Selected abstracts from the Expedition Medicine symposium

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OSTEOPROTEGERIN: A MARKER OF HYPOXIC VASCULAR REMODELLING?

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Background Pulmonary hypertension due to hypoxic vascular remodelling is associated with a poor prognosis in chronic lung disease. Recent evidence has shown that osteoprotegerin (OPG), a member of the tumour necrosis factor receptor superfamily, stimulates pulmonary artery smooth muscle cell proliferation and migration and may therefore play an important role in pulmonary vascular remodelling.[1]

Method We investigated whether OPG plays a role in early hypoxic pulmonary vascular remodelling by measuring serum OPG levels in healthy lowland volunteers ascending to high altitude.

Subjects flew to La Paz, Bolivia (3,650 m/12,000 ft) and after four to five days' acclimatisation ascended over 90 minutes to the Chacaltaya laboratory (5,200 m/17,060 ft) by off-road vehicle. Venous blood samples were obtained at sea level and within six hours, three days and one week after arrival at 5,200 m. Serum was stored at –80°C until analysis. Samples from 18 subjects were available for OPG analysis by enzyme-linked immunosorbent assay (ELISA) (R&D Systems). Systolic pulmonary artery pressure was estimated on the same sample days using transthoracic doppler echocardiography.

Results Serum OPG increased significantly from a mean of 667.7 pg/ml (95% CI 570.0–765.5) at sea level to 813.9 pg/ml (95% CI 694.7–933.0) on day three at 5,200 m. There was no correlation between serum OPG level and pulmonary artery pressure or oxygen saturation at altitude.

Conclusion The rise in serum OPG at altitude has not previously been described. Our results suggest that hypoxia may stimulate release of OPG, but further work is required to determine whether OPG plays a role in hypoxic pulmonary vascular remodelling.

Reference

1 Lawrie A, Waterman E, Southwood M et al. Evidence of a role for osteoprotegerin in the pathogenesis of pulmonary arterial hypertension. *Am J Pathol* 2008; 172:256–64.

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Conflict of interest No conflicts of interest declared.

THE IMPACT OF EXPOSURE TO HIGH ALTITUDE UPON PHYSIOLOGICAL PARAMETERS IN TREKKERS ON THE INCA TRAIL

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Background Each year increasing numbers of tourists travel to high-altitude destinations, exposing themselves to risk of acute mountain sickness (AMS). On the Inca Trail, which reaches a peak altitude of 4,280 m, many trekkers suffer from symptoms of AMS, yet the pathophysiology of this condition is poorly understood.

Aims To examine the impact of high altitude upon physiological parameters in AMS and non-AMS groups.

Methods Aberdeen University Wilderness Medical Society (AUWMS) planned and obtained funding for an expedition to Peru. The 12 expedition members measured and recorded their heart rate, respiratory rate, peripheral oxygen saturation (SaO_2), blood pressure, peak expiratory flow rate and forced expiratory volume over one second, at various altitudes on the Inca Trail. At each altitude, members scored any AMS symptoms, according to the Lake-Louise scale. Statistical significance was tested between data sets in all incidences using an independent t-test.

Results Four of the 12 people met Lake-Louise criteria for AMS. This group had a significantly higher RR (24 bpm, 95% CI 22–26) compared to non-AMS sufferers (16 bpm, 95% CI 11–21 bpm) at the peak altitude of 4,280 m (p=0.003). SaO_2 decreased in all subjects during ascent from 2,967 m (94%, 95% CI 93–95) to 4,280 m (90%, 95% CI 88–92) p<0.001. There was, however, no significant difference between the groups at any altitude. No significant variations in other physiological parameters were found between the two groups.

Conclusions These findings show that AMS sufferers had a significantly increased respiratory rate at altitude compared with non-AMS sufferers, but SaO_2 values between the groups were not different. This suggests that AMS sufferers require a greater increase in respiratory rate in order to maintain SaO_2 levels comparable with non-AMS sufferers.

Conflict of interest No conflicts of interest declared.

AWARENESS OF ALTITUDE ILLNESS IN TREKKERS ON THE INCA TRAIL

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Background Altitude sickness is a growing public health issue due to the increasing numbers of travellers to high altitude destinations. Trekkers are at risk from developing acute mountain sickness (AMS) and severe, potentially life-threatening complications. Previous studies have shown that people who have a good knowledge of altitude illness are less likely to suffer from AMS. Vaccinations against infectious diseases and malaria prophylaxis are familiar topics to healthcare providers; however, altitude illness is rarely addressed in the pre-travel consultation.

Aims To assess the knowledge and awareness of altitude sickness in trekkers on the Inca Trail, and determine the source of their knowledge.

Methods A structured questionnaire, consisting of a combination of multiple-choice and fill-in questions, was issued to travellers trekking the Inca Trail. The questionnaires were distributed before the start of pre-trek briefings with 12 different trekking companies. Trekkers had to be over 18 years of age and able to read English to participate.

Results A total of 333 questionnaires were completed. Knowledge of altitude illness was generally poor; only 34.5% of trekkers were able to identify headache as the primary symptom of AMS. Prior to travelling, 94.6% of respondents received the recommended vaccinations, the most common sources of these being a general practitioner, private travel clinic or practice nurse. Overall, 70.5% of the study population who sought travel health advice received information about altitude illness; however, only 25.4% of the trekkers from the UK (63) were warned of the dangers of high-altitude travel.

Conclusions Knowledge about altitude illness among travellers is largely inadequate for safe travel to high altitude. Travel health practitioners, particularly those in the UK, should be providing more information to give trekkers a basic awareness of the symptoms, prevention and treatment of altitude illness.

Conflict of interest No conflicts of interest declared.

THE PERFORMANCE OF OXYGEN DELIVERY DEVICES AT PHYSIOLOGICAL EXTREMES

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Background Historically, research into the performance of oxygen delivery devices (ODD) has usually been undertaken on healthy human volunteers during short periods of rest and moderate hyperventilation. While this provides a considerable amount of information, it does little to predict the performance of ODDs in our most breathless patients. On Mount Everest the demands placed upon the cardiovascular and respiratory systems are immense. Breathlessness is commonplace. The aim of this study is to take advantage of these physiological changes and study the impact of three ODDs upon them.

Method Five healthy, well-acclimatised mountaineers completed the study at 6,100 m on Mount Everest. Each mountaineer completed a period of rest and sub-maximal exercise (50W) while breathing air (AIR) or a mixture of air and supplemental oxygen (O_2) from three ODDs. O_2 was delivered through either a constant flow open circuit (CF-OC), a demand flow open circuit (DF-OC) or a constant flow closed circuit (CF-CC). The CF-OC delivered 2 l/min of O_2 continuously, while the DF-OC delivered a pulse of 33 ml O_2 only during inspiration. In the CF-CC a mixture of 2 l/min of O_2, air and exhaled gases was inspired. In order to prevent the inspiration of carbon dioxide, the CF-CC was fitted with a carbon dioxide absorber.

Results During rest the arterial oxygen saturation (SaO_2) rose from 78.6% (AIR) to 97.6% (CF-OC), 93.4% (DF-OC) and 99.4% (CF-CC). During sub-maximal exercise the SaO_2 increased from 72% (AIR) to 90% (CF-OC), 80.6% (DF-OC) and 99% (CF-CC). A significant fall in SaO_2 was observed during exercise in AIR, CF-OC and DF-OC ($P<0.05$). Significant differences in heart rate (HR), tidal volume (VT), respiratory rate (RR) and minute ventilation (VE) were not observed between the three ODDs during rest or sub-maximal exercise.

Conclusion At high levels of ventilation, the choice of ODD has a significant impact upon oxygenation.

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AN INDIVIDUAL ACCOUNT OF HIGH-ALTITUDE EXPEDITION DOCTORING

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Background I have acted as an expedition doctor on two trips: to Lhakpa La, on the flank of Mount Everest, 6,860 m (Great Walks of the World, 2006), and the summit of Denali, 6,190 m (American Alpine Institute, 2008).

Aim To illustrate through my experience the main issues that confront an expedition doctor at altitude, and aid this by describing major medical problems I encountered on each trip.

Summary The demands of high-altitude mountaineering, to simply keep yourself warm, fed and hydrated, take a huge amount of time, energy and organisation. The additional task of a team doctor to a group of 'patients' whom you have only just acquainted, and who will all react unpredictably to the environment, is very challenging.

Lhakpa La
A client developed pulmonary oedema as we started traversing the remote Kharta glacier. This was the route taken by George Mallory in 1921, and as he described it was a 'glacier furnace' with a steep, heavily crevassed climb to the col. This caused various logistical problems in getting the sick client to the relative safety of Everest Advanced Base Camp, some 8 km away.

Denali
A solo climber fell more than 60 m from the ridge above camp 3, resulting in a fracture dislocation of his ankle. He was able to radio for help, but his rescue was delayed because of 100 km/h winds and a –30°C temperature. He fortuitously landed beside a tent that had been blown down from camp 4 and which he used for protection; otherwise he would not have survived. He arrived at camp 3 severely hypothermic and dehydrated, and the rescue helicopter was weather-delayed by three days.

Conflict of interest No conflicts of interest declared.