

Children at High Altitude – Managing the Risks

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There are many opportunities for children to travel to areas of high altitude (>2500m) for tourism, for skiing, and for racing and training. This short summary focuses on some of the hazards that may affect children at altitude, and identifies ways in which the risks can be managed, notably by careful planning, awareness and rapid and effective treatment. It is intended primarily for those with no specialist medical knowledge; some references for further reading are listed. **Careful assessment and management of the risks will facilitate safe enjoyment of some of the most beautiful places in the world (Pollard, Murdoch, 1996).**

Factors which affect the safety and physical well-being of children high in the mountains include:

- Mountain/environmental/climatic hazards, including terrain, snow conditions, crevasses, rock/ice falls, avalanches, changeable weather, wind, visibility (not covered in this short risk management summary)
- Cold exposure
- Sun exposure
- Dehydration
- Individual responses to altitude, and the various forms of altitude sickness

Cold exposure - Small children are particularly vulnerable to the effects of

cold because of their large surface area to volume ratio. Adequate clothing is essential to prevent misery, hypothermia, and frostbite. Physical exercise will allow the children to generate heat through muscle activity, and the risk of hypothermia will be lessened. Younger children may become susceptible to hypothermia on long slow chairlifts at any altitude; T-bar or Poma alternatives should be used in preference. Remember to make particular allowance for the added effects of wind-chill.

Sun exposure - Reflection from snow and a thinner atmospheric layer at high altitude make the risk of solar ultraviolet radiation burns more likely than at sea level. Children are more likely to burn than adults if exposed to excess sun. Snow blindness results from solar damage to the cornea and conjunctiva. Appropriate sun-block creams (protection from UVA and UVB, SPF at least 30, applied before sun exposure), hats, long sleeves and goggles are required to prevent sunburn or snow blindness.

Dehydration - Since minute ventilation is about 20% higher at an altitude of 2500m and each breath must be humidified, relative dehydration is a frequent issue. Adequate fluid intake should be encouraged, and sports drinks should be available for ‘resuscitation’.

Children with pre-existing illnesses - Children with certain underlying chronic

medical conditions may be at increased risk of developing either an exacerbation of their chronic illness or an illness directly related to altitude. Risk factors include a history of high-altitude illness, residence at an altitude below 900m, exertion, and certain pre-existing cardiopulmonary conditions.

N.B. Don't travel on cable cars or any aircraft with sick children – the pressure changes are too rapid.

Individual responses to altitude, and the various forms of altitude sickness

The major categories of altitude illness are acute mountain sickness (AMS), high altitude pulmonary oedema (HAPE), and high altitude cerebral oedema (HACE). The two latter more serious conditions are usually preceded by AMS. The mainstay of treatment for each of these conditions is DESCENT. The incidence of acute mountain sickness (AMS), the most common form of altitude illness, is high – approximately 1 in 4 visitors to Colorado ski resorts develop AMS symptoms.

Acute mountain sickness (AMS)

- An acute illness characterised by headache, anorexia, nausea, vomiting, fatigue, weakness, dizziness, light-headedness, and sleep dis-order. The symptoms typically develop within 6 to 10 hours after ascent, but sometimes as early as 1 hour.
- Children are no more susceptible than adults; being fit doesn't help.
- Previous history may indicate susceptibility

High altitude pulmonary oedema (HAPE)

- Acute pulmonary oedema (swelling of or fluid on the lungs) caused by altitude hypoxia, presenting as dyspnoea (breathing difficulty), reduced exercise tolerance, cough, haemoptysis (coughing up blood), tachycardia (fast pulse), tachypnoea (fast breathing), cyanosis (blueness of fingers, lips etc), fever
- Conditions that predispose a child to HAPE include recent inflammatory processes, such as viral infection, and conditions linked with underlying pulmonary hypertension.

High altitude cerebral oedema (HACE)

- HACE is swelling of, or fluid on the brain and consists of headache, ataxia (disturbances of balance), behavioural changes, hallucinations, confusion, disorientation, decreased level of consciousness, focal neurological signs, and coma.
- There is no published information about the incidence of HACE in children.

Sleeping Altitude

- Most mountain tourist sites and ski resorts are located at or below about 3200m, and the majority of travelers to these sites will sleep at 2000m or below.
- Ascents with sleeping altitudes at or below 3000m carry a low risk of serious altitude illness. Sleeping altitude is more important than

‘active altitude’, perhaps because with wakefulness and activity the ventilation rate is higher and therefore oxygen saturations are higher.

- Staying even one night at lower elevation significantly mitigates the incidence of AMS
- Remember, wherever possible ‘climb high, sleep low’.

Risk Management re Altitude illnesses:

Planning

- Plan for slow graded ascent
- Plans should include sleeping at lower altitude wherever possible
- Drug prophylaxis (usually acetazolamide*) may be used in adults but is not indicated in children except under special circumstances
- Management of group size, provision for adequate supervision at all times on the hill
- Prepare an evacuation strategy in case urgent descent is necessary
- Be flexible – if one child becomes sick the group plan may need to be adjusted

Awareness

- Full awareness by all responsible adults re signs and symptoms
- Watch out for all in a big group
- Be aware that non-specific signs (e.g. fussiness) may present in younger children

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This short summary has been gleaned from the literature, in particular from the publications listed below.

- Care – upper respiratory infections are a predisposing factor for HAPE; URTI may also lead to
- problems of equalising pressure on rapid ascent in lifts, perforated eardrums

Treatment

- DESCENT (a descent of only 500 to 1000m usually leads to resolution of AMS)
- Further ascent is contraindicated
- Descent, when possible, should involve minimal exertion (exertion is likely to exacerbate the symptoms); the child should be carried where practical during descent.
- Oxygen when available
- If HAPE is suspected, the patient should remain sitting upright.
- Call for urgent medical assistance if HAPE or HACE are suspected

*NB acetazolamide (used in the prophylaxis and treatment of altitude illness) is on the WADA list of prohibited drugs.

In short, the keys to management of the risks of altitude illness are careful planning, full awareness of the risks and of the signs and symptoms, flexibility and rapid treatment – most notably descent.

References

For those who would like to read more, and for medical personnel requiring more detailed information regarding prophylaxis and treatment:

Children at High Altitude: An International Consensus Statement by an Ad Hoc Committee of the International Society for Mountain Medicine, March 12, 2001 – Pollard et al, published in HIGH ALTITUDE MEDICINE & BIOLOGY, Volume 2, Number 3, 2001; Mary Ann Liebert, Inc.

High Altitude Illness – Peter H Hackett, MD, & Robert C Roach, PhD; published New England Journal of Medicine, Vol. 345, No. 2, July 12, 2001

The High Altitude Medicine Handbook – Andrew Pollard & David Murdoch (Third Edition 2003); published by The Radcliffe Medical Press, Oxford

Travel to High Altitude with Young Children: An Approach for Clinicians - Michael Yaron and Susan Niermeyer; published in HIGH ALTITUDE MEDICINE & BIOLOGY, Volume 9, Number 4, 2008

Children at Altitude – 2008 Consensus Statement of the UIAA Medical Commission, Meijer, H.J. & Jean, D