

LETTER

Mains-powered hypoxic gas generation: a cost-effective and safe method to evaluate patients at risk from hypoxia during air travel

For the evaluation of patients at risk of hypobaric hypoxia during air travel, the British Thoracic Society Recommendations describe the normobaric hypoxic challenge as a substitute for the use of hypobaric chambers, which are not widely available.¹

In the normobaric hypoxic challenge, breathing 15% oxygen at sea level replicates the reduced P_{O_2} in ambient air at 8000 ft (2438 m), the maximum permissible cabin altitude during commercial flight. This method has been shown to produce results comparable with those obtained using hypobaric chambers and oxygen desaturation similar to that found in patients with chronic obstructive pulmonary disease (COPD) during flight.^{2,3} The methods described in the British Thoracic Society Recommendations include using a cylinder of 15% oxygen in nitrogen, delivered by either a breathing circuit or a body box. Alternatively, a cylinder of nitrogen may be used to drive a 40% Venturi mask resulting in a fractional inspired oxygen (F_{iO_2}) of 15%. As pure nitrogen is an asphyxiant gas, F_{iO_2} can fall dangerously low if Venturi mask ports become blocked or the nitrogen concentration becomes too high in an enclosed space. Furthermore, these methods require the use of gas cylinders which are costly, unwieldy, carry potential Health and Safety hazards, and incur significant expense for shipping and daily hire.

We use a mains-powered hypoxic gas generator (Hypoxico Everest Summit II, Sequal Technologies, San Diego, CA, USA), a CE-certified molecular filtration unit delivering hypoxic gas mixtures via a full-face continuous positive airway pressure (CPAP) mask, or into a sealed tent for paediatric or mask-intolerant patients. Supplementary oxygen is easily administered by nasal cannula in conjunction with the mask or tent. This equipment is commonly used by mountaineers to acclimatise to high altitude and by athletes in altitude training for performance enhancement.^{4,5} We have found it to have several advantages for hypoxic challenge testing. As a result of no longer purchasing nitrogen cylinders we have recouped the cost of the equipment after ~60 tests; centres using other methods, such as a 15% oxygen mixture with a breathing circuit or in a body box, which require additional equipment and higher gas consumption, may find the cost savings to be greater. The generator delivers a stable mixture of hypoxic gas, confirmed in validation tests using a calibrated oxygen analyser (Maxtec OM25-RME, Maxtec, Salt Lake City, Utah, USA). This showed a constant output of $15 \pm 0.1\%$ O_2 for >1 h, so avoiding the risk of excessive hypoxia.

The generator can be easily adjusted to deliver mixtures equivalent to any altitude up to 29 000 ft (8839 m). This ease of adjustment of F_{iO_2} provides improved versatility in research and clinical testing. For instance, a hypoxaemic patient planned a month-long holiday at high altitude but did not wish to use supplementary oxygen. By using the generator to vary F_{iO_2} to levels equivalent to altitudes up to 10 000 ft (3048 m) and measuring the resultant P_{aO_2} , we found that by staying at an altitude no higher than 6000 ft she could be expected to

maintain a P_{aO_2} of at least 7.3 kPa. She was able to take this holiday within the prescribed altitude limit without ill effect.

We believe mains-powered hypoxic gas generation to be a safe and potentially cost-effective alternative to using cylinders of nitrogen or gas mixtures for centres offering a pre-flight assessment service or undertaking research.

Kristofer J Spurling,¹ Christopher Zammit,² Stefan Lozewicz²

¹Respiratory Physiology Department, North Middlesex University Hospital NHS Trust, London, UK; ²Chest Clinic North Middlesex University Hospital NHS Trust, London, UK

Correspondence to Kristofer Spurling, Respiratory Physiology Department, North Middlesex University Hospital NHS Trust, London N18 1QX, UK; kristofer.spurling@nmh.nhs.uk

Competing interests None.

Provenance and peer review Not commissioned; externally peer reviewed.

Accepted 8 November 2010

Thorax 2010; ■:1. doi:10.1136/thx.2010.141655

REFERENCES

1. **British Thoracic Society Air Travel Working Party.** *Managing Passengers with Respiratory Disease Planning Air Travel.* British Thoracic Society Recommendations, 2002.
2. **Dillard TA,** Moores LK, Bilello KL, *et al.* The preflight evaluation. A comparison of the hypoxia inhalation test with hypobaric exposure. *Chest* 1995;**107**:352–57.
3. **Kelly PT,** Swanney MP, Seccombe LM, *et al.* Air travel hypoxemia vs. the hypoxia inhalation test in passengers with COPD. *Chest* 2008;**133**:920–6.
4. **McArdle WD,** Katch FI, Katch VL. *Essentials of Exercise Physiology.* Philadelphia, PA: Lippincott Williams & Wilkins, 2000:543.
5. **Wilber RL.** Current trends in altitude training. *Sports Med* 2001;**31**:249–65.