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CONSENSUS STATEMENT

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Emergency Field Management of Acute Mountain Sickness, High Altitude Pulmonary Oedema, and High Altitude Cerebral Oedema

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

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Introduction

Acute mountain sickness (AMS), high altitude pulmonary oedema (HAPE) and high altitude cerebral oedema (HACE) are the most important and most common altitude-related diseases. Up to altitudes of about 5000-6000m, symptoms of altitude illness are a direct result of poor acclimatization. Dependent on the ascent profile, up to and >70% of mountaineers will suffer from symptoms. Primary prevention is therefore considered the gold standard to avoid altitude illness. This includes a conservative ascent profile, adequate hydration and energy intake, and early recognition and management of potential medical problems, both before and during the trip.

This recommendation focuses on:

1. situations where prevention has failed or other factors contributed to the development of AMS, HACE or HAPE (weather, rescue missions, predisposition etc) and;
2. on adult mountaineers (for children see UIAA Standard No. 9)

Risk situations for AMS, HAPE, and HACE

- Rapid ascent to high altitude
  - E.g.: airport of destination at high altitude, ascent by vehicle or undertaking an “aggressive” altitude profile while hiking
  - Team blocked at high altitude
- Previous History of AMS, HACE or HAPE
- Victim ignored early symptoms of altitude illness
- Dehydration
- Typical altitudes at risk:
  - >ca. 2,500 m for AMS
  - >ca. 3,000 m for HAPE
  - >ca.4,000 – 5,000 m for HACE
  - **Note:** symptoms lower than the altitudes mentioned are rare, but even severe cases are possible!
- Typical time frame for symptoms
  - AMS: >4 hrs and <24 hrs after ascent to new altitude
  - HAPE (& HACE): >24 hrs
  - **Note:** Onset of AMS-symptoms <4 or >24 hrs, or HAPE-symptoms <24 hrs is rare, but possible!

Typical symptoms of AMS

- Several of the following symptoms:
  - Headache (most often diffuse and non-localized, but other types of headache do not exclude AMS)
  - Sleep disorders
  - Loss of appetite
  - Listlessness
  - Peripheral oedema
  - Severe heart palpitation
  - Nausea or vomiting

    - Dyspnoea at light workload
- **Note:** Typical symptoms may not all be present, in a few cases even headache may missing
- **Note:** In case of severe listlessness or somnolence: consider HACE! (see below)
- **Note:** Dyspnoea at light workload or even at rest: consider HAPE!

The **Lake Louise Symptom Score** (see Appendix 1) was primarily established to quantify the severity of AMS for scientific purposes (field studies). It may also be used for diagnostic purposes, but for field management of AMS the symptoms listed above and the consequences described below and in Appendix 2 are sufficient.

Typical symptoms of HAPE

- Dyspnoea even at light workloads progressing to dyspnoea at rest
    - High breathing rate (>30/min. in 69% of the cases [1])
- Rapid decrease in performance
- Cough
- High pulse rate
- Chest tightness
- Bubbling breath, cyanosis and bloody/foamy expectoration in severe cases
- Mild fever

Typical symptoms of HACE

- Severe headache without response to usual painkillers
- Nausea and vomiting
- Dizziness
- Ataxia
    - The heel-to-toe walking test is a very sensitive and simple field test which also helps to differentiate unclear situations (e.g. if people want to mask their symptoms)
- Vertigo
- Altered consciousness, confusion or hallucinations
    - Irrational behaviour may indicate an early stage!
- Final stage: coma and death by respiratory paralysis

Note: Lay persons should always treat mountaineers for AMS, HAPE, HACE first, except if they are absolute sure that there is another reason for the symptoms. Doctors should also always consider AMS, HAPE, or HACE at (high) altitude first, but they should always take other diagnoses into account, especially those listed in the following tables:

Most important differential diagnoses in AMS and HACE

Diagnosis	Patient's history	Symptoms	Therapy	Remarks
Exhaustion	Previous intense activity?	Impaired fitness, lack of motivation, impaired mood, headache. Severe cases: collapse.	Rest, refuel with carbohydrates, fluid, and cold protection. Severe cases: glucose i.v., passive transport	Eating complex carbohydrates are preferred to carbohydrates with a high glycaemic index to prevent the risk of hypoglycaemia occurring during treatment!
Dehydration	Hot climate, inadequate fluid intake, diarrhoea, vomiting	Thirst, lack of motivation, impaired mood, impaired fitness, headache, oliguria, dry skin and mouth, fever. Severe cases: tachycardia, collapse dizziness, delirium, seizures	Rest and rehydrate! Slight hypotonic beverages are best. Severe cases: glucose 5%, potassium lactate, or NaCl 0.9% i.v. (at least 1000 ml, continued by oral rehydration)	Restoring a normal hydrated status may need several days! Lack of thirst does not indicate adequate hydration at altitude! Drink even when you don't feel thirsty! The colour of urine does not indicate adequate or inadequate fluid balance (but urine volume of at least 1 l/day does)
Sunstroke	Exposure to intensive sunlight?	Meningitis-like headache, fatigue, dizziness, nausea, vomiting, tachycardia. Final stage: stupor, coma.	The victim should take no further activity. Place him in the shade or inside a room. Drink plentiful cool fluids. Take a painkiller.	Monitor the patient, situation may be life-threatening!
Heat stroke	Hot climate, inadequate fluid intake, lack of fitness combined with physical activity	Similar to dehydration, but with neurological symptoms and collapse, respiratory arrest and circulatory collapse. Hot skin	Rest in shade, cool patient, apply fluid to his/her clothing to increase evaporation, survey breathing and circulation. Passive transport.	Life-threatening situation! Allow time for appropriate heat adaptation before demanding activities are started!
Hangover	Previous intake of alcohol of any kind of wine / liquor?	Diffuse, non-localized headache, fatigue, nausea, lack of motivation	Except applying non-alcoholic fluid (with electrolytes) none (just wait) Survey patient!	Don't belay, don't lead. You won't make good decisions! **Note:** Be warned that recent reports suggest excessive drinking is occurring more frequently in mountain huts.

Other (rarer) differential diagnoses

Diagnosis	Patient's history	Symptoms	Therapy	Remarks
Seizures	Ask about previous seizures! If patient is unconscious, comrades may be able to give information.	Localized or generalized attacks with sudden onset, sometimes aura or postictal semi-conscious state	Protect the patient from falls first, especially in the mountains! Diazepam rectally or i.v. in severe cases.	First seizure at altitude is an extreme rare event!
CO intoxication	Cooking or fuel powered lights inside of the tent or a snow cave	Headache, confusion.	Oxygen (if available) or fresh air (open tent or cave!)	**Note:** No cyanosis!
Acute psychosis	Psychic or psychiatric history?	Complete loss of control of acceptable behaviour, resulting in extraordinary risk for the patient and possibly other group members in the mountains.	Sedative or antipsychotic drugs in severe cases. **Note:** some drugs may impair breathing, especially if used at altitude!	First episode of a psychiatric disease at altitude in patients without any psychiatric history is an extreme rare event!
Stroke (TIA / progressive stroke)	In most cases no special history	More or less sudden onset of paresis, speech impediments, and other neurological symptoms	In regions with some infrastructure (e.g. Alps): Passive transport to hospital as soon as possible. On some expeditions passive transport is not appropriate, but most cases recover within 24-48 hours. In any case: monitor patient, stabilize blood pressure in case it becomes >200/100 mmHg	Potentially life-threatening situation!
Brain tumour	In most cases no special history	More or less sudden onset of paresis, speech impediments, and other neurological symptoms. Normally misinterpreted as stroke / TIA (see above)	Cortisone i.v. (high dosage). Stabilize blood pressure in case it becomes >200/100 mmHg. Monitor patient. Passive transport to hospital as soon as possible.	If no history of tumor / metastases is known, this diagnosis is almost impossible to make in the field.

(cont. next page)

Other (rarer) differential diagnoses (cont.)

Diagnosis	Patient's history	Symptoms	Therapy	Remarks
Hypoglycae-mia	Diabetes? **Note:** Specific risk for diabetic mountaineers: Acetazolamide (contraindication for diabetic patients!)	Hunger, nausea / vomiting, tachycardia, restlessness / tremor, sweat, impaired fitness, lack of motivation, impaired mood, dizziness, mydriasis, hypertension	Rest and feed complex carbohydrates (oligosaccharides). Measure blood glucose concentration every 15 min. until patient is fine and concentration is stable >60 mg/dl (>3.3 mmol/l).	Significant hypoglycaemia without diabetes is a very rare event and normally not induced by physical activity!
Diabetic ketoacidosis	Only in diabetic patients. With modern therapy rare, but possible if the diabetic problem is combined with fluid loss (e.g. traveller's diarrhoea or high altitude dehydration). **Note:** Specific risk for diabetic mountaineers: Acetazolamide (contraindication for diabetic patients!)	First signs similar to Dehydration (see there). Severe cases: tachycardia, hypotension, oligo-anuria, hyperglycaemia	Potentially life-threatening situation! Monitor patient continuously! Rehydrate patient (NaCl 0.9% i.v., 1000 ml 1st hour, continued according to symptoms). Rapid acting insulin "low dose scheme" (20 E i.v. as bolus, followed by 5 – 10 E/hr i.v.) until blood glucose concentration is <250 mg/dl (<13.9 mmol/l). Transport to hospital as soon as possible.	Devices to measure blood glucose concentration give false-low results if used at <14°C (<0°C no measurement possible). **Note:** bicarbonate administration in the wilderness without lab results is very risky! It may induce extreme hypokalaemia
Hyponatriae-mia	Intake of high amounts of salt-free beverages (water, tea…), normally in hot climate or in cases of traveller's diarrhoea.	Impaired fitness, lack of motivation, impaired mood, dizziness, syncope, collapse. Salt stained clothing or sweat stings eyes.	Rest. Give oral rehydration solution, or beverages with a small pinch of salt. If severe, administer hypertonic mannitol, i.v. hypertonic NaCl 3% at rate 1-2 ml/kg/hr.	Allow time for appropriate heat adaptation before demanding activities will be started! Do not drink excessive quantities of water or plain tea.
Meningitis / Encephalitis	No special history in most cases (contact with persons who had similar symptoms some days ago?)	Massive, meningi-tis-like headache, fatigue, dizziness, nausea, vomiting, tachycardia, fever. Final stage: stupor, coma.	Antibiotics, painkillers. Take care for your safety and that of the group's - the patient should wear a mask! Transport to hospital as soon as possible.	Survey patient! **Note:** situation may be life-threatening!
Intoxication / drug abuse	Intake of any drug or plant?	Several neurological / psychiatric symptoms, depending on the drug used.	Monitor patient (circulation, breathing). Cold protection.	Treatment with specific drugs is normally not realistic in the mountains.

Most important differential diagnoses in HAPE

Diagnosis	Patient's history	Symptoms	Therapy	Remarks
"Physiological dyspnoea"	High altitude exposure	Tachypnoea without any other symptom	none	--
Altitude cough ("Khumbu cough")	Exhaustive work at high altitude or in very cold environment	(Very) severe dry cough which may cause pain (chest, trachea, throat), no fever	Antitussive drugs, throat lozenges. **Note:** Most antitussive drugs contain codeine (respiratoric depressor), but that should be no problem if normal dosage is used (e.g. 5 mg / ½ tabl. dihydrocodeine). Alternatively use noscapin 25 mg	Only relief is by descent to low altitude
Hyperventilation syndrome	Agitation, massive fright	Tachypnoea, often combined with tingling sensations of the extremities, dizziness, sometimes collapse / unconsciousness	Calming down the patient, breathing controlled by counting seconds. Normally no drug therapy necessary	Self limiting after collapse. Most important danger: injuries caused by fall.
Sleep apnea	High altitude exposure	Phases of dyspnoea or apnoea at night	Improve acclimatization. If symptoms persist, try theophylline 300 – 400 mg slow release or acetazolamide 250mg in the evening **Note:** theophylline slow release is not available in some countries	--
Cardiac insufficiency	Coronary heart disease / myocardial infarction? Cardial insufficiency / valvular heart disease	Dyspnoea, moist rales, pathologic cardiac sound	Furosemide 40 – 80 mg i.v.	--
Pulmonary embolism (/deep vein thrombosis, DVT)	Dehydration, immobilization (flight!) varicosis, contraception pills, factor V leiden	Dyspnea, tachycardia, splitted 2nd cardiac sound, one-sided swollen leg possible	Heparin 25,000 I.E., if available	Most important non-traumatic risk for fatal incidences at high altitude!
Pneumonia	Infection, fever, cough, expectoration	Cough, expectoration, chills, one-sided pulmonary rales	Antibiotics (macrolides or tetracycline)	Fever does not exclude HAPE from pneumonia!

Other (rarer) differential diagnoses to HAPE

Diagnosis	Patient's history	Symptoms	Therapy	Remarks
Asthma	Strain / stress? Infection? Aspirin? Cold air?	Ronchus, dry rales, expiratoric dyspnea	Betamimetics (aerosols with aerochamber or i.v.), corticoides i.v., theophylline (i.v. or klysma), in extreme situations ketamine narcosis	First asthma episode at altitude is a very rare event! Ask for history of asthma!
CO intoxication	Cooking or fuel powered lights inside of the tent or a snow cave	Headache, confusion.	Oxygen (if available) or fresh air (open tent or cave!)	**Note:** No cyanosis!
CO_2 narcosis	Very tightly closed tent or snow cave	Sluggishness, somnolence, dyspnea	Oxygen (if available) or fresh air (open tent or cave!)	--
Pneumothorax	Spontaneous or traumatic	Acute dyspnea, one-sided reduced or missing respiratory sounds	Puncture / drainage (severe cases only)	--
Neurogenic pulmonary oedema	High altitude exposure, unsuccessful therapy of HAPE	Symptoms of HACE, sings for intracranial pressure, pulmonary oedema	Massive therapy of the HACE (high dosages of corticoide and oxygen!)	--
Drug induced pulmonary oedema	Heroine? Cocaine (mountaineering in the Andes!)?	Heroine: Miosis; Cocaine: Mydriasis (of both pupillae)	Diuretics, no nifedipine!	--
Aspirin induced pulmonary oedema	Headache and aspirin intake	Typical pulmonary oedema	Cortisone, diuretics, no nifedipine!	--

Of course, there are some other rare diagnoses (e.g. pertussis).

Emergency management of AMS (see also **flow chart in appendix 2**)

- Light to moderate symptoms
  - Stay at the same altitude (rest day) until symptoms have completely disappeared
    - No further ascent with symptoms!
  - Avoid any workload, especially with forced respiration during expulsion
  - Treat symptomatically (oral therapy)
    - Nausea: antiemetics (e.g. dimenhydrinate)
    - Headache: paracetamol or ibuprofene (no acetyl salicylic acid - aspirin)
    - Acetazolamide 250mg bid (2x/day) may be considered if the above fail after 6-12 hours
  - Try to drink enough in spite of nausea
  - Descend if symptoms do not improve or worsen within 24 hours
  - Sleep with slightly elevated upper body

- Severe symptoms
  - Exclude HACE!
    - If there should be any doubt: Treat as HACE!
  - Rest immediately, never continue ascent!
    - Protect patient against cold
  - Treat symptomatically as described above
  - Dexamethasone 8 mg
    - May be repeated after 6 hrs, if symptoms should be still severe
  - Acetazolamide 250mg bd.
  - Descent as soon as possible to the last camp or hut, where the patient was well (or at least about 500 (– 1,000) meters)
    - "As soon as possible" means, that the symptoms were significantly ameliorated before and the patient will be able to manage the terrain (distance, steepness…) safely
    - The patient shouldn't carry loads while descending
    - Do not leave the camp for descending if there are ascents en route.
      - With severe symptoms the patient will be unable to manage such ascents, even if they are short.
      - If you are worried that the patient might die, your fears may be justified if retreating with an ascent en route!
    - If possible, do not descent completely, otherwise there wouldn't be any stimulus for acclimatization anymore
  - If a portable hyperbaric chamber is available, refer to UIAA recommendation No.2
  - No re-ascent before the patient feels completely well.

Emergency treatment of HAPE

- Rest immediately, never continue ascent!
  - Upper body in upright position
  - Protect patient against cold

- Oxygen (if available)

- Nifedipine slow release, 20 mg
    - Onset of the effect after 10 – 15 min.
    - Repeat, if symptoms should worsen again
        - No time frame possible! Pure clinical decision based on symptoms.
    - Avoid using nifedipine short release! This may cause a severe decrease of blood pressure.
- Portable hyperbaric chamber
    - For use and tactics refer to UIAA recommendation No.3
- PEEP valve, if patient accepts it
- Leave high altitude
    - Passive transport, where available (stretcher, helicopter etc)
    - Where passive transport is impossible descent as soon as the treatment decreases symptoms.
        - Take equipment down to continue therapy en route if necessary
        - The patient should never carry any load
        - see also remarks on descending with HACE (see below)

Note: Do not use diuretics (e.g. Furosemide as recommended in the past for treatment)!

Emergency treatment of HACE

- The management is the same as for HAPE but instead of Nifedipine give Dexamethasone as follows:
    - Dexamethasone
        - If the patient is conscious they should be given 8 mg orally every 6 hours until they are free of symptoms
        - In severe cases a parenteral initial dose of 8-10 mg (depending on size of ampoule dose) should be given either i.v. or i.m.
        - In extremeis in adverse weather conditions this parenteral dose may have to be given i.m. through clothing to a moribund patient and under these circumstances higher initial doses have been tried. Preloaded ready to use syringes can be easier to handle and use in these adverse conditions
        - It is also possible to drink the ampoule's content
- Additional Acetazolamide 250mg bid may be an additional benefit
- While descending, pay more attention to the patient's safety, especially in any case of dizziness or ataxia!

Emergency treatment of combined HAPE and severe AMS

- Manage as for both HAPE and HACE.

APPENDIX 1:
Lake Louise Symptom Score (LLSS) self-report-questionnaire for adults

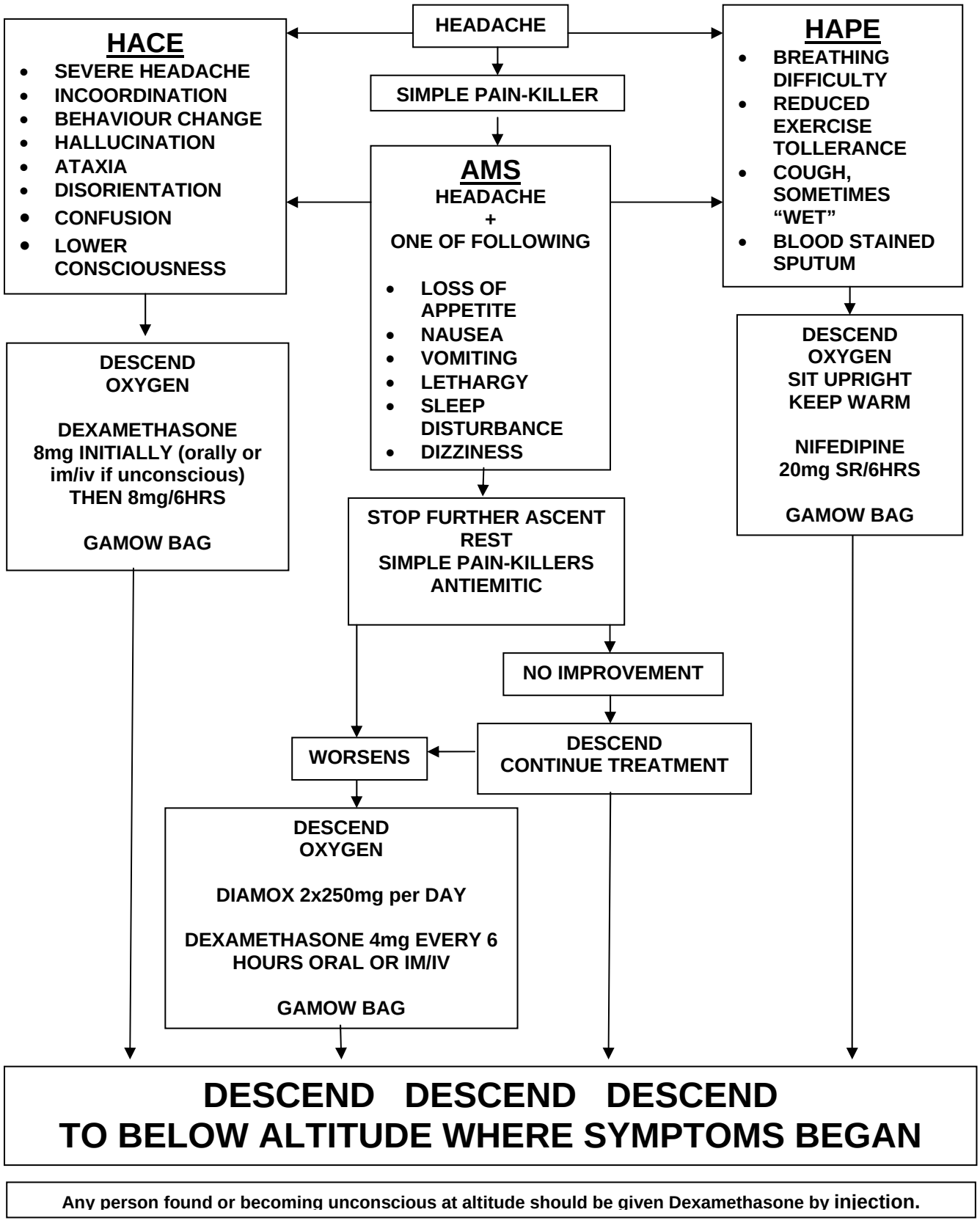
Symptoms	Severity	Points
Headache	- no headache - mild headache - moderate headache - severe headache, incapacitating	0 1 2 3
Gastrointestinal	- no gastrointestinal symptoms - poor appetite or nausea - moderate nausea or vomiting - severe nausea or vomiting, incapacitating	0 1 2 3
Fatigue and / or weakness	- 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

A total of > 3 points indicates AMS (if no evidence for other reason of symptoms)

Note: For scoring systems for children see UIAA Consensus Paper No.9 "Children at Altitude"

APPENDIX 2:

AMS is a serious medical condition which can quickly lead to HACE or HAPE which are life threatening emergencies. Any signs or symptoms should be reported to expedition leader. All symptoms at altitude must be considered as altitude related until proven otherwise.



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History of this recommendation paper
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