ICAR **REC M 0013 E**

International Commission for Alpine Rescue

Commission for Mountain Emergency Medicine

Recommendation REC M 0013 of the Commission for Mountain Emergency Medicine

of 1999

On Site Treatment of Avalanche Victims

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Paper intended for physicians and paramedics

An avalanche accident is a medical emergency. In all decisions the goal of rapid rescue of the victim(s) must be balanced against the risks to the rescue team. The possibility of a second avalanche, snow conditions, as well as topographic and meteorological factors must be evaluated. “Thinking ahead” should be the guiding principle of the rescue procedure. Try to bring emergency doctors and/or paramedics and dog handlers with dogs (“docs and dogs") as soon as possible to the site of the avalanche. The more persons buried the more doctors and/or paramedics you need.
In case of a short burial time (up to 35 minutes) a rapid extrication has absolute priority. If a buried person is in a critical condition, it will probably be attributable to acute asphyxia or to mechanical trauma. In case of respiratory arrest start artificial respiration as soon as possible during recovery. After a complete burial (head and trunk buried) hospitalise the patient in any case for 24 hours for observation (pulmonary complications: aspiration, pulmonary oedema).
After a prolonged burial time (as from 35 minutes) hypothermia is to be expected, therefore extrication should be not as speedy as possible but as gently as possible. An air pocket and free airway are essential for survival and that's why on uncovering the face it's absolutely necessary to look for them. So far a core temperature of 13° can be supposed as lower therapeutic limit for re-warming, but core temperature in that limit area has to be measured oesophageally since an epitympanic measurement can give falsely low values (see ICAR guidelines for hypothermia treatment). Many clinicians reject a lower temperature limit on principle so as not to wreck therapeutic outcomes in future. Nowadays a non-lethal injury is no longer a contra-indication for re-warming with cardiopulmonary bypass. If several buried persons must be attended to simultaneously, the maintenance of vital functions of surviving patients must have priority over reanimation of buried ones without vital functions.

Equipment

Complete winter equipment. Thermometer for core temperature measurement, hot packs (table 1) **and hot, sweet tea.** Consider **airway warming device** (to administer warm, moistened O2). If the outside temperature is low make sure batteries are fully charged. If there is enough time, install a **depot** with a tent for medical care beyond the avalanche. Have medicines and instruments (metallic laryngoscope) kept warm, e.g. put a hot pack in the emergency physician's bag, carry medicines on the body.

Localisation and extrication of the patient

Get the emergency physician and/or paramedic to the scene after position finding, not just on rescuing.·
Look out for an air pocket (= any cavity in front of the mouth and nose, no matter how small, provided the airway is clear).·
Avoid any destruction of an existing air pocket during extrication! Don't dig vertically from above but diagonally from the side in direction of the buried victim.·
Absolutely avoid unnecessary movements of trunk and of main joints (shoulder, hip and knee). If movements cannot be avoided, carry them out as slowly as possible.

Monitoring

ECG-monitoring during all the time of rescuing.·
Look for provoked arrhythmia and ventricular fibrillation during extrication and removal.·
Core temperature monitoring. For measuring with an epitympanic thermometer the auditory canal must be dry. Consider oesophageal measurement in the lower third part of the oesophagus (preferable in hypothermia stages III-IV). ·
Pulse oximetry can be disregarded since it results in wrong values due to centralisation.

Staging of hypothermia

Swiss staging (table 1) has the advantage that it can be established by non-medical rescuers, since it is not based on measurement of the core temperature.

Hypothermia I: patient alert, shivering (core temperature about 35-32ºC [95-89,6º F])
Hypothermia II: patient drowsy, non-shivering (core temp. about 32-28ºC [89,6-82,4º F])
Hypothermia III: patient unconscious (core temperature about 28-24ºC [82,4-75,2º F])
Hypothermia IV: patient not breathing (core temperature < 24º C [< 75,2º F])

Assessment of the patient and On-site Treatment

Single steps are shown in figure 1. In all cases: core temperature and ECG monitoring, oxygen inhalation, insulation in supine position (table 1). Consider airway warming. 0.9% NaCl and/or 5% glucose only if an intravenous line can be established within a few minutes. The administration of ACLS drugs, including epinephrine and vasopressin, is not recommended so far in hypothermia stages III – IV, since cardioactive drugs may have arrhythmogenic effects and can accumulate to toxic levels. In stages I – II, ACLS drugs may be administered, but with longer intervals between doses than in normothermic patients. Trauma treatment if indicated.

Patient alert or drowsy

Change wet clothing without unnecessary movements (cutting).·
Hot sweet drinks as long as swallow reflex preserved.·
Nearest hospital with intensive-care unit.

Patient unconscious

Intubation: whether a hypothermia stage III patient has to be intubated at the site of the accident or not, is still a matter of discussion. For the intubation of a patient with protective reflexes an intravenous line is needed for the administration of medicine. The risk of further heat loss during the time of treatment and transport has to be evaluated in relation to the advantages of the intubation. Danger of provoked ventricular fibrillation is negligible.·
Be ready for resuscitation.·
Hospital with intensive care unit and hypothermia experience or (preferably) unit with cardiopulmonary bypass.

Patient not breathing

Exclude obvious fatal injuries.·
Start cardiopulmonary resuscitation, intubate the patient.·
Check burial time and/or core temperature·
Asystole: triage only by the emergency physician aiming to differentiate hypothermia stage IV from asphyxia and to bring patients with hypothermia stage IV for re-warming to a hospital with cardiopulmonary bypass. Criteria: burial time, core temperature, air pocket and airway.

The information about the air pocket and airway must be given by the emergency physician or by the rescuer. Core temperature must be measured immediately after the rescue, later measures are not reliable. Following situations are possible:

Burial time = 35 minutes and/or core temperature = 32°C: continue resuscitation, follow standard ACLS protocol. Successful: ? transport to the nearest hospital with intensive-care unit. In case of failure the emergency physician can establish death by "acute asphyxia".

Burial time > 35 minutes and/or core temperature < 32°C:·

Air pocket present and airway free (or uncertain): suspect hypothermia stage IV. **Resuscitation must be continued** without break until re-warming. Therefore, start cardiopulmonary resuscitation only from the moment when an uninterrupted resuscitation is possible. Cardiopulmonary resuscitation as per normal guidelines. ? **Hospital with cardiopulmonary bypass** continuing cardiopulmonary resuscitation. Only if unit with cardiopulmonary bypass cannot be reached directly by road or aerial means: ? **nearest hospital** continuing resuscitation **for determination of serum potassium** (criterion of irreversibility). With values exceeding **12 mmol/l,** resuscitation can be stopped, with values of 12 mmol/l or less a further transport should follow – under constant resuscitation - for re-warming to a hospital with cardiopulmonary bypass (cave: haemolysis, rhabdomyolysis, see ICAR-guidelines for hypothermia treatment).·

No air pocket present and/or airway blocked: resuscitation can be interrupted by the emergency physician and death "by asphyxia with subsequent cooling down" established. .

Ventricular fibrillation at core temperature < 28° C: electric defibrillation generally vain, up to 3 attempts with 200-300-360 J. ? **hospital with cardiopulmonary bypass** under constant resuscitation.

Prevention of heat loss in all stages:insulation, hot packs

2 to 3 chemical hot bags, 1 aluminium foil, 2 wool blankets, 1 cap are needed.

a) ***2 to 3 chemical hot packs*** *near the heart on thorax and upper part of abdomen, not directly on the skin.*

b) *Before removing the patient prepare the stretcher with* ***2 wool blankets and 1 aluminium foil.***

c) *On removing the patient* ***avoid big movements.***

d) Wrap up the patient closely packed in the blankets and in the aluminium foil.

e) ***Cap*** *(30 - 50 % of body heat get lost over the head).*

Table 1

This paper has been discussed and accepted 1998 (Fanes Hut, Italy) and 1999 (Sonthofen, Germany) by the International Commission for Mountain Emergency Medicine by following members: Wiget U (President, Switzerland), Agazzi G (Italy), Aleraj B (Croatia), Beaufort J (Czech Republic), Bonthrone I (Great Britain), Brandt S (Italy), Elsensohn F (Austria), Escoda M (Andorra), Farstad G (Norway), Flora G (Austria), Forster H (Germany), Hora L (Rumania), Jakomet H (Switzerland), Krassen D (Bulgaria), Ledoux X (France), Marsigny B (France), Miko I (Slovakia), Morandeira JR (Spain), O´Gorman J (Ireland), Phleps W (Austria) Rammlmair G (Italy), Rheinberger P (Liechtenstein), Syme D (Great Britain), Swangard M (Canada), Tekavcic I (Slovenia), Thomas A (Germany), Zafren K (USA).

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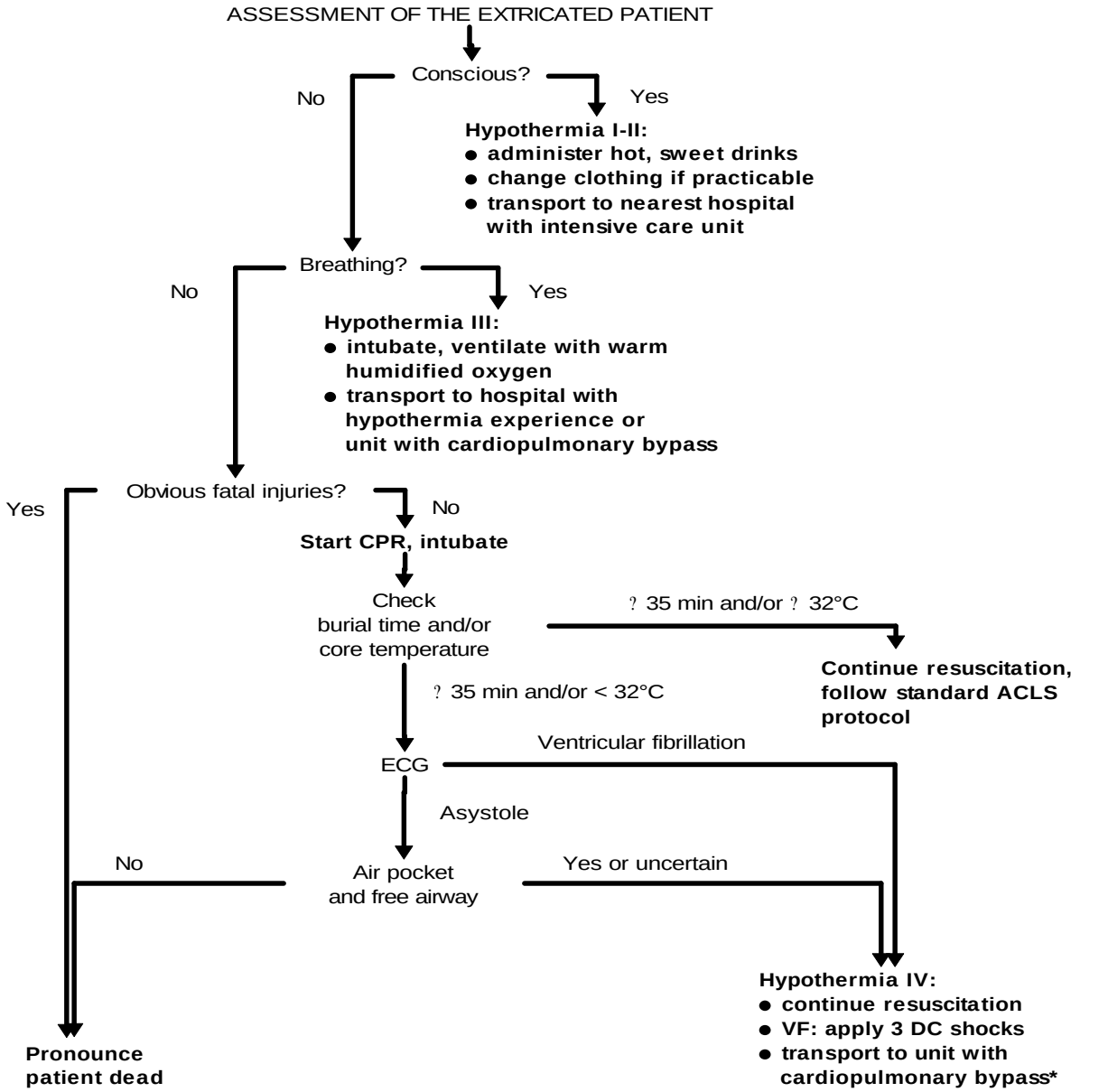

Figure 1: Algorithm for on-site management of avalanche victims. Staging of hypothermia according to Swiss Society of Mountain Medicine guidelines. * Transport to the nearest hospital for serum potassium measurement if hospitalisation in a specialist unit with cardiopulmonary bypass facilities is not logistically possible (see text). Reprint from: Brugger H, Durrer B, Adler-Kastner L, Falk M, Tschirky F: Field management of avalanche victims. Resuscitation 51:7-15 (2001).