node), it then passes through the atria where it reaches the atrio-ventricular node (AV node) and is then conducted through the ventricles.

When there is a change in the formation of the electrical impulse, impulses may be formed in the SA node at a very fast or slow rate (sinus tachycardia and sinus bradycardia, respectively). Sometimes the electrical impulses start to originate from areas in the heart outside the SA node. This may either occur occasionally (such as in supraventricular ectopic or ventricular ectopic) or else, all electrical impulses start to originate from outside the SA node (atrial fibrillation or ventricular fibrillation). The former type usually results in impulses which follow the baseline sinus rhythm but which are too fast or too slow. On the other hand, the latter usually result in electrical impulses which arise in a very fast and irregular manner. The exceptions to this are junctional rhythm, which involves electrical impulses arising from the AV node at a very slow and regular rate, and supraventricular tachycardia, which involves electrical impulses arising from a site in the atria outside the SA node at a fast but regular rate.

When there is a change in electrical impulse conduction the result is heart block.
Heart block can be classified as 1st, 2nd or 3rd degree. In 1st degree heart block there is a delay in the conduction of electrical impulse at the AV node. In 2nd degree heart block there is intermittent non-conduction of the electrical impulses at the AV node. In 3rd degree heart block none of the electrical impulses arising in the SA node are conducted through the AV node to the ventricles.
Cardiac arrythmias can usually be successfully managed with medication, discontinuing any causative drugs or else by inserting a pacemaker in the case of heart block.