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Children at Altitude

Intended for Physicians, Interested Non-medical Persons and Trekking or Expedition Operators

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Introduction

Each year many thousands of lowland children travel to high altitude uneventfully. The majority of these ascents involve trips to mountain resorts, especially in North America and Europe. In addition, an increasing number of children are moving to reside with their families at high altitude as a result of parental occupation. While altitude travel is without incident for most, some of these children develop symptoms that may be attributed to altitude exposure.

The particular risks of exposure of children to high altitude have not been thoroughly studied and much of the advice must necessarily be extrapolated from adult data with due considerations of the influence of growth and development. As known so far children are not under more restrictions to acute exposure to altitude than adults. Nevertheless, adults should clarify the following questions well in advance if they want to go to altitude with children:

1. Will the child really like it?
    - Plan a child-specific tour character!
        - Adventure and play are more important to a child than achieving or residing at any summit
2. Is the trip pampering to the parental ego rather than to the needs of the child?

The following consensus view described here provides the conservative recommendations that should be helpful for mountaineers and physicians who are required to offer advice about ascent to high altitude with children.

Note: Young children are generally poor at communicating their physiological discomfort, i.e. unlikely to say they are dangerous cold, can't feel their fingers (assuming they have enough language skills). They would probably just become very quiet and still. A child's thermal regulation is immaturely developed, as is their ability to adapt to hypoxic exposure when compared to an adult.

Definitions

- *Children*: 0 – 18 years of age
    - newborn: 0 – 1 month of age
    - infant: 1 – 23 months of age
    - preschool child: 2 – 5 years of age
    - child: 6 – 12 years of age
    - adolescent: 13 – 18 years of age

Otalgia and other ear, nose and throat risks

The most common topic concerning children at altitude is the risk or otalgia caused by rapid changes of atmospheric pressure, e.g. by fast ascents by car or cable car, but also by any aircraft (sightseeing flights). The risk is increased for very young children or babies and for babies or infants with pre-existing upper respiratory tract infections. They are unable to balance the pressure in the ears if the nose is blocked

by cold. An additional problem may arise for the parents to interpret the symptoms at a crying non-verbal child.

Small children should be completely healthy if they are taken to altitude. If possible, clean the nose as well as possible with saline solution to avoid blocked nose. Take some time and do some stops while driving an alpine pass. Let them suck every 300 to 500 m of altitude. Rest before and after the top, but not on the top (unless the child shows completely normal behaviour and obviously feels well). When going down quickly (car, cable car) advise the child to their pinch nose and blow hard with their mouth closed. Don't travel on cable cars or any aircraft with sick children – the pressure changes are too rapid. Nasal sprays which are designed for small children may be used regularly while ascent to altitude (saline solution). **Note:** Laryngitis and nose bleeding are common in winter ski resorts (dry air, overheated rooms). This can be prevented by humidification of the air.

Altitude related illnesses: AMS/HAPE/HACE/SIMS

Young children are not reliable reporters of symptoms, even when they can talk. In children under 3 years of age, travel to any new environment may result in alterations of sleep, appetite, activity and mood. Some older children, particularly those in the age range 3 – 8 years old, and children with learning or communication difficulties may also be poor at describing their symptoms, making altitude illness difficult to recognize. In children 8 years and older, it is assumed that altitude illness will present in much the same way as it does in adults.

At all ages (children and adults) the symptoms of altitude illness are non-specific and can be confused with unrelated variables such as concurrent illness, dietary indiscretion, intoxication or psychological factors associated with remote travel or pre-existing problems. However, when ascending with children, it is wise to assume that such symptoms are altitude related until proven otherwise and appropriate action is undertaken. Although data are preliminary, children need a similar time for acclimatization to that of adults.

Although there are no scientific data, it is generally recommended not to ascend to a sleep altitude of higher than 3,000 to 4,000 m with preschool child, and to prefer a sleep altitude of <2,500m.

Diagnostic guidelines:

1. Risk factors:
    - Rate of ascent, absolute altitude gained, time elapsed since after ascent (onset of symptoms typically after 4-12 hours, but > 1 day possible)
    - exertion, cold, dehydration
    - preceding and current viral respiratory infections
    - unilateral absence of a pulmonary artery
    - pulmonary hypertension, perinatal pulmonary hypertension
    - congenital heart disease

- Down syndrome
- individual susceptibility
- re-ascent to altitude after long or lifetime stay at altitude
- organised groups

2. Testing and scoring systems:
   - Lake Louise Symptom Score (LLSS) self-report-questionnaire for adolescents [1]
   - Lake Louise Age-Adjusted Symptom Score (LLAASS) questionnaire for 4 –11 year olds [2], [3]
   - Lake Louise Symptom Score (CLLS) for pre-verbal children [3]

Table 1: Lake Louise Symptom Score (LLSS) self-report-questionnaire for adolescents [1], [4]

Symptoms	Severity	Points
Headache	- no headache - mild headache - moderate headache - severe headache, incapacitating	0 1 2 3
Gastrointestinal	- no gastrointestinal symptoms - poor appetite or nausea - moderate nausea or vomiting - severe nausea or vomiting, incapacitating	0 1 2 3
Fatigue and / or weakness	- not tired or weak - mild fatigue/weakness - moderate fatigue/weakness - severe fatigue/weakness, incapacitating	0 1 2 3
Dizziness / lightheadedness	- not dizzy - mild dizziness - moderate dizziness - severe dizziness, incapacitating	0 1 2 3
Difficulty of sleeping	- slept as well as usual - did not sleep as well as usual - woke up many times, poor night's sleep - unable to sleep	0 1 2 3

> 3 points = AMS (if no evidence for other reason of symptoms)

Note: Headache should be present (only a few cases without headache were reported)

Table 2: Lake Louise Age-Adjusted Symptom Score (LLAASS) questionnaire for 4 –11 year olds [5]

Symptoms	Severity	Points
Do you have headache?	- no headache (face no. 0) - a little headache (face no. 1) - more than a little headache (face no. 2) - really bad headache (faces nrs. 3-5)  	0 1 2 3
Are you hungry?	- yes, hungry - not really hungry or a little upset stomach - upset stomach or throwing up a little - really upset stomach or throwing up a lot	0 1 2 3
Are you tired?	- not tired - a little tired - more than a little tired - really tired	0 1 2 3
Are you dizzy?	- not dizzy - mild dizziness - more than a little dizzy - really dizzy	0 1 2 3
How did you sleep last night?	- slept as well as usual - did not sleep as well as usual - woke up many times during the night - could not sleep at all	0 1 2 3

≥ 3 points = AMS (if no evidence for other reason of symptoms)

Note: This score is not yet validated, so it should be used with caution. Nevertheless, it was included here because it seems to be very helpful for the diagnosis of AMS in this specific age group.

Table 3: Lake Louise Symptom Score (CLLS) for pre-verbal children [2], [3]

Symptoms	Severity	Points
Rate the amount of unexplained fussiness * of your child today when awake Rate the intensity of unexplained fussiness * of your child today when awake	Amount: 0 No fussiness 1 2 3 Intermittent fussiness 4 5 6 Constant fussiness Intensity: 0 No fussiness 1 2 3 Moderate fussiness 4 5 6 Hard crying & extreme fussiness Fussiness Score = amount + intensity:	0 - 12
Rate how well your child has eaten today	- normal - slightly less than normal - much less than normal - vomiting or not eating	0 1 2 3
Rate how playful your child is today	- normal - playing slightly less - playing much less than normal - not playing	0 1 2 3
Rate the ability of your child to sleep today	- normal - slightly less or more than normal - much less or more than normal - not able to sleep	0 1 2 3

≥7 points = AMS (if no evidence for other reason of symptoms)

with both the fussiness score ≥4 points and eating + playing + sleeping score ≥3 points [2]

* Fussiness = a state of irritability not easily explained by a cause as tiredness, hunger, teething or pain from an injury. Fussy behaviour may include crying, restlessness or muscular tension. Rate the child's typical fussy behaviour during the last 24 hours without the benefit of your intervention.

Table 4: Additional factors in the diagnosis of altitude-related disorders in children

Diagnosis		Symptoms
AMS	in the setting of a recent gain in altitude, the presence of headache and at least one of the following symptoms:	• gastrointestinal (loss of appetite, nausea or vomiting) • fatigue or weakness • dizziness or lightheadedness • difficulty sleeping (use the Lake Louise Scoring Systems)
HAPE	in the setting of a recent gain in altitude, the presence of at least two of the following symptoms: *and* at least two signs of:	• shortness of breath at rest • cough • weakness or decreased exercise performance • with or (often) without the presence of AMS • crackles or wheezing in at least one lung field • central cyanosis • high breathing rate • high heart rate
HACE	in the setting of a recent gain in altitude, *either*:	• in the presence of a change in behaviour and/or ataxia in a person with AMS • *or,* in the presence of a change in behaviour *and* ataxia in a person without AMS

Management guidelines for AMS/HAPE/HACE:

1. Prevention
    - *Graded ascent*. Slow graded ascent, allowing time for acclimatization, is necessary. An ascent rate of 300 m per day above 2500 m (sleeping altitude) and a rest day every 1000 m has been recommended.
    - *Drug prophylaxis* to aid acclimatization in childhood should be strictly avoided, because there are no data or experience! Slower ascent achieves the same effect in most cases and minimizes the unnecessary use of drugs in childhood. In rare cases, when a rapid ascent is unavoidable, use of acetazolamide to aid acclimatization might be warranted in a child, after medical advice and with doses adjusted to body weight.
2. *Education*
    - Children and their carers should be acquainted with the symptoms of altitude illness and its management prior to altitude travel (above 2500 m). Parents should also know their children's reactions during travel, irrespective of altitude, to be capable of differentiating high altitude illness from simple travel symptoms.
3. *Emergency plan*
    - An emergency contingency plan should be made by all groups travelling to a remote altitude location prior to travel so as to ensure access to oxygen and/or hyperbaric chamber and evacuation of a sick member of the party, if necessary. Part of the emergency plan should include provision of communications to facilitate evacuation.
    - For children any emergency plan should strictly include the possibility of an immediate descent.
4. *Pre-excursion planning*
    - Excursions are a popular educational experience for older children. It is essential that organizations planning group excursions to (sleeping) altitudes above 2500 m plan an itinerary that allows graded ascent, rest days, easy descent, and a flexible itinerary in case of illness. Also the medical history for each child should be assessed in the pre-excursion period.

Table 5: Treatment of altitude-related disorders in children

Diagnosis	Treatment
AMS	**Mild symptoms:** • rest (stop further ascent) or preferably descend until symptoms cease, particularly with young children • symptomatic treatment, such as a painkiller (e.g. paracetamol, acetaminophen, ibuprofen) and an antiemetic (e.g. metoclopramide or dimenhydrinate) in appropriate paediatric doses for the particular age of the specific child. **Moderate/severe symptoms:** (worsening of symptoms of AMS despite rest and symptomatic treatment • Descent • Oxygen • Acetazolamide**: 2.5 mg /kg body weight per 8-12 hours orally (maximum 250 mg per dose) • Dexamethason**: 0.15 mg/kg body weight per 6 hours orally • Hyperbaric chamber, only used to facilitate descent, which should be undertaken as soon as possible • Symptomatic treatment such as painkillers (e.g. paracetamol, acetaminophen, ibuprofen) and antiemetics (e.g. metoclopramide or dimenhydrinate) in appropriate paediatric doses for the particular age of the specific child.
HAPE	• Descent • Sit upright • Oxygen • Nifedipine** only in the rare case when response to oxygen and/or descent is unsatisfactory. Dosage: 0.5 mg/kg bodyweight per 8 hours orally (maximum 40mg for tablets / day, slow release preparation only!) • Use of dexamethasone** should be considered in the case of associated HACE (see: HACE) • Hyperbaric chamber, only used to facilitate descent, which should be undertaken as soon as possible • Monitor patient permanently! **Note**: there are no data about the drug therapy of HAPE in children!
HACE	• Descent • Oxygen • Dexamethasone**: 0.15 mg/kg bodyweight per 6 hours orally, if the child is conscious. If the child accepts or in severe cases parenteral application should be preferred (at least for the first one) • Hyperbaric chamber, only used to facilitate descent, which should be undertaken as soon as possible • Monitor patient permanently! **Note**: there are no data about the drug therapy of HACE in children!

** to be prescribed by physicians only

SIMS & SHAPH

- Definitions
    - *SIMS*, subacute infantile mountain sickness: this is a subacute form of SHAPH in infants
    - *SHAPH,* symptomatic high altitude pulmonary hypertension: includes acute bouts of high blood pressure in the lungs as well as the subacute forms (as in “subacute infantile mountain sickness” *(SIMS*) and “high altitude heart disease“)

- Anamnesis / background
    - SIMS is a subacute form of SHAPH and begins with poor feeding, sleepiness and sweating. Later signs of heart failure such as dyspnoea, cyanosis, cough, irritability, sleeplessness, enlarged liver, oedema and decreased urine production may become apparent.
    - It occurs almost exclusively in infants of low-altitude ancestry who are continuously exposed to altitudes over 3,000 m for more than 1 month.
- Treatment
    - The management of the subacute form of SHAPH is different from acute mountain sickness and is directed at control of congestive cardiac failure and reversal of the high blood pressure in the lungs. Treatment consists of administration of oxygen, drug induced increase of urine production and urgent descent.

SIDS

- Definition
    - *SIDS*, sudden infant death syndrome: sudden unexpected death in an infant <1year old and in which a thorough post-mortem examination fails to demonstrate an adequate cause for death.
- Background
    - Infants are at risk until they are one year old, with a maximum of risk from 2- 4 months.
    - It is unclear whether exposure to high altitude invokes an increased risk of SIDS as there are conflicting reports. There is also a theoretical risk and some evidence that exposure to altitude may interfere with the normal respiratory adaptation that occurs following birth. Theoretically, the higher the altitude, the higher the risk due to the hypoxia at altitude.
    - The possibility of an association warrants careful consideration of an ascent to altitude of >2,500m with a young (<1 year old) infant. The risk has been described as low as 1,000m, but 1,600m is the limit of sleep

altitude usually recommended for infants <1 year of age normally living at sea level.

- Management guidelines
    - As at sea level, the risk of SIDS may be reduced by laying the infant to sleep on the back and avoiding passive exposure to tobacco smoke and overheating of the room.

Cold exposure

Infants and small children are particularly vulnerable to the effects of cold because of their large surface area to volume ratio. The child who has to be carried during a hike is not generating heat through muscle activity and is at risk of hypothermia. Adequate clothing is essential to prevent misery, hypothermia, and frostbite. One has to be aware of a number of cases of frostbite of extremities, including those necessitating amputations, especially after the use of baby carriers in winter. Protection of the head with a cap is highly recommended, because of the higher ratio of head volume in children, allowing higher loss of heat by this way.

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. 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 snowblindness. Sun protection that prevents sunburning can be achieved by children seeking shade, wearing protective clothing, and limiting exposure during peak hours (ie 11 am to 3 pm).

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. Few to no data exist for determining the risk for specific medical conditions.

Therefore first risk factors for the development of altitude-related illnesses should be checked and then assessed, how in each individual child this may affect his or her medical condition in an environment with less oxygen. By this it may be possible to determine the relative risk of developing complications at altitude.

1. Heart and lung disorders

It is therefore logical to believe that children [6]:

- who lack one of their two lung arteries
- who have certain congenital heart defects
- who have significant lung disease secondary to premature birth
- who have cystic fibrosis
- who have Down syndrome [7],
- who have actual infections of the respiratory tract [8]

are at risk for the development of HAPE at altitude.

2. Other important disorders

- Increased risk for children with sickle cell disease, thalassaemia [9], [10], [11]
- Severe anaemia
- Development of HAPE was seen with adrenogenital syndrome, but few to no data exist on this subject.
- Development of HAPE was seen after chemotherpay for cancer, but few to no data exist on this subject.
- Recurrent seizures were seen in children who are no longer on medication at as low as 2,700m, but few to no data exist on this subject.

Evaluation

If parents decide to travel to altitude with children with chronic medical conditions, special planning to ensure adequate supplies and for expedient evacuation is essential. This likely means limiting travels to more developed altitude destinations, rather than isolated backcountry trips. Recently isobaric hypoxia chambers give the chance to check whether the child will tolerate altitude or not.

Miscellaneous

Boredom. Young children typically have a short attention span and will easily become bored after travelling relatively short distances. A stimulating itinerary should be carefully chosen.

Physical ability. Estimates of distances that young children might be expected to walk (at sea level) have been made, but these should only be used as guidelines that may be adjusted for each individual child. It should be emphasized that children should only walk as long as they want to.

Food. Some young children may be very poorly adaptable to changes in circumstances and refuse unfamiliar food. It is helpful to try foods out prior to altitude travel when possible. It is important to ensure an adequate food and liquid intake.

Hygiene. In remote treks, travelling with young infants may be particularly stressful for parents trying to maintain appropriate hygiene for their child.

Concurrent illness. Gastroenteritis is probably no more common among child travellers than among adults. But children are more prone to develop severe, life-threatening dehydration with gastroenteritis, and supplies to make a safe oral rehydration solution (ORS) should be part of every medical kit. The dose should be adjusted for children as most ORS are produced for adults.

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History of this recommendation paper

The first edition was written and presented by D. Jean at the UIAA MedCom meeting in Aspen (Colorado) 1995. This was followed by an UIAA consensus statement of an international ad hoc committee formed by the International Society for Mountain Medicine at the Jasper Park Hypoxia Symposium 2001 and published in 2001. At the UIAA MedCom Meeting at Snowdonia in 2006 the commission decided to update all their recommendations. The version presented here was approved at the UIAA MedCom Meeting at Adršpach – Zdoňov / Czech Republic in 2008. This actual version is mainly based on [3].