

Position Paper

On-Site Treatment of Avalanche Victims ICAR-MEDCOM-Recommendation

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INTRODUCTION

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, and topographic and meteorological factors must be evaluated. *Thinking ahead* should be the guiding principle of the rescue procedure. Rescuers should 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 that are needed.

With a short burial time (up to 35 min), rapid extrication has absolute priority. If a buried person is in critical condition before 35 min, acute asphyxia or mechanical trauma is the most likely cause. In case of respiratory arrest, start artificial respiration as soon as possible during recovery. After a complete burial (head and trunk buried), hospitalize the patient for 24 hr to observe for pulmonary complications such as aspiration and pulmonary edema.

After a prolonged burial time (more than 35 min), hypothermia is to be expected, and therefore extrication should be not as speedy as possible but as gentle as possible. An air pocket and free airway are essential for survival, and

therefore on uncovering the face it is absolutely necessary to look for these. To date, a core temperature of 13°C can be assumed as the lower therapeutic limit for rewarming, but core temperature in this range has to be measured esophageally, because an epitympanic measurement can give falsely low values. Many clinicians reject a lower temperature limit on principle so as not to affect future therapeutic outcomes. Nowadays a nonlethal injury is no longer a contraindication for rewarming with cardiopulmonary bypass. If several buried persons must be attended to simultaneously, the maintenance of the vital functions of the survivors must have priority over resuscitation of buried victims without vital functions.

EQUIPMENT

Complete winter equipment includes a thermometer for core temperature measurement, hot packs (Table 1), and hot, sweet tea. Consider an airway warming device to administer warm, moistened oxygen. If the outside temperature is low, make sure that batteries are fully charged. If time permits, install a depot with a tent for medical care beyond the avalanche. Keep medicines and instruments (metallic laryngoscope) warm; for example, put

This article reflects the consensus of opinion of the International Commission for Mountain Emergency Medicine, which has full responsibility for its content. It is intended for use by physicians and paramedics.

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TABLE 1. PREVENTION OF HEAT LOSS IN ALL HYPOTHERMIA STAGES: INSULATION, HOT PACKS

Two to three chemical hot bags, one aluminum foil, two wool blankets, one cap are needed.

1. **Two to three chemical hot packs** near the heart on thorax and upper part of abdomen, not directly on the skin.
2. Before removing the patient, prepare the stretcher with **two wool blankets and aluminum foil**.
3. On removing the patient, **avoid big movements**.
4. Wrap up the patient closely packed in the blankets and in the aluminum foil.
5. **Cap** (30% to 50% of body heat is lost through the head).

a hot pack in the emergency physician's bag and carry medicines on the body.

LOCALIZATION AND EXTRICATION OF THE PATIENT

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

MONITORING

We recommend ECG monitoring during the entire time of rescue. Observe for provoked arrhythmia and ventricular fibrillation during extrication and removal. For core temperature monitoring, the auditory canal must be dry when using an epitympanic thermometer. Consider esophageal measurement in the lower third of the esophagus (preferable in hypothermia stages III and IV). Pulse oximetry can be disregarded because it results in wrong values due to peripheral vasoconstriction.

Staging of hypothermia

Swiss staging (Fig. 1) has the advantage that it can be established by nonmedical rescuers, because it is not based on measurement of the core temperature.

ASSESSMENT OF THE PATIENT AND ON-SITE TREATMENT

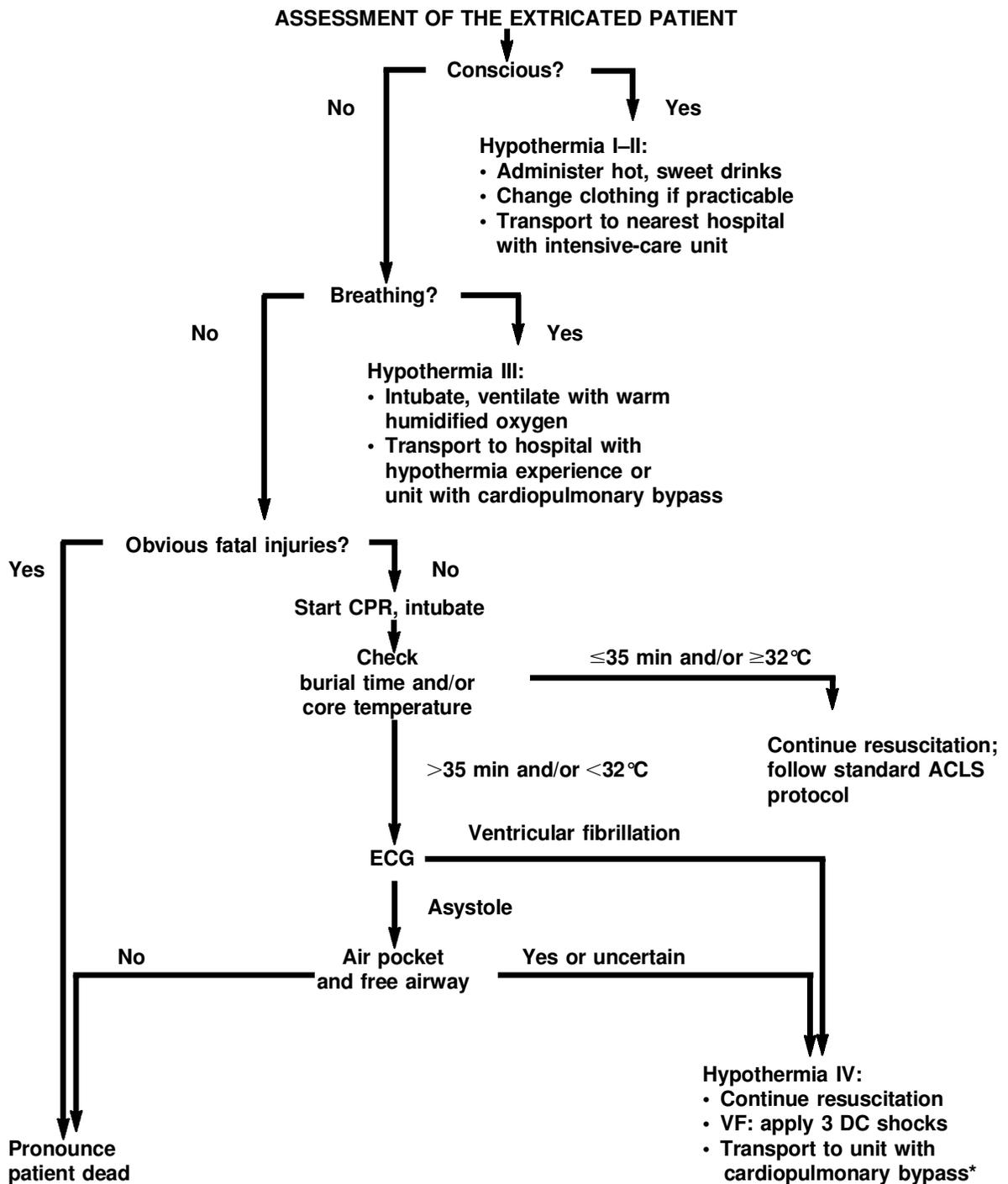
The individual steps for assessment are shown in Fig. 1. All cases require core temperature and ECG monitoring, oxygen inhalation, and insulation in supine position. Consider airway warming. Only if an intravenous line can be established within a few minutes, 0.9% NaCl and/or 5% glucose can be administered. The administration of ACLS drugs, including epinephrine and vasopressin, is not yet recommended in hypothermia stages III and IV, because cardioactive drugs may have arrhythmogenic effects and can also accumulate to toxic levels. In stages I and II, ACLS drugs may be administered, but with longer intervals between doses than in normothermic patients. Trauma treatment is provided as indicated.

Patient alert or drowsy

Change wet clothing without unnecessary movements (cutting is preferred). Hot sweet drinks are suitable as long as the swallow reflex is preserved. Transport to the nearest hospital with an intensive-care unit.

Patient unconscious

Whether a hypothermia stage III patient should be intubated at the site of the accident is still a matter of discussion. For intubation of a patient with protective reflexes, an intravenous line is needed for administration of medications. The risk of further heat loss during the time of treatment and transport has to be evaluated in relation to the advantages of intubation. Danger of provoked ventricular fibrillation with intubation is negligible. Transport to a hospital with an intensive-care unit and hypothermia experience or, preferably, a unit with cardiopulmonary bypass.



Hypothermia I: Patient alert, shivering (core temperature about 35°–32°C [95°–89.6°F]).
Hypothermia II: Patient drowsy, nonshivering (core temperature about 32°–28°C [89.6°–82.4°F]).
Hypothermia III: Patient unconscious (core temperature about 28°–24°C [82.4°–75.2°F]).
Hypothermia IV: Patient not breathing (core temperature <24°C [<72.2°F]).

Brugger H., Durrer B. (2002). On-site treatment of avalanche victims.

FIG. 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 hospitalization in a specialist unit with cardiopulmonary bypass facilities is not logistically possible (see text). Reprinted by permission of Elsevier from H. Brugger, B. Durrer, L. Adler-Kastner, M. Falk, and F. Tschirky (2001). Field management of avalanche victims. Resuscitation 51:7–15.

Patient not breathing

Exclude obvious fatal injuries. Start cardiopulmonary resuscitation and intubate the patient. Check burial time and/or core temperature.

Asystole. Only the emergency physician should triage victims with asystole, in order to differentiate hypothermia stage IV from asphyxia. Bring patients with hypothermia stage IV to a hospital with cardiopulmonary bypass for rewarming. Criteria for rewarming include burial time, core temperature, air pocket, and airway. The emergency physician or the rescuer must provide the information about the air pocket and airway. Core temperature must be measured immediately after the rescue, because later measures are not reliable. The following situations are possible:

1. *Burial time ≤ 35 min and/or core temperature $\geq 32^{\circ}\text{C}$:* Continue resuscitation, following standard ACLS protocol. Successful: transport to the nearest hospital with an intensive-care unit. In case of failure the emergency physician can establish death by "acute asphyxia."
2. *Burial time > 35 min and/or core temperature $< 32^{\circ}\text{C}$*
 - a. *Air pocket present and airway free (or uncertain):* Suspect hypothermia stage IV. Resuscitation must be continued without break until rewarming. Therefore, start cardiopulmonary resuscitation only from the moment when an uninterrupted resuscitation is possible. Use normal guidelines for cardiopulmonary resuscitation. Transport to a hospital with cardiopulmonary bypass, continuing cardiopulmonary resuscitation. If a unit with cardiopulmonary bypass cannot be reached directly by road or air, transport to the 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 resuscita-

tion) for rewarming to a hospital with cardiopulmonary bypass.

- b. *No air pocket present and/or airway blocked:* The emergency physician can terminate the resuscitation and establish death "by asphyxia with subsequent cooling."
- c. *Ventricular fibrillation at core temperature $< 28^{\circ}\text{C}$:* Electric defibrillation is generally unsuccessful, but can be tried up to three attempts with 200, 300, and 360 J. Transport to a hospital with cardiopulmonary bypass under constant CPR.

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