

Expedition medicine symposium 2005

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ABSTRACT This meeting, the first held on this subject by the College, aimed to address the medical challenges presented by the advent of 'adventure tourism', focusing on topics helpful for expedition medics.

KEYWORDS Expedition medicine, high altitude physiology, wilderness training

LIST OF ABBREVIATIONS Acute mountain sickness (AMS), blood oxygen saturation (SaO₂), cardiopulmonary resuscitation (CPR), high altitude cerebral oedema (HACE), high altitude pulmonary oedema (HAPE), International Union of Alpine Associations (UIAA), magnetic resonance imaging (MRI)

DECLARATION OF INTERESTS No conflict of interests declared.

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HIGH ALTITUDE PHYSIOLOGY

Professor D Bailey (Department of Physiology and Biochemistry, University of Glamorgan, Pontypridd, Wales) outlined the evidence for a pathophysiological role for free radicals in the development of high altitude headache (also known as AMS). Inspiratory normobaric hypoxia activates oxidative stress, particularly in individuals exercising hard.¹ Severe AMS can develop into the more serious HACE. Magnetic resonance imaging has revealed HACE to be associated with reversible white matter oedema in the *corpus callosum*, initially thought to be caused by increased permeability of the blood–brain barrier.² In a recent study, healthy volunteers were subjected to 18 hours of either hypoxia (12% oxygen) or normoxia (21% oxygen). Hypoxic individuals, with severe AMS and increased brain volumes, did not display an increase in blood–brain barrier permeability.³ Professor Bailey, therefore, proposed that free radicals, generated under hypoxic conditions, cause cerebral oedema by intracellular cytotoxic effects rather than by influencing blood–brain barrier permeability. Animal model studies have also suggested that factors released by the hypoxic brain play a role in the development of HAPE.

Dr P Barry (University of Leicester, England) discussed the issues and risks of taking infants or young children to high altitude. Although this is becoming increasingly common there has been limited study in this area, resulting in much practical advice being extrapolated from adults.⁴ The chronic hypoxia of high altitude can have marked effects on cardiopulmonary transition at birth.⁵ Blood oxygen saturation is not solely dependent upon the partial pressure of oxygen, but also is affected by the rate and pattern of respiration. Han Chinese neonates in Lhasa, Tibet (3,658 m)

exhibit more periodic breathing during sleep and so have a lower SaO₂ than native Tibetans growing up at the same altitude. Low SaO₂ prevents the decline in pulmonary artery pressure seen at sea level in the first days following birth. Offspring of native lowlanders (Han Chinese) who are born and develop at high altitude are therefore at increased risk of developing pulmonary arterial hypertension, either acutely or later in life. For such reasons, many of the Han Chinese of Lhasa, descend to lower elevations for the birth and first year of life of their offspring. A successful expedition involving children and young infants involves the '3 Ps':

- Preparation (taking a full medical history of the children; planning the trip to accommodate their limited physical capabilities; thinking through such issues as how to dispose of nappies with limited environmental impact);
- Prevention (immunisations; ensuring the children are familiar with the food and culture of the country to be visited);
- Practicalities (protection from sun/wind/rain; appetising food; suitable games and diversions for bad weather days).

In the limited studies carried out to date, AMS has not been found to be of increased incidence in young children compared to adults. The difficulties of diagnosing AMS in pre-verbal children has resulted in the development of special scoring systems.⁶ It is important to have a very low threshold for AMS diagnosis in infants. The mainstay of treatment is descent, as pharmacological therapy has not been studied in this patient population.

The Sydney Watson Smith lecture was given by Dr C Sartori (University Hospital Lausanne, Switzerland). He has performed numerous studies, at sea level and

at the beautifully situated Capanna Regina Margherita (4,559 m), investigating the pathophysiology of acclimatisation to high altitude. Pulmonary oedema results when there is an imbalance between alveolar fluid production and clearance within the lung. Impaired nitric oxide availability,⁷ elevated endothelin production,⁸ increased sympathetic nerve activation⁹ and augmented oxidative stress have all been shown to contribute to the exaggerated hypoxic pulmonary vasoconstriction seen in HAPE-prone individuals. The resulting elevated pulmonary artery pressures are important in the pathogenesis of HAPE, most likely through increased alveolar fluid production. The susceptibility of individuals to HAPE is influenced by environmental factors. Transient perinatal hypoxia also predisposes to pulmonary arterial hypertension in adults exposed acutely to high altitude, most likely due to impaired nitric oxide synthesis.¹⁰ However, elevated pulmonary pressures are not enough to result in HAPE. Transepithelial sodium transport, important in the clearance of alveolar fluid, is impaired in HAPE-prone subjects at sea level, and is reduced further on climbing to high altitude.¹¹ Stimulating alveolar clearance with inhaled beta-adrenergic agonists has been shown to reduce the incidence of HAPE¹² and may represent a potential new therapy in the management of this condition.

COMPLICATIONS OF EXTREME ENVIRONMENTS

Dr I Grant (Senior Medical Officer, British Antarctic Survey, Plymouth, England) discussed the hazards presented by putting man (a 'tropical animal', comfortable when unclothed at 27–29°C) in an environment such as the Antarctic, with an average winter temperature of -65°C. Hypothermia is always an issue here, particularly as an average human at rest produces about as much heat as a light bulb. Accurate measurement of body temperature is a practical difficulty in the field – a hand on the abdomen is often the most useful guide. It is important to rewarm the patient at the rate at which they cooled. The management of cardiac arrest in the setting of hypothermia is complicated. Chest compressions can precipitate ventricular fibrillation and CPR is not advised if any respiratory effort is present no matter how slight. Even with the best intentions, in the Antarctic a few minutes with outer gloves removed can result in either frostnip or full frostbite. Successful management depends upon adequate analgesia, avoiding re-freezing, keeping surgical colleagues at bay, with consideration given to the use of aspirin and vasodilators, such as nifedipine.

Temazepam is known to improve the quality of sleep in the often uncomfortable environment of a tent at high altitude.¹³ Dr A Nickol (Medical Expeditions, www.medex.org.uk) presented the results of a study performed at Chamlang base camp (5,000 m), to investigate whether such night sedation results in

impaired cognitive performance the following day. Previous work has demonstrated that treatment with temazepam improves reported sleep quality through a reduction in periodic breathing in subjects sleeping at high altitude. The current study demonstrated that treatment with temazepam did not impair daytime performance as assessed by reaction time or vigilance, although it was associated with a lower mean nocturnal SaO₂, perhaps through a reduction in the incidence of periodic breathing. Such work suggests that benzodiazepines could join acetazolamide in the medical kit of the high altitude expedition medic.

PRACTICAL ASPECTS OF EXPEDITIONS: HOW DO I TREAT?

Professor D Warrell (Nuffield Department of Clinical Medicine, University of Oxford, England) emphasised the need to be fully aware of the dangers posed by bites and stings from snakes and other exotic animals, by presenting a sobering case report of an experienced zoologist, who failed to appreciate the severity of a bite from a Krait snake in Burma. This, along with delayed treatment, resulted in swift paralysis and death less than 48 hours later. The need for pressure immobilisation in the management of such neurotoxic bites, along with the use of anti-venom (high risk of anaphylactoid reaction) for other snake bites was discussed.

A significant problem for Mr P Marquis (Manager, British Antarctic Survey Medical Unit, Plymouth, England) is the issue of whether to evacuate an injured or sick survey member, or to treat them on the base. As the Antarctic is one of the most remote locations on the planet, the potential of telemedicine has been fully realised. This allows specialists back in the UK to view digital images sent via satellite, make diagnoses and suggest appropriate treatment. Many examples of its use were given including a case of a ski-doo driver who had severed the extensor tendons of the thumb of his dominant hand, while clearing snow from the engine of his machine. Rather than have to leave the base and be sent back to the UK, the driver's hand was reconstructed by the base doctor, with the constant support and instruction from a UK-based plastic surgeon, linked via satellite.

Dr J Dallimore (Bristol Royal Infirmary, England) not only works as a GP and in the emergency department of his local hospital, but also has extensive experience as the doctor on over 20 expeditions. He highlighted the most important contents of the expedition medical kit, and how this should be capable of being split up for smaller groups leaving the main party. As the medical officer on an expedition, life is often not busy, and so a team-playing attitude and the ability to take on other roles is essential. However, if one of the group becomes ill, they will require attention around the clock, perhaps

for several days. He proposed that expedition medicine, without senior or peer backup, or the facilities for investigations, is the last bastion of true clinical medicine. Lastly, he emphasised the importance of preparation, including being physically fit and gaining useful qualifications, such as the UIAA Diploma in Mountaineering Medicine,¹⁴ or participating in a specialised course on expedition medicine, such as those run by Wilderness Medical Training.¹⁵

EXPERIENCES IN THE HIGHLANDS OF SCOTLAND AND DURING AN ASCENT OF EVEREST

The last two talks put some of the lessons learnt earlier in the day into context. Dr B Tregaskis (Consultant Physician, Belford Hospital, Fort William, Scotland) discussed medicine in the West Highlands of Scotland, focusing on the work of the voluntary rescue teams. Of the 450,000 visitors who come to Glen Nevis each year, more than 300 require the help of the Mountain Rescue Services. Although often reaching the news headlines, the total number of mountaineering-related deaths in Scotland are few compared to the death toll on the roads and related to water. Whilst trauma and hypothermia are significant problems, major factors in most mountain incidents are a lack of preparedness and poor navigational skill. Examples of difficult mountain rescues, often involving RAF helicopters, and the integrated role of the local hospital in the strategy for rescue were described.

Dr C Hornsby (General Practitioner, Elgin, Scotland) recounted his experiences of climbing to the summit of

Mount Everest as a member of the British Mount Everest Medical Expedition in 1994.¹⁶ This involved over 70 expedition members carrying out numerous research projects into the physiological challenges posed by high altitude exertion. Of the six climbing members, only C Hornsby and his climbing partner, Dr R Kirkwood, made it to the summit. The talk brought the everyday challenges of such a project to life: how a lack of good appetising food at the end of a long day can devastate morale, the logistical problems of establishing camps high up the mountain, and the constant worries over the weather situation.

As well as the oral presentations, many of the participants presented posters. Several of these concerned the physiological adaptations to high altitude trekking and climbing. One study identified that rapid ascent was the most significant factor in determining the onset of AMS in children; another reviewed the anatomical abnormalities associated with HAPE. Other topics including the experiences of a crew medic on several 'Round-the-world yacht races'; setting up a worldwide network of satellite blood banks for emergency use by travellers; and the establishment of a wireless remote communication system for the transmission of clinical data using mobile phone technology.

The symposium was extremely well attended, with over 200 participants. The great range of subjects covered, from studies of endothelial biology at high altitude, through to more practical aspects such as managing hypothermia and exotic bites and stings, to the eye-witness account of a successful attempt on the summit of Everest, revealed the appeal of expedition medicine in all its forms.

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