

«Up to which altitude above sea level a potential risk of hypoxia is negligible for infants? Under which circumstances?»

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Each year many thousands of lowland children travel to high altitude uneventfully. The majority of these pediatric ascents involve trips to mountain resorts while a smaller proportion involve journeys to remote highland areas in nonindustrialized nations (i.e. Altiplano in South America, Himalaya region). In addition, an increasing number of children are moving to reside with their families at high altitude (> 2500m) as a result of parental occupation. Unfortunately, the particular risks of exposure of children to high altitude have been little studied and much of the advice must necessarily be extrapolated from adult data with due consideration of the influence of growth and development¹.

Being aware of this lack of important information regarding the safety and wellness of children (particularly the non-verbal age group among them) in high altitude, during the Jasper Park Hypoxia Symposium in March 2001 the International Society for Mountain Medicine released the first Consensus Statement for Children at High Altitude². Subsequently you will find a short summary of the above mentioned Consensus.

In healthy children and infants ascents higher than 3000m that are prolonged (>1 day) or require sleeping above 3000m increase the risk of acute mountain sickness and should be undertaken cautiously with slow graded ascent, built-in rest days, and emergency planning (provision of communications to facilitate evacuation, descent or access to oxygen should be possible immediately, i.e. within hours).

In circumstances where the child is traveling above 2500m altitude because of parental occupation and prolonged altitude residence is anticipated, slow graded ascent should be undertaken. For infants (<1 year) planning to reside permanently at altitude, delaying ascent to altitude until beyond the first year of life is recommended because of the slight risk of SIMS (subacute infantile mountain sickness) above 3000m. This is usually impractical if pa-

rental separation is to be avoided. Therefore, after a careful physical exam before ascent and initial acclimatization to high altitude, the infant should be followed closely with respect to growth percentiles, pulse oximetry may be useful, especially during sleep, and the ECG should be monitored periodically for the development of right ventricular hypertrophy.

Further notice should be taken from the child's history before ascent. High altitude travelling is not recommended in children with any possible history for underlying congenital heart disease, perinatal pulmonary disorders or ongoing respiratory infection before specialists consultation.

In older children (>8 years), it is assumed that altitude illness will present in much the same way as it does in adults. Under 3 years of age, travel to any new environment may result in alterations of sleep, appetite, activity, and mood. Differentiating behavioral changes caused by travel alone from changes caused by altitude illness can be difficult. Because of variability in the developmental level of perception and expression in young children, they are not reliable reports of symptoms of altitude illness even when they can talk. Symptoms may appear as nonspecific behavioral changes, rather than specific complaints of headache or nausea. The typical symptoms of acute mountain sickness in infants include increased fussiness, decreased appetite or vomiting, decreased playfulness, and sleeping disorders. These symptoms usually begin 4 to 12 hours after ascent to altitude. Some older children, particularly those in the age range from 3 to 8 years, and children with learning or communication difficulties may also be poor at describing their symptoms, making altitude illness difficult to recognize.

Acute mountain sickness

Mild

1. Rest (stop further ascent) or preferably descend until symptoms cease (particularly with younger children).
2. Symptomatic treatment, such as analgesics and antiemetics.

Moderate

1. Descent
2. Oxygen
3. Acetazolamide 2.5 mg/kg/dose p.o. 8 to 12 hourly (maximum 250 mg per dose)
4. Dexamethasone 0.15 mg/kg/dose p.o. 6 hourly
5. Hyperbaric chamber (only used to facilitate descent, which should be undertaken as soon as possible)
6. Symptomatic treatment, such as analgesics (acetaminophen, ibuprofen) and antiemetics in appropriate pediatric doses. Use of aspirin is not recommended in young children, due to the association with Reyes syndrome.

High altitude pulmonary edema

1. Descent
2. Sit upright
3. Oxygen
4. Nifedipine 0.5 mg/kg/dose p.o. 8 hourly (maximum 20 mg for capsules and 40 mg for tabs, slow release preparation is preferred). Nifedipine is necessary only in the rare case when response to oxygen and/or descent is unsatisfactory.
5. Use of dexamethasone should be considered because of associated HACE.
6. Hyperbaric chamber (only used to facilitate descent, which should be undertaken as soon as possible)

High altitude cerebral edema

1. Descent
2. Oxygen
3. Dexamethasone 0.15 mg/kg/dose p.o. 6 hourly
4. Hyperbaric chamber (only used to facilitate descent, which should be undertaken as soon as possible)

Transferring these outlined guidelines into Swiss settings we have to consider that the Swiss Alps are placed in the «far» northern hemisphere, between the 40s and 50s degree of latitude while the corresponding regions like the Himalaya and the Colorado Plateau are closer situated to the Equator, i.e. between the 30s and the 40s degree of latitude. The third important big region in high altitude environment, the Southamerican Altiplano is almost located at the equator. The equatorial air layers are much more spread than the ones closer to the poles. This means that the oxygen partial pressure at high altitude in Central Europe decreases faster while ascent whereas in the other regions the difference might not be that significant. This theory matches with the observations of the incidence of reported acute mountain sickness in the alpine regions where even pulmonary edema or cerebral edema formations are documented at lower sea level than in the other regions. A slow graded ascent for considered travels with children and infants 1700m above sea level should be recommended. Moreover the parents should be aware of the possible implications of travelling or staying in high altitude.

References

- 1) Berghold F, Wandern und Bergsteigen mit Kindern. Alpin and Höhenmedizin, Lehrskriptum der österreichischen und deutschen Alpinärzteausbildung (Handbook of the Austrian Society for Mountain and Altitude Medicine and the German Society for Mountain and Expedition Medicine). Austrian Society for Mountain and Altitude Medicine and the German Society for Mountain and Expedition Medicine, Innsbruck, 2000, Vol. 3, pp. 1–18.
- 2) Pollard AJ, Niermeyer S, et al. (2001) Children at High Altitude: An International Consensus Statement by an Ad Hoc Committee of the International Society for Mountain Medicine, March 12, 2001. High Altitude Med & Biol 2: 389–403.

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