Armed Forces personnel flying with respiratory disease: am I fit to fly?

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Abstract

Respiratory problems account for 10% of inflight medical emergencies; this is usually due to the acute physiological stress induced by hypobaric hypoxia on board aircraft. During a typical commercial flight, the cabin pressure is the equivalent of breathing 15% oxygen at sea level, as opposed to 21% (~ 15.2 kPa versus 21.2 kPa FiO_2). The response to this hypobaric hypoxia is mediated by the autonomic nervous system; it is characterised by an increased rate and depth of breathing, mild tachycardia, and hypoxic pulmonary vasoconstriction. Patients who are able to walk 50 metres without developing shortness of breath are generally "fit to fly" from a respiratory perspective, and those with resolved pneumonia may fly if they are clinically stable. Military patients with asthma and COPD are generally safe to fly, as they must have stable airways disease to remain medically fit for service. A recent or unresolved pneumothorax is an absolute contraindication to air travel. Other absolute contraindications for air travel include tuberculosis, major haemoptysis and an oxygen requirement of ≥4 l/min. If there is any doubt regarding a patient's fitness to fly, an opinion from a respiratory physician should be sought. All patients flying with a respiratory condition must carry their medications onboard, have up-to-date vaccinations and seek advice from their doctor should they have any concerns over their fitness to fly. This review article will explore the effect of air travel on the respiratory diseases most likely to be seen in the UK military population: airways disease (COPD and asthma), respiratory infections, pneumothorax, and spontaneous pulmonary embolism.

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Introduction

Air travel is routinely used by the UK Armed Forces to deploy its troops around the globe, and with roughly one in every 604 commercial flights having an inflight medical emergency, it is important for military doctors to be aware of the potential health implications of airline travel.[1] Reflecting the increasing importance of aviation medicine, the General Medical Council introduced the ability to specialise as a consultant physician in aviation and space medicine in 2016, with the Royal Air Force (RAF) now recruiting doctors into this speciality.

This review article will focus on the potential hazards posed by airline travel to military personnel with respiratory diseases. It will not discuss diseases which are uncommon in military personnel, such as interstitial lung disease, lung cancer, obstructive sleep apnoea, dysfunctional breathing, recurrent venous thromboembolism and severe cardiac comorbidity. It will focus on diseases more commonly seen in a military population, namely airways disease, respiratory infections, pneumothorax and spontaneous pulmonary embolism.

Aviation physiology

A modern airliner cabin, as in the RAF Voyager aircraft, is pressurised to 8,000ft (2438m); this can be considered the equivalent to breathing 15% oxygen (~ 15.2 kPa FiO_2) at sea level.[2] This reduction in the partial pressure of oxygen at altitude is termed hypobaric hypoxia. It remains prohibitively expensive for commercial aircraft to replicate the atmosphere at sea level (101.3 kPa or 1 bar), due to the implications on aircraft weight and fuel burn.

Although healthy patients normally compensate easily for the physiological stress that air travel induces, patients with respiratory disease may not be able to compensate and may be deemed unfit to fly, as illustrated in Figure 1.

A healthy subject would sustain a drop in arterial partial pressure of oxygen to 8.0 kPa and of oxygen saturation to 89-94% during air travel.[3] The physiological response to hypobaric hypoxia is well characterised.[2] Reduced alveolar oxygen (PAO_2) leads to reduced arterial oxygenation (PaO_2), which is termed hypoxic hypoxaemia. The reduced PaO_2 is detected by peripheral chemoreceptors in the carotid bodies, which leads to increased sympathetic efferent activity to increase the rate and depth of breathing. This leads to an increased minute volume and tidal volume to compensate against hypobaric hypoxia.[2] PaO_2also leads to hypoxic pulmonary vasoconstriction; the increased pulmonary vascular resistance leads to increased pulmonary artery pressure due to increased right ventricular afterload. There is also a mild tachycardia during air travel, which allows cardiac output to increase to compensate for reduced oxygen delivery throughout the body.

Respiratory disease during air travel

A recent systematic review of inflight medical emergencies (IMEs) demonstrated that the three most common IMEs

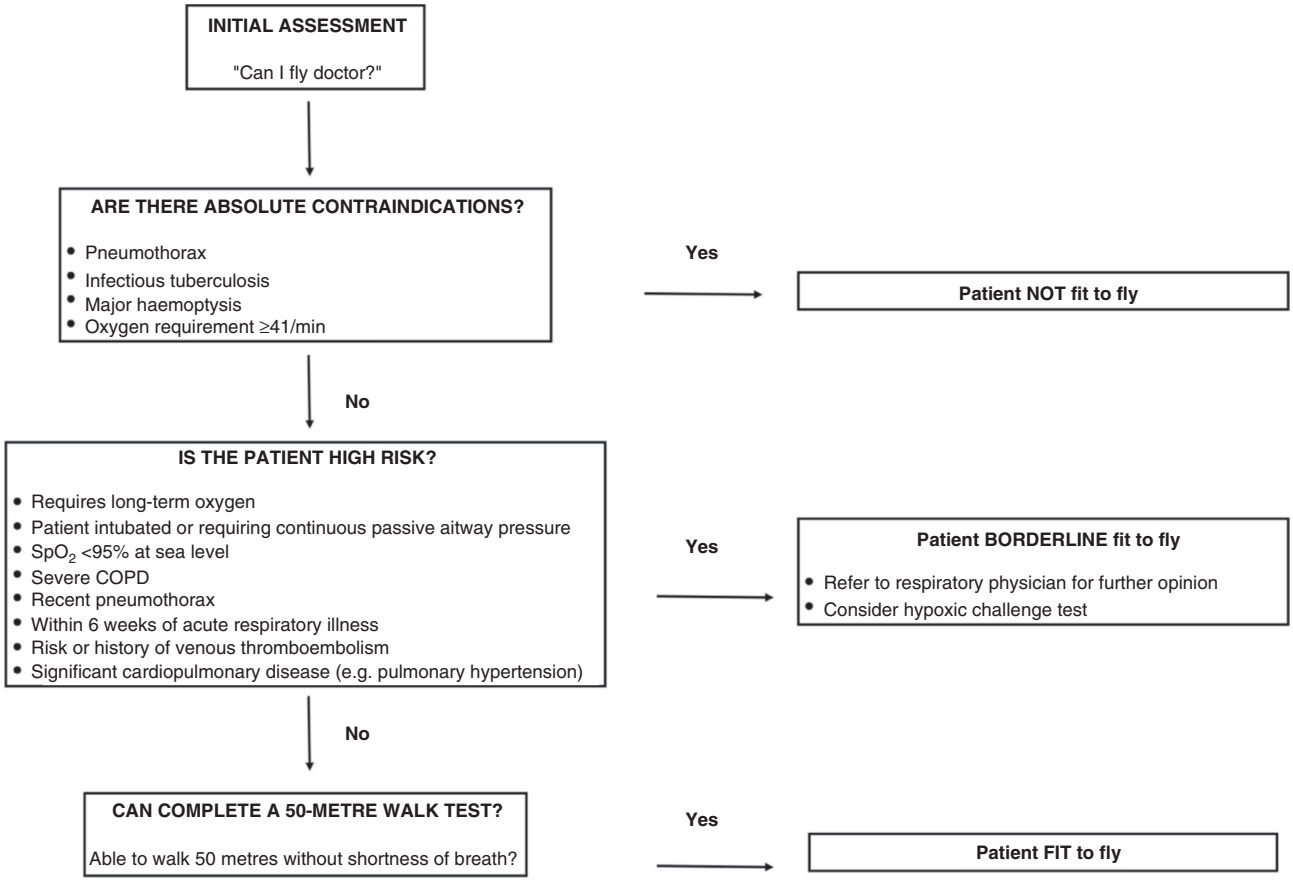

Figure 1: am I fit to fly? Adapted from Josephs et al. (2013).[6]

were syncope or near-syncope, gastrointestinal conditions and respiratory conditions.[1] Respiratory problems accounted for 10% of all reported IMEs (4,953 of 49,100 events) – see Table 1.

Airways disease: COPD and asthma

Acute bronchospasm may occur in patients with airways disease when flying, due to airway irritation from the low level of humidity in an airline cabin. There is also a reported risk of infective exacerbations of airways disease after air travel. This would be due to the shared atmosphere and close proximity of other infected passengers, but is exceptionally rare.[3]

Asthma has significant potential occupational health implications, and there are therefore strict entry requirements. JSP 950 advises that applicants with a recorded history of asthma which has required treatment or caused symptoms within the last 4 years, or who have a significant decrease in pulmonary function, are permanently barred from entering service in the Royal Navy (RN).[4] Applicants who have a history of wheeze require careful screening and further investigations before a decision about entry can be made. During service, if asthma does develop, then individuals should be graded appropriately to their branch and environment. Individuals requiring maintenance inhaled corticosteroid therapy should be graded as medically limited for deployment, and if requiring further medication to control symptoms, then their grading should be assessed on an individual basis.

A general duties medical officer may, however, come across a small number of patients who have mild asthma or COPD during their time at sea. Although rates of smoking in the UK military continue to decline, it is known that nearly a third of male personnel smoke.[5] It is therefore possible that there may be a small cohort of serving personnel who develop COPD.

Asthma

Asthmatic patients should be permitted to fly if their asthma is well controlled and they are under the regular care of their GP.[6] Civilian patients with severe or uncontrolled asthma who are being managed in a military environment should seek specialist advice before flying. Importantly, from a practical perspective, asthma patients should be advised never to leave their medication in hold luggage.

COPD

Patients with well-controlled COPD are fit to fly if their condition is well managed at baseline and they are able to walk 50 metres without developing shortness of breath.[3] Indeed, the frequency of severe adverse effects is very low in this patient group. Complications of severe COPD (FEV1 <30% predicted) will not be routinely seen in the military

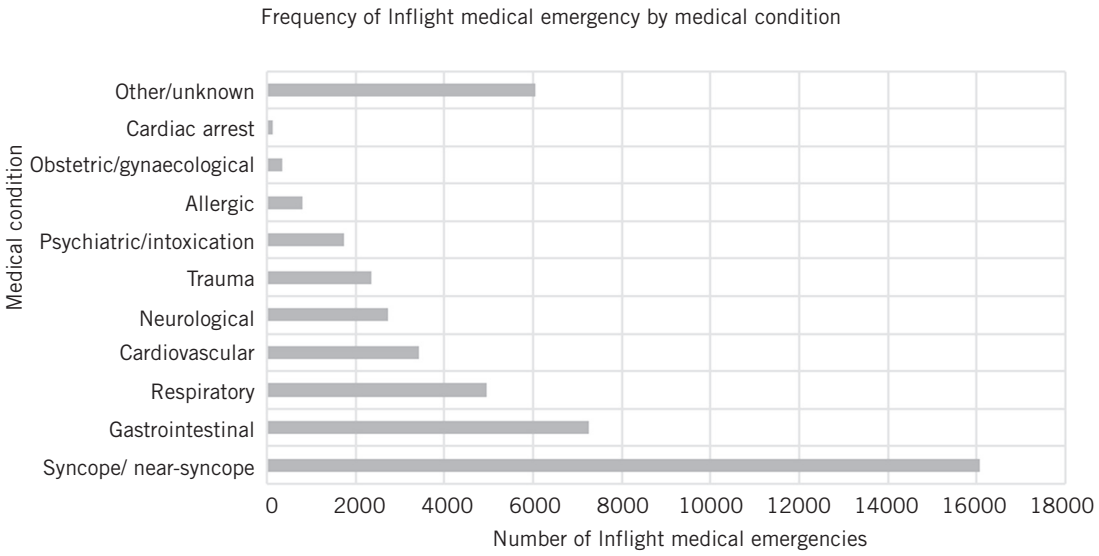

Table 1: The frequency of inflight medical emergencies by medical condition. Data adapted directly from Martin-Gill et al. (2018).[1]

population, and would require further assessment by a respiratory specialist, who may wish to perform hypoxic challenge testing (see below for protocol details). Inflight COPD exacerbations can be minimised if patients carry their bronchodilators and a rescue pack (containing prednisolone and antibiotics) onboard.[7]

Respiratory tract infections

Pneumonia

Patient with pneumonia should avoid air travel until they are apyrexial, clinically stable, and able to maintain oxygen saturations of 94-98% in room air.[3] There is also an increased risk of transmitting infectious respiratory disease during flight due to the proximity of other passengers.

Viral upper respiratory tract infections (URTIs)

Viral URTIs may lead to eustachian tube dysfunction during flight due to the hypobaric environment, which can lead to pain, dulled hearing and a feeling of pressure or fullness in the affected ear. This can be treated with oral and topical decongestant medication.[6]

Tuberculosis (TB)

The World Health Organisation recommends that all TB patients are told by their doctor that they are not permitted to fly until they are disease-free. Any military recruit with active tuberculosis is permanently barred from entry to the RN, although those with a history of latent or confirmed previous infection with TB may be considered suitable for entry by an occupational physician.[4] It is absolutely contraindicated for any patient to travel with infectious TB; only after two consecutive negative sputum samples, proving that they are disease-free, should they be considered fit to fly.[3]

Risk of developing a pulmonary embolism when flying

The risk of developing venous thromboembolism (VTE) such as a deep vein thrombosis (DVT) or pulmonary embolism (PE) when flying is very low. A systematic review concluded that the risk of developing a symptomatic DVT due to long-haul air travel is 27 cases per 1 million passengers.[8] If concerned about the risk of developing a DVT when flying, patients should be advised to keep mobile when onboard; although rare, the consequences of developing a VTE during flight can be severe if a PE develops. There is no evidence to show that prophylactic aspirin prevents DVT.[3] Patients undergoing MEDEVAC should have appropriate VTE prophylaxis, such as low molecular weight heparin, prescribed when necessary.

Absolute contraindications to air travel

There are four important absolute contraindications to airline travel.[6] These include recent pneumothorax, infectious TB, major haemoptysis, and a normal long-term oxygen (LTOT) requirement of ≥ 4 l/min.

Pneumothorax

A history of spontaneous pneumothorax, which did not receive definitive treatment (via open or video-assisted thoracoscopic surgery) at the time, is a permanent bar to entry into the RN.[4] This is because the recurrence rate of an ipsilateral or contralateral pneumothorax is very high; the RAF advises that the recurrence rate of spontaneous pneumothorax without definitive treatment is up to 30%.[9] Patients who have had a traumatic pneumothorax – which does not carry the same recurrence rate as a spontaneous pneumothorax – should be considered for entry into the RN (graded P2) if their lung function is normal.[4]

During Op HERRICK, thoracic injury was seen in 339 (17.10%) of all trauma patients,[10] and traumatic pneumothorax is predicted to account for a third of all preventable deaths on the battlefield.[11] As such, traumatic pneumothorax presents a significant health hazard to the aeromedical evacuation process. The potential consequences of flying with a pneumothorax are explained by Boyle's law: the volume of a gas increases as pressure decreases. At 8,000ft (2438m), as seen inside an airliner, gases increase in volume by 38% when compared to

sea level. Patients with a current pneumothorax are therefore not fit to fly and should wait at least seven days after a chest x-ray confirms the resolution of their pneumothorax. Only patients who have received definitive treatment of their pneumothorax (i.e. with pleurodesis via thoracoscopic or video-assisted thoracoscopic surgery) should be considered fit to fly without further x-rays.[3]

Military aircrew who have suffered a traumatic pneumothorax should be made medically fit to fly three months after definitive treatment has been performed, and once they are completely recovered from the incident.[9]

Predicting fitness to fly

The 50-metre walk test remains the most widely used and acceptable measure of a patient's fitness to fly; if a patient can walk 50 metres (or climb 10-12 stairs) without significant dyspnoea, no oxygen requirement, and no need to stop walking, they should be considered fit to fly.[2] This is because this simple exercise demonstrates they have sufficient cardiopulmonary reserve for flying.

Hypoxic challenge testing is performed by providing patients with 15% FiO_2 via a tight-fitting face mask at normal altitude, then measuring PaO_2 via arterial blood gas sampling. This test is carried out by physiologists to more accurately assess a patient's fitness to fly, because it predicts the extent of hypoxaemia during air travel. However, this test is not routinely performed outside the expert setting, because it is not a validated test and, although it can predict PaO_2, it does not predict inflight symptom severity.[2]

Advice for patients when flying

Patients with underlying respiratory disease should receive relevant vaccinations before flying, ensure medications and inhalers are taken on board (i.e. not packed in the hold), move regularly when on board to prevent VTE formation, and avoid alcoholic drinks to prevent dehydration.[6] A rescue pack of antibiotics and steroids may be provided prior to departure should COPD symptoms worsen during or after flight.

Conclusion

Air travel is a physiological stressor which is normally well tolerated by healthy military individuals, who are unlikely to have significant respiratory disease due to the military's strict entry and in-service medical requirements. Respiratory physicians are subject matter experts in aviation medicine and should be the first point of contact should there be any doubt over a patient's fitness to fly. It remains the patient's responsibility to seek advice and check that their travel insurance is valid in the event of flying with pre-existing respiratory disease on civilian airlines.

Conflict of interest

The authors declare no conflict of interest in publishing this review article.

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