Is air travel safe for those with lung disease?
Study design: prospective, multi-centre and observational

Coker RK, Shiner RJ, Partridge MR
Respiratory Medicine, Hammersmith Hospitals NHS Trust and National Heart & Lung Institute, Imperial College London

Corresponding Author:
Dr Robina K Coker PhD FRCP
Consultant & Honorary Senior Lecturer
Respiratory Medicine, Hammersmith Hospital
150 Du Cane Road
London W12 0HS
UK
Tel 44 208 383 3329
Fax 44 208 383 4957
Email robina.coker@imperial.ac.uk

Short title: Air travel in lung disease

Abstract

Introduction
Airlines commonly report respiratory in-flight emergencies; flight outcomes have not been examined prospectively in large numbers of respiratory patients. We conducted a prospective observational study of flight outcomes in this group.

Methods
UK respiratory specialists were invited to recruit patients planning air travel. Centres undertook their usual pre-flight assessment. Within two weeks of return, patients completed a questionnaire documenting symptoms, in-flight oxygen use, and unscheduled healthcare use.

Results
Six hundred and sixteen patients were recruited; 500 (81%) returned questionnaires. The commonest diagnoses were airway (54%) and diffuse parenchymal lung disease (23%). Twelve patients died, seven before flying and five within one month. Pre-flight assessment included oximetry (96%), spirometry (95%), hypoxic challenge (45%) and walk test (10%). Eleven percent did not fly. In those who flew, unscheduled respiratory healthcare use rose from 9% in the four weeks beforehand to 19% in the four weeks after travel. However, when compared with self-reported data during the preceding year, medical consultations rose by just 2%.

Conclusions
In patients flying after careful respiratory specialist assessment, commercial air travel appears generally safe.

Keywords
Air travel, altitude, COPD, hypoxaemia, hypoxic challenge testing

Copyright 2007 by the European Respiratory Society.
Introduction
Commercial air travel remains popular despite escalating oil prices, international security and environmental concerns. How many commercial aircraft passengers have respiratory disease is unknown, but in 1974 around 5% were described as ‘ambulatory patients’.\[1\] As Western populations age, the proportion of passengers with pre-existing morbidity is likely to rise. Longer flights further increase the risk of in-flight medical emergencies.

There are no established methods for quantifying morbidity associated with air travel. However, major airlines consistently report around 10% of in-flight medical emergencies resulting from respiratory conditions. Medaire, a US company providing radio-link emergency medical assistance to major commercial airlines, cites respiratory conditions as the third commonest cause of in-flight medical emergencies.\[2\] Respiratory problems are also the third commonest reason for medical diversion, the commonest being cardiac and neurological conditions (including syncope). In 2002, Medaire recorded 414 diversions for medical emergencies; in 2006 the cost of airline diversion was estimated at around 100,000 US dollars.\[3\]

Commercial aircraft fly at around 38,000 ft but are pressurised to a cabin altitude of 8,000 ft (2438 m). Variations in cabin altitude, up to 2717 m, have been reported.\[4\] The reduced partial pressure of oxygen at this altitude equates to breathing 15% oxygen and lowers the PaO\(_2\) of a healthy passenger to 7.0-8.5 kPa (53-64 mmHg). The effect, limited by the shape of the haemoglobin dissociation curve, usually goes unnoticed. This exposure may however have a profound effect on those with lung disease, especially if they are hypoxaemic at sea level, because the steeper part of the dissociation curve is involved. Other consequences of air travel include immobility, predisposing to venous thrombosis, increased gas volumes, lowered humidity and potential for transmission of infection.

British Thoracic Society (BTS) recommendations on respiratory disease and air travel were first published in 2002 and updated in 2004.\[5,6\] In the absence of good quality trials, they suggest that adults with resting oxygen saturations on air at sea level of 92-95% and an additional risk factor (such as FEV\(_1\) < 50% predicted) should undergo hypoxic challenge testing (HCT). However facilities for pre-flight assessment, including HCT, are not universally available in the UK, and at least one major British airline reports that they are rarely provided with the necessary information, such as spirometry or oximetry, to assess risk. The BTS statement therefore identified a need to establish the size of the risk from flying, the predictive value of pre-flight assessments, and the outcome of air travel in passengers prescribed in-flight oxygen.

To address these questions we undertook the UK Flight Outcomes Study, a prospective, multi-centre, observational study aimed at examining the outcomes of commercial air travel for patients with respiratory disease. Specifically, we wished to determine the magnitude of the risk of air travel for adults with respiratory disease, how best to assess it, and whether in-flight oxygen reduces or eliminates the risk.

Methods
Fifty-eight UK respiratory specialists who had expressed interest were invited to participate. Patients were eligible if under the care of an adult respiratory specialist and planning air travel on a commercial airline. For each patient the recruiting physician completed a Physician Questionnaire (Fig 1) with questions about their medical condition, test results and planned date of travel. Patients were excluded if it was felt they would be unable to complete the patient questionnaire, even with assistance, because of language difficulties or psychiatric co-morbidity.
Patients were assessed within three months of their outward flight according to the centre’s usual practice. Pulse oximetry (SpO₂) and FEV₁ were suggested as a usual minimum. If centres usually performed a walk test, HCT and/or DLCO measurements, or if recent results from these were available, the findings were attached to the Questionnaire.

Patients received an information sheet and signed a consent form consenting to transfer of personal details to the principal investigator. Within two weeks of the predicted date of their return, we sent patients a Patient Questionnaire (Fig 2) with questions about their outward flight, stay abroad, return flight and any complications. Distress during flight was quantified using numbered scales for breathlessness, chest pain and cough. Data were collated centrally for analysis. Reminders were sent to patients who did not respond after one month, after checking with the recruiting centre that no untoward incident had occurred.

The questionnaires were employed to determine major and minor outcomes. Major outcomes were defined as the numbers of patients experiencing distress during flight, the numbers requiring in-flight assistance, and the numbers requiring unscheduled use of health service resources within four weeks of their outward or return journey. Minor outcomes were defined as the numbers of in-flight oxygen prescriptions and deaths within one month of air travel.

The size of the study took into account that no comparative (control) data were available and that conventional sample size calculations could not be applied. Analysis was therefore based on descriptive methods. Subgroup analysis of a smaller number of patients compared outcomes in those patients who had undergone HCT and/or received in-flight oxygen. The study received national multi-centre research ethics approval (MREC 03/4/088).
Results

Thirty-seven UK centres participated. Six hundred and sixteen patients were recruited between December 1st 2003 and November 31st 2005, and 500 patient questionnaires returned after air travel (81%). Mean age was 61 years (range 18-91); there were 325 males and 291 females. Patients had a wide range of respiratory conditions. The commonest diagnoses were airway disease, with asthma and chronic obstructive pulmonary disease (COPD) accounting for 54%, and diffuse parenchymal lung disease (DPLD), excluding sarcoidosis, accounting for 23%. Table 1 summarises the clinical characteristics of all the patients recruited and table 2 shows the main characteristics of patients who underwent HCT.

Mean SpO₂ was 95% on air (range 74-100%) and mean FEV₁ 58% predicted (range 9-131%). According to the Global Initiative for Obstructive Lung Disease (GOLD) classification [6], 2% of all our patients with COPD had mild disease (FEV₁ > 80% predicted), 29% moderate disease (FEV₁ 50-80% predicted), 43% severe disease (FEV₁ 30-50% predicted) and 26% very severe disease (FEV₁ < 30% predicted). In the group with COPD who underwent HCT, none had mild disease, 24% had moderate disease, 46% had severe disease and 30% very severe disease.

Of the 616 patients recruited, pre-flight oximetry was available in 594 (96%) and pre-flight spirometry in 588 (95%). HCT results were available in 275 (45%) and walk test data in 60 (10%). Eighty five patients (19%) of the 500 who flew and returned their questionnaire were prescribed in-flight oxygen, of whom 68 (80%) had undergone HCT. HCT was performed in 22 of the 37 centres (59%). Only limited gas transfer measurements were available. Carbon monoxide diffusing capacity expressed as DLCO (% predicted) was only available in 47 out of 243 COPD patients (19%) and in 100 out of 141 (71%) DPLD patients. We therefore only analysed results in the DPLD group. The range of DLCO (% predicted) was 18-93% predicted in the DPLD group, mean 46% predicted. The values did not predict outcome.

Figure 3 summarises patient outcomes. Sixty-nine of the 616 recruited (11%) did not fly. Of these, 31 experienced deterioration in their condition beforehand, of whom 19 were advised not to fly by their specialist or general practitioner. The mean age of the latter was 59 (range 41-75) and there were 8 males. Of these, 13 had COPD, with 62% having very severe disease according to GOLD criteria. Nine patients experienced difficulties arranging oxygen, reported prohibitive insurance costs, or declined to travel with the recommended oxygen. Two patients reported they could not book charter flights or package holidays because the airlines would not provide oxygen. Twenty patients did not fly because of unforeseen changes in personal circumstances.

Seven patients died before flying, all but one from respiratory causes. Five patients died within one month of flying. Two of these had COPD as their primary diagnosis, two had DPLD and one had cancer. Two patients died while away following acute cardiac events. One patient had co-existing ischaemic heart disease and peripheral vascular disease; the other had documented hypertension. There were no in-flight deaths. Overall mortality within one month of air travel was thus < 1%. Of the three patients who died after returning home, one died of liver cirrhosis, one following rapid recurrence of carcinoma and one during an exacerbation of COPD. Mean pre-flight FEV₁ in those who died was 57% predicted, compared with 58% predicted overall. Mean pre-flight SpO₂ in those who died was 93%, compared with 95% overall. Three of the five patients who died after travel had undergone HCT beforehand, and two had received in-flight oxygen.

Seventy nine patients (18%) experienced in-flight respiratory distress. Of these, 38 patients reported distress on both flights and 41 on just one flight. The commonest symptom among the 79
was worsening breathlessness, reported by 61 patients (77%). Thirty five (44%) reported cough and 18 (23%) chest pain. Severity of symptoms ranged from mild to moderate. Flight duration averaged 7.6 hours in patients who reported worsening symptoms compared with six hours in those who did not. In patients who experienced symptoms on only one flight, symptoms were commoner on the return flight (26 patients) than on the outward flight (15 patients). Five patients required in-flight assistance, but this was triggered by worsening respiratory symptoms in only one case. This patient received in-flight oxygen which had been ordered in advance as a precaution. There were no flight diversions or emergency repatriations.

Seventeen patients were admitted to hospital for respiratory illness within one month of flying. There were no significant differences in pre-flight observations in this group compared with the group overall (mean pre-flight FEV$_1$ 49% predicted compared with 58% predicted overall; mean pre-flight SpO$_2$ 94% compared with 95% overall). Nine (53%) had undergone pre-flight HCT compared with 45% overall; four (23%) had received in-flight oxygen compared with 19% overall. Figure 4 summarises pre-flight assessment results and in-flight oxygen use overall and in those patients who were admitted to hospital or died within one month of flying.

In the 468 patients who undertook flight, we compared the need for unscheduled healthcare for a respiratory problem while away or in the four weeks after flying with the four weeks before travel. The numbers of patients consulting a doctor or requiring medical treatment rose from 40 (9%) before flying to 81 (19%) within four weeks of returning. Of these, 53 (65%) reported antibiotic treatment for lower respiratory tract infections. A further 18 patients (4%) required unscheduled medical care while away. Although four patients developed symptoms suggesting venous thrombo-embolism (VTE), there were no confirmed episodes. Patients with DPLD (excluding sarcoidosis) were more likely to require unscheduled healthcare for respiratory events than were patients with other diagnoses, including airway disease. Figure 5 shows use of unscheduled healthcare according to diagnosis.

We also compared need for unscheduled healthcare for respiratory problems with a self-reported baseline during the 12 months preceding air travel. Self-reported baseline figures show 16 hospital admissions a month compared with 17 admissions within four weeks of flying. There were 11 additional hospital admissions while away from home. Visits to a doctor (either in primary or secondary care) were similar; 58 per month in the 12 months preceding air travel (13%) and 64 in the month afterwards (15%).

Two hundred and seventy five patients underwent HCT; 129 (47%) were advised to have in-flight oxygen. Analysis of HCT results where complete data were available showed that in 82 patients (23%), resting Sp$_02$ was ≥ 96% beforehand. In 19 (23%), pO$_2$ fell to <6.6 kPa (<50 mmHg) or Sp$_02$ fell to ≤ 85%.

Average flight duration was six hours (range 1-30), and was identical in those admitted to hospital within four weeks of air travel. Mean flight duration in those who died was four hours (range 1-11). Most flights were undertaken in the third and fourth quarters of the year.
Discussion

The most important finding of this study was that for patients with lung disease flying after careful respiratory specialist assessment, commercial air travel appears to be safe. Overall mortality within one month of flying was < 1%, and there was no appreciable increase in use of unscheduled respiratory healthcare in the four weeks after travel when compared with self-reported data during the preceding year.

To our knowledge this is the first prospective multi-centre observational study of flight outcomes in large numbers of passengers with respiratory disease, and thus provides valuable information on morbidity and mortality associated with air travel in this group. The large number of UK centres who took part and patients recruited suggests, as we have previously noted, that potential problems associated with respiratory disease and air travel are well-recognised [8], as is the need for more substantial evidence on which to base future recommendations. With a few exceptions, [9-12] previous studies aimed at determining risk in adult passengers have examined small numbers of patients with COPD [13-22] in the acute setting. They have largely excluded co-morbidity and studied stable patients. Our study has examined over 240 patients with COPD prospectively in a real-life setting. As far as we are aware it is also unique in including patients with a wide range of respiratory diagnoses, and in attempting to determine outcomes within one month of air travel.

Pre-flight assessment was conducted according to the centre’s usual practice and included all methods commonly used in secondary care. We have previously shown [8] that fewer than 10% of hospital physicians use regression equations.[13,16,21-23] As anticipated, most patients had SpO2 measurements. Most of the patients who did not undergo spirometry were assessed for obstructive sleep apnoea syndrome (OSAS). Walk tests were used infrequently, probably because they are time-consuming. This is despite recognition that they test the patient’s capacity to increase minute ventilation and cardiac output in response to exercise, and potentially provide useful information on cardio-respiratory reserve.[5]

Our previous data show that HCT is performed in over half of specialist referral centres but by fewer than 10% of respiratory specialist in district hospitals.[8] In this study HCT was performed in nearly half the patients and in 22 centres. This may suggest an increase in availability of HCT in the UK in the last seven years, but may also be explained by the fact that the respiratory specialists involved were likely to be particularly interested in flying and have more methods of assessment available in their departments. Furthermore, the high number of patients undergoing HCTs reflects at least in part patient recruitment by two specialist centres, one a supra-regional tertiary referral centre. The severity of COPD patients, with 67% classed as severe or very severe according to GOLD criteria, reflects recruitment from secondary rather than primary care. There did not appear to be any other major differences (gender, diagnosis or severity of COPD) between the patient group overall and those who underwent HCT.

Eighteen percent of patients reported respiratory distress during the flight; its severity was however generally mild. It is less surprising that the commonest symptom was worsening breathlessness, and patients should probably be forewarned of this risk. The high proportion of patients reporting symptoms may reflect selection bias since such patients were likely to have greater awareness of potential problems associated with air travel. Worsening chest pain in 7% of passengers suggests, as outlined in the BTS recommendations, that cardiac co-morbidity should be considered when assessing patients with respiratory disease before air travel. This is further reinforced by the fact that the only two patients who died while away succumbed to acute cardiac events. Evaluation of patients with cardiovascular disease prior to air travel has recently been reviewed and the risk felt
Specific recommendations include advising patients with an abnormal electrocardiogram to carry a copy, and patients with a pacemaker or implantable cardiac defibrillator to carry contact details of the device manufacturers. Co-morbidity may confer a greater risk than respiratory disease alone.

Taken together the data are consistent with previous studies [9-10,12,15,18,20] suggesting that air travel is safe for patients with respiratory disease under specialist supervision. Whether this is true for those with respiratory disease not under the care of a specialist respiratory physician is unclear. Study participants are likely to have had a special interest in, and awareness of, the potential adverse effects of air travel. Despite 67% of the 241 COPD patients who flew being in the severe or very severe GOLD categories, there were no in-flight deaths, and only one patient with COPD died within four weeks of returning. There were no episodes of venous thromboembolism. A relatively high proportion of patients recruited (11%) did not fly, and over half of these changed their plans on medical advice. Many in this group had severe disease, supporting the view that respiratory specialist assessment is important in preventing complications of air travel in this group.

Referral for pre-flight HCT and recommendation for in-flight oxygen appear to be markers of disease severity, without predicting outcome. FEV₁ as a % predicted did not predict outcome in our study, and in-flight oxygen did not eliminate the risk from air travel for patients with severe disease. However, owing to the small percentage of complications a type II error cannot be excluded; in particular it is likely that the sickest patients received oxygen and were most likely to die or have complications. These results do not therefore support hypoxaemic patients travelling without in-flight oxygen. It is striking that considerable numbers of patients were referred for HCT despite resting oxygen saturations of ≥ 96%. According to BTS recommendations these patients do not require HCT or oxygen. Nevertheless in nearly 25%, arterial oxygen levels fell below the threshold for recommending in-flight oxygen. This suggests that resting SpO₂ is not a good predictor of desaturation at altitude; such findings are consistent with those of previous, smaller, studies.[11,15,20] Further in-flight studies are clearly now required to determine what happens to SpO₂ in-flight, and the effect of in-flight oxygen.

The relatively high proportion of patients requiring antibiotics for respiratory tract infections within a month of flying suggests this may be a significant potential complication of air travel in this group. However, there was no control group and factors other than flying, such as travel itself and exposure to different climates, levels of physical activity and new pathogens, could be responsible. Further studies are clearly required.

It is reassuring that none of our patients developed confirmed VTE within four weeks of flying. Patients with DPLD were most likely to require unscheduled healthcare for respiratory problems within four weeks of air travel (figure 5). It may be that these patients are not well adapted to hypoxia, that diffusion is disproportionately affected by reduced partial pressure of oxygen at altitude, or that they receive less advice about self-management than patients with COPD.

Recognising that symptoms will develop in this group irrespective of flying, we compared our results in those who fly with published data on the unscheduled use of health service resources in comparable patients. A recent study showed that 317 out of 400 patients with COPD (79%) made unscheduled visits to their general practitioner during one year.[25] Although the level of need in our patients was higher than this, it was comparable to that recorded in a self-reported baseline during the previous year.
Clearly there are several limitations to our study. Firstly, patients were chosen because they were under the care of respiratory specialists who had a declared interest in air travel and lung disease. The patient population is thus subject to bias and one cannot over-interpret the safety of air travel. Secondly, given the relatively small percentage of complications, it is not possible to say with certainty whether pre-flight spirometry or oximetry, or in-flight oxygen, predict outcomes in this group of patients. Furthermore, owing to the absence of a control group, it is not possible to ascertain whether symptoms reported during air travel were exclusively related to underlying respiratory disease. Finally, we cannot be sure that our results can be extrapolated to patients flying from other countries, or to patients on somewhat longer flights.

Conclusions

We have completed the largest prospective study of air travel in patients with respiratory disease. Our results indicate that air travel is generally safe for patients who are under specialist respiratory care. More detailed studies of patients undergoing full pre-flight assessment, subsequently monitored by oximetry during flight (with and without oxygen as appropriate), may enable us to determine the most useful tests, and the patients most at risk. In the meantime the current study results will be used to inform future BTS recommendations on air travel in respiratory disease, and reassure us that for those assessed by respiratory physicians with an interest in flight, air travel is relatively safe.

Acknowledgements

The study was funded jointly by the British Lung Foundation (BLF) and the British Thoracic Society (BTS). The authors wish to thank the following centres (consultants) that submitted patients, without whom this study would not have been possible. They are: Brighton General Hospital (Drs J Hartley, M Jackson), Bristol Royal Infirmary (Dr M Hetzel), Chase Farm Hospital (Dr A Mier), Conquest Hospital (Dr A Dyson), Doncaster Royal Infirmary (Dr T Rogers), Epsom General & St Hellier Hospitals (Drs N Cooke, S Paramothayan, S Rahman), Glenfield Hospital (Dr L Khan), Halton General Hospital (Dr J Williams), Hammersmith Hospitals (Drs F Bowen, R Coker, A Cummin, S Gibbs, P Ind, Prof MR Partridge, Drs R Shiner, S Shovlin, M Sridhar), Hull & East Yorkshire Hospitals (Dr A Arnold), James Cook University Hospital (Dr G Antunes), James Paget Hospital (Drs I Connell, T Cotter, D Ellis, G Moorthie, Z Pond), Leeds General Infirmary (Drs M Bradley, M Henry, M Muers, S Pearson, CB Pepper, J Watson), Llandough Hospital (Dr C Gelder), Newcastle upon Tyne Hospitals (Dr P Corris, Prof G Gibson, Drs B Higgins, A Ward), Pilgrim Hospital (Drs D Boldy, I Campbell), Pontefract General Infirmary (Dr O Johnson), Queen Elizabeth II Hospital (Dr R Dent), Queen Margaret Hospital (Dr C Selby), Queen’s Hospital (Dr P Beckett), Royal Alexandra Hospital (Dr J Gravil), Royal Berkshire Hospital (Drs S Packham, C Davies), Royal Brompton Hospital (Professors R du Bois, F Chung, S Durham, D Geddes, M Hudson and A Wells, Mr G Ladas, Dr D Mitchell, Prof A Newman Taylor, Drs M Polkey, M Rosenthal, P Shah, A Simonds, Professor R Wilson, Mr Derek Cramer), Southampton General Hospital (Dr P Howarth), Southend Hospital (Dr A Davison), St John’s Hospital (Dr F Bollert), Stobhill Hospital (Drs C Bucknall, R Milroy), Sunderland Royal Hospital (Drs H Clague, N Keaney, K Sridharan), Taunton & Somerset Hospital (Dr J Pepperell), Torbay District General Hospital (Dr L Dobson), University Hospital Aintree (Dr R Angus, Prof P Calverley, Dr L Davies, Prof P Davies, J Earis, C Warburton), University Hospital Lewisham (Dr N Eiser), Western General Hospital (Drs J Faccenda, R Fergusson, Prof A Greening, Drs A Hill, N Hirani, A Innes, T Mackay, P Reid, H Rogers, J Simpson), Whips Cross University Hospital (Drs S Quantrill, A Reinhardt, Prof C Roberts, Dr R Taylor), Worcestershire Royal Hospital (Dr S O’Hickey), Wythenshawe Hospital (Drs H Anderson, A Jones, C Leonard, R Niven, Professors J Vestbo, A Woodcock), York District Hospital (Drs A Hunter, J White). We also acknowledge with thanks the assistance and expertise of the clinical scientists in these centres who undertook the physiological
assessments. The authors gratefully acknowledge help from Louise McNamara, Sajini Wijetilleka and Nicola Hawthorne with data collection and processing.
References
1. Iglesias R, Cortes MDCG, Almanza C. Facing air passengers’ medical problems while on board. *Aerosp Med* 1974; 45: 204-206
18. Graham WGB, Houston CS. Short-term adaptation to moderate altitude. Patients with chronic obstructive pulmonary disease *JAMA* 1978; 240: 1491-1494


Table 1 Patient Characteristics (n = 616)

<table>
<thead>
<tr>
<th>Age (yr), mean, (range)</th>
<th>61 (18-91)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex M:F</td>
<td>325: 291</td>
</tr>
</tbody>
</table>

**Commonest diagnoses (%)**

- COPD: 243 (39%)
- Diffuse parenchymal lung disease (excluding sarcoid): 141 (23%)
- Asthma: 90 (15%)
- Bronchiectasis: 49 (8%)
- Sarcoidosis: 45 (7%)

**Less common diagnoses**

- Obstructive sleep apnoea syndrome: 10
- Cystic fibrosis: 5
- Pleural disease: 5
- Pulmonary hypertension: 6
- Cancer: 5
- Chest wall disease: 2
- Previous venous thromboembolism: 1
- Other: 14

Table 2 Patient Characteristics (HCT group, n = 275)

<table>
<thead>
<tr>
<th>Age (yr), mean, (range)</th>
<th>61 (18-86)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex M:F</td>
<td>140: 135</td>
</tr>
</tbody>
</table>

**Commonest diagnoses (%)**

- COPD: 113 (41%)
- Diffuse parenchymal lung disease (excluding sarcoid): 82 (30%)
- Asthma: 20 (7%)
- Bronchiectasis: 18 (7%)
- Sarcoidosis: 12 (4%)
**Figure legends**

**Figure 1  Physician Questionnaire**
Figure shows the one page physician questionnaire completed at recruitment, containing questions about the patient’s diagnosis, test results and planned date of travel.

**Figure 2  Patient Questionnaire**
Figure shows the two page patient questionnaire completed after the return flight, containing questions about the patient’s outward flight, stay abroad, return flight and any subsequent complications.

**Figure 3  Outcomes in respiratory patients planning air travel**
Figure shows the outcomes of 616 patients with respiratory disease planning air travel.

**Figure 4  Pre-flight FEV₁, Sp₀₂, HCT and in-flight oxygen use**
Figure shows the results of pre-flight FEV₁, oximetry, hypoxic challenge testing and oxygen use overall and in those patients who either died or who were admitted to hospital within one month of flying.

**Figure 5  Unscheduled healthcare use by diagnosis**
Figure shows unscheduled healthcare use within four weeks of air travel stratified according to the initial primary diagnosis (airways disease, bronchiectasis, diffuse parenchymal lung disease, sarcoidosis or obstructive sleep apnoea syndrome).
**Figure 1**  Physician Questionnaire

<table>
<thead>
<tr>
<th>Consultant name</th>
<th>Patient name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Planned date of patient's air travel

**Diagnosis**

1. Respiratory diagnosis

2. Co-existing disease (cardiac/cerebrovascular/malignancy)

3. Risk factor(s) for venous thromboembolism (VTE): please tick any that apply:
   - Obesity
   - Extensive varicose veins
   - Minor surgery within last 72 hrs
   - MI within 6/52
   - Thromophelia
   - Family history of VTE
   - Pregnant/2-52 post partum
   - Oestrogen therapy (OCP/HRT)
   - Immobility/trauma/major surgery
   - Malignancy

Please list cardiac and respiratory drugs

Age……………………Sex M / F …………Height …………Weight…………

**Basic lung function tests. Please attach results to this sheet or write below.**

Minimum includes:

- FEV(1)…………………..(predicted)
- FVC…………………..(predicted)
- SpO2 at rest on air…………………..

**Further assessment.** Includes walk test (describe), DLCO/KCO or hypoxic challenge (state method). Please photocopy and attach results to this sheet

Walk Test (please describe and attach results)……………………………..

DLCO/KCO:  Yes/No Please attach result if performed……………………………..

Hypoxic Challenge:  Yes/No  **State method** and attach result if performed

Please state if patient was advised to fly: Yes/No
Please confirm your patient has been advised they will receive a questionnaire and is willing to participate:  YES (please tick) □

Please return this form, using the attached address label, to Dr Robina Coker, Respiratory Medicine, Hammersmith Hospital London W12 OHS
Figure 2 Patient Questionnaire

Patient Questionnaire
When complete, please return this form, using the attached address label, to Dr Robin Coker, Respiratory Medicine, Hammersmith Hospital, London W12 OHS WITH YOUR NAME HERE...

Q1. Did you receive supplemental oxygen during your flight? Yes/No

Q2. During your outward flight, did you notice any of the following?
   1. Chest pain Yes/No
   2. Palpitations Yes/No
   3. Worsening breathlessness Yes/No
   4. Swollen or painful calves Yes/No
   5. Abdominal pain Yes/No
   6. Dizziness or a feeling of faintness Yes/No
   7. Worsening cough Yes/No

If the answers to parts 1, 3 or 7 were yes, please circle one number below for each symptom (chest pain, breathlessness or cough) to show how severe it was (-5 = better than ever before; 0 = usual; +5 = very severe compared to my usual)

- Chest pain: -5 (best) → -3 → 0 (usual) → +1 → +3 → +4 → +5 (worst ever)
- Breathlessness:  -5 (best) → -3 → 0 (usual) → +1 → +3 → +4 → +5 (worst ever)
- Cough: -5 (best) → -3 → 0 (usual) → +1 → +3 → +4 → +5 (worst ever)

If you answered yes, did you receive treatment from a flight attendant and/or a doctor while on board, or airport staff immediately after landing because you felt unwell? Yes/No

Q3. Did you consult the flight attendant and/or a doctor while on board, or airport staff immediately after landing because you felt unwell? Yes/No

Q4. During your stay away from home, did you notice any of the following?
   1. Worsening breathlessness, cough, phlegm Yes/No
   2. A deterioration in your usual condition Yes/No

Q5. During your stay away from home did you?
   1. Consult a doctor for your lung condition Yes/No
   2. Receive treatment from a doctor Yes/No
   3. Have to be admitted to hospital Yes/No

If you consulted a doctor or received treatment, what was your reason for doing so, what treatment did you receive and how soon after flying did you receive attention? Please give brief details.

Q6. During your return flight, did you notice any of the following?
   1. Chest pain Yes/No
   2. Palpitations Yes/No
   3. Worsening breathlessness Yes/No
   4. Swollen or painful calves Yes/No
   5. Abdominal pain Yes/No
   6. Dizziness or a feeling of faintness Yes/No
   7. Worsening cough Yes/No

If you answered yes to parts 1, 3 or 7, please circle one number below for each symptom (chest pain, breathlessness or cough) to show how severe it was (-5 = better than ever before; 0 = usual; +5 = very severe compared to my usual)

- Chest pain: -5 (best) → -3 → 0 (usual) → +1 → +3 → +4 → +5 (worst ever)
- Breathlessness: -5 (best) → -3 → 0 (usual) → +1 → +3 → +4 → +5 (worst ever)
- Cough: -5 (best) → -3 → 0 (usual) → +1 → +3 → +4 → +5 (worst ever)

If your return journey was not made by air, please say why and how you came home.

Q7. During the four weeks after returning home did you?
   1. Consult a local doctor Yes/No
   2. Receive treatment from a doctor Yes/No
   3. Have to be admitted to hospital Yes/No

If you consulted a doctor or received treatment, what was your reason for doing so, what treatment did you receive and how soon after flying did you receive attention?

Q8. Do you plan to fly again?
   Yes/No

If the answer is no, please say why below.

Q9. In the last year, how many times have you been admitted to hospital for breathing difficulties?

Q10. In the last year, how many times have you had to see your doctor during an unannounced visit for breathing difficulties?

Q11. Do you smoke?
   Yes/No

Q12. On which airline did you fly?

Q13. How many hours roughly was your plane in the air on your outward journey?
   □

Q14. How many hours roughly was your plane in the air on your return journey?
   □

Q15. On the way home, how many hours passed between you leaving your accommodation and reaching your front door?
   □
A Physician Questionnaire was completed for 616 patients planning air travel.

- 96% had oximetry
- 95% had spirometry
- 45% had hypoxic challenge
- 10% had a walk test

500 returned patient questionnaires

- 431 flew
  - 5 died
  - 4 needed in-flight assistance
  - 18 (4%) needed healthcare while away
  - 81 (19%) needed post holiday healthcare compared with 9% in 4 weeks pre flight

- 69 did not fly
  - 7 died
  - 11 had difficulties with the airline, cost of oxygen/insurance or declined to use oxygen
  - 31 deteriorated and/ or received medical advice against travel
  - 20 gave other reasons

- 500 returned patient questionnaires
Figure 4 Pre-flight FEV1, Sp02, HCT and in-flight oxygen use
Figure 5  Unscheduled healthcare use by diagnosis

![Bar chart showing unscheduled healthcare use by diagnosis. The x-axis represents diagnoses: Airways, B'iectasis, DPLD, Sarcoid, OSAS. The y-axis represents the percentage of total recruited, ranging from 0 to 30. DPLD has the highest percentage, followed by B'iectasis, Sarcoid, Airways, and OSAS.]