

## Avalanche First Aid

### Key points:

- **Companion rescue and first aid/resuscitation are an avalanche victim's best chance of survival.**

Thankfully, not many of us have been in an avalanche rescue situation, which is why it is important to practice search and rescue each tour. But the scenario practice usually stops when you dig the transceiver out, so what happens in real life when you dig a victim out? This article attempts to explain some of the key science and strategy behind avalanche first aid. This should also be practised or visualised before every tour, so you know what to do in the high stress of a real life rescue.

### Avalanche Mortality and Survival

In North America and Europe approximately 150 people are killed per year in avalanches, and this statistic has remained relatively constant despite the rising popularity of winter sports.

The overall survival rate of avalanche victims is approximately 77%, and survival depends on:

- the grade of burial
- duration of burial
- presence of an air pocket and a free airway
- the severity of trauma

Grade of burial is still the strongest single factor for survival – so if the first rule of avalanche survival is “**don't get avalanched**”, the second rule is “**don't get buried**”.

From Swiss data, the mortality rate is 52.4% in completely buried (head below the snow) victims, but only 4.2% in partially buried (head above snow) victims.

By preventing burial Avalanche Airbag systems may dramatically improve survival; in one study effectively reducing the likelihood of complete burial from 39% to 16.2% and thus lowering mortality rate from 23% to 2.5%.

Survival is inversely related to the duration of burial, and bio statistical analysis in Switzerland and Canada has given similar Survival curves (see Fig 1), where the different phases of the time line of survival are determined by:

- the severity of trauma – highly dependent on the terrain(e.g. rocky, forested) and snow composition (e.g. heavy, wet snow),
- The presence or absence of free airway (unobstructed air tube from mouth/nose to lungs), plus the presence or absence of an air pocket (a clearly visible air space in front of the mouth and nose on extrication) – necessary for survival beyond 30 minutes even if clear airway.
- the pathological processes of asphyxia and hypothermia (cooling rate of up to minus 9°C per hour of burial)

**Figure 1 - Avalanche Survival Curve**

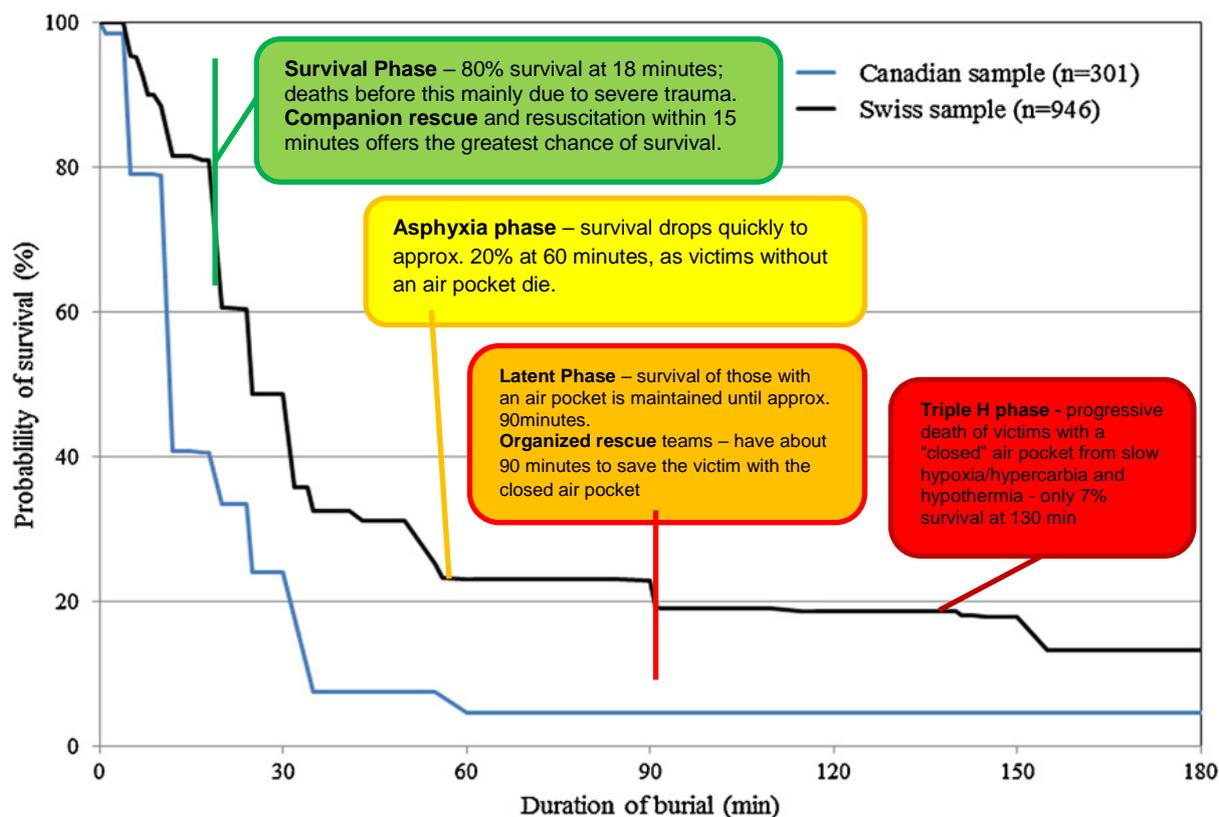


Fig 1 – Comparison of survival curves in Canada (Blue; n= 301) and Switzerland (Black; n=946) from 1980 to 2005. Extracted from Haegli P., et al (2011).

Comparative data from Colorado on survival by type of rescue shows that Companion rescue offers the best chance of survival (63% survival by companion rescue but only 19% survival by organised rescue).

Every minute counts and effective companion rescue needs strategic leadership, methodical transceiver search and probing, with efficient shovelling to dig the victim(s) out as quickly as possible. See the collected resources suggested on the Avalanche Awareness pages for further reading.

So when an avalanche victim is dug out, the rescuer (medical or non medical) needs a straightforward and memorable structure for the resuscitation/first aid. Many rescuers will already be familiar with the basic principles of first aid using the A,B,C,D approach, and the First Aid training mnemonic **Safety, ABCDEFG** is used in this article and algorithm as a way of remembering and providing structure to avalanche first aid.

## Avalanche Victim First Aid Algorithm



Note:	
Time of Avalanche	.....
Time face exposed	.....
Air pocket	Y/N
Time Rescue Services contacted	.....
First Aider Contact details	.....

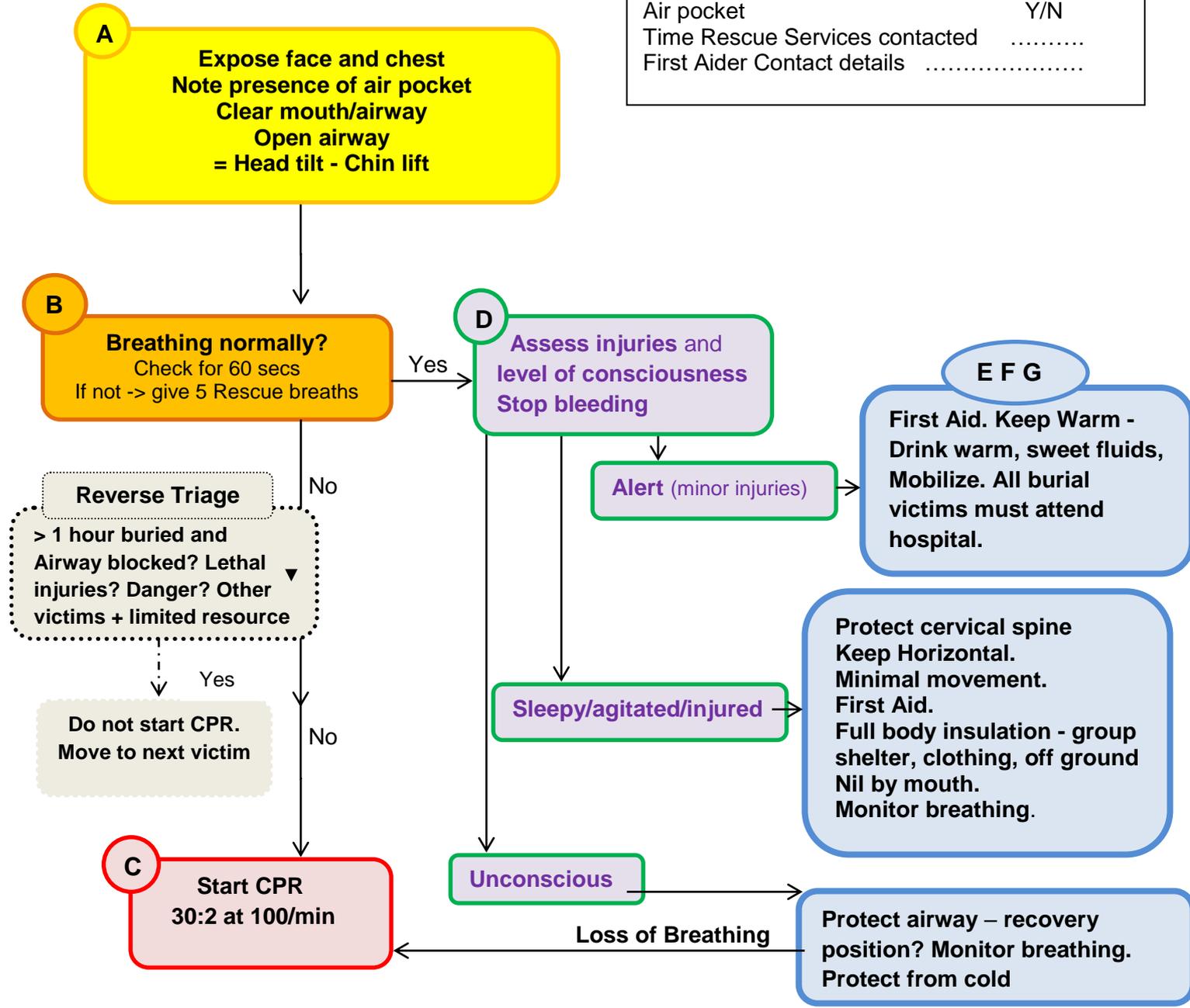


Figure 2 – Avalanche First Aid algorithm (2018 revision) developed by Dr Catherine Mangham - UIAA Diploma in Mountain Medicine - Available as A5 printout for lamination and use as **ESC Avalanche First Aid Card**

## Avalanche First Aid

- Extract and assess victim as quickly but as carefully as possible, using **Safety, A, B, C, D, E, F, G, H** approach – managing problems as you proceed.
- Note:
  - **Time elapsed from avalanche to Time face exposed** – this may be crucial in determining the duration and extent of resuscitation ;
  - if **Air pocket** around mouth or airway blocked with snow.
  - any obvious **Fatal injuries** – it is emotionally and clinically difficult for a non medical companion rescuer to confirm death. In practice, fatal injuries may be distressingly obvious to a non medical rescuer, though there may also be clinical levels of complexity beyond the scope of a first aider. However, in a multiple burial scenario moving on from a victim with clear fatal injuries may allow you to save someone else (see below for detailed discussion on Reverse Triage).

### Safety

- **S = Safety** – safety check for risks (e.g. secondary slide, uncontrolled fall) - safety should be assessed at the start of the rescue, but needs to be continually monitored throughout the process.
- **s = Send for help only if can be delegated** (enough rescuers) **and feasible** (in an area where organised rescue might arrive < 60 minutes). If within Mobile phone range immediate call for help, but **do not divert scarce Rescuer resource from immediate companion rescue for the first 15 minutes.**

### A = Airway

- Check if **Air pocket** is present
- **Clear space round face and chest - Clear snow from mouth and airway**
- If the victim is unresponsive and **not breathing normally** (<8 or >30 breaths/minute) - the rescuer should **open the airway** - use **Head Tilt - Chin lift** technique (= place one of your hands on the victim's forehead and apply gentle, firm, backward pressure using the palm of your hand. Place the fingers of the other hand under the bony part of the chin. Lift the chin up and support the jaw, helping to tilt the head back). This manoeuvre will lift the victim's tongue away from the back of the throat and provide an adequate airway. This position needs to be physically maintained while an unconscious victim is on their back until they can be safely turned into the recovery position.

### B = Breathing

- Check for breathing – usually obvious but in a hypothermic victim buried >60 minutes breathing may be very shallow and may need careful assessment for up to 1 minute.
- If unconscious but breathing, place in **Recovery Position.** (<http://www.nhs.uk/Conditions/Accidents-and-first-aid/Pages/The-recovery-position.aspx>) - If you suspect spinal injury and you have sufficient rescuers you might choose to maintain the Head Tilt - Chin Lift position and other spinal precautions until definitive rescue arrives.
- If Unresponsive and not Breathing – give **5 Rescue Breaths** (tilt the head back, pinch the nose closed and administer 5 separate mouth to mouth breaths sufficient to inflate the chest) and start CPR as soon as head and chest are free.

### C = Circulation

- If still no response or signs of life after 5 rescue breaths - **Start Cardio Pulmonary Resuscitation (CPR)** according to **Basic Life Support (BLS)** algorithm **30:2 at rate 100 compressions/minute** = 30 chest compressions at a rate of 100 per minute, followed by 2 rescue breaths – repeated.

- Note – resuscitation guidance no longer emphasises non medical first aiders checking for a pulse before starting CPR and this would be especially difficult in an avalanche situation with cold hands, cold victim.
- Note - no role for compression only CPR in an avalanche resuscitation – because first correcting the primary lack of oxygen by rescue breaths is the key to restarting the heart.
- Duration of attempted CPR depends on the situation:
  - Resources and personnel on scene – CPR is very tiring and will exhaust a single rescuer quickly – take turns.
  - Time to definitive rescue by an organised medical team with Automatic external defibrillator (AED) – in the side country of a ski resort this may be <15 minutes; in European alps <30 minutes; on a remote expedition = days
  - Duration of burial –
    - If < 60 minutes – organised rescue teams would attempt CPR for at least 30 minutes in the absence of hypothermia <30°C and asystole on the ECG.
    - if > 60 minutes the body may have been cooled and protected by “metabolic icebox” effect, and victims of a potential hypothermic cardiac arrest with a patent or unknown air pocket should be resuscitated until rewarmed to core body temperature >30°C before a final decision is made (“**not dead until rewarmed and dead**”).

#### D = Disability

- Use AVPU scale to assess conscious level
    - Alert fully
    - Voice only
    - Pain only
    - Unconscious
- Altered level of consciousness may be the result of head injury and/or hypothermia

#### E = Exposure

- **Keep victim warm and prevent further heat loss** - by Ground insulation/Extra clothes, hat, gloves/ Blizzard bag/Group shelter
- Change wet clothing only if possible without unnecessary movements or increased exposure. **Further insulation layers** over wet clothing may be more effective.
- **Hot, sweet, non alcoholic drinks** only if conscious at least to voice and able to swallow.
- **Shivering or not** – shivering is a protective heat generating reflex between 32°C and 35°C – absence of shivering after a prolonged (>60 minutes) avalanche burial should be interpreted as serious advancing hypothermia (temperature < 32°C) and prompt extra care in handling, aggressive prevention of further hypothermia and transfer to appropriate hospital (see H below).
- **Gentle extrication and immobilise horizontally**– in a hypothermic victim (buried >60 minutes) rough movements of limbs especially the legs may force cold blood from the peripheries to the heart and trigger cardiac arrest (“post rescue collapse”) Allow an uninjured, shivering, mildly hypothermic victim to exercise and generate heat but otherwise nurse horizontal.

#### F = Fractures

- **Spinal precautions from the start, but airway and CPR take precedence.** Avoid unnecessary movements of neck and spine and if sufficient help available, then a rescuer may place both hands on either side of the victim's head to hold the head gently but firmly in a straight line position and to keep it from moving. If competent, log roll techniques may be used to move victim onto insulation while awaiting definitive rescue and spinal care.

- **Treat injuries**
  - Splint and immobilise fractures
  - Stop bleeding – direct pressure to wound

### **G = General**

- If further Help is required, and not already requested – use mobile phone/radio or send someone with verbal/written report with nature of incident, duration of burial, numbers and status of victims, exact grid reference.
- If Helicopter on the way - Prepare for safe level helicopter landing – Secure and tie down all equipment, rucksacks, loose clothing or anything that might blow away. Protect victims face and eyes from downdraft blizzard. Attract attention of helicopter by standing and facing it with both arms in air making Y shape. Down draft can knock you over. Do not approach helicopter unless signalled to do so by pilot.
- Debrief after incident

### **H = Hospital**

Even after successful search and rescue and basic first aid, there are further ongoing risks to the victim such as:

- Aspiration pneumonitis – inflammation of the lungs from inhalation of snow.
- “Afterdrop” – further and potentially fatal drop in temperature after rescue.

Transfer of the victim to hospital will usually be part of organised rescue, but the First aider should know the following principles:

- All full burial victims if responsive– should be assessed in the nearest A+E department.
- All full burial victims if not responsive to voice or with hypothermia – should be transferred to hospital with hypothermia resuscitation knowledge and active rewarming facilities.
- Any hypothermic victim (burial time > 60min or temp < 30°C ) in cardiac arrest – should ideally be transferred to a hospital with facilities for extracorporeal circulation life support (ECLS), where the blood is recirculated externally through a rewarming machine.

A **Handover** from First aider to Rescue/Hospital team is important and could be verbal or ideally written. It should include key data on time of avalanche; time to face exposed; presence/absence of air pocket; nature of injuries and first aid measures carried out.

### **Triage**

Note: this is intended as a basic first aid algorithm for the companion rescuer. It is not intended to cover the Triage of all avalanche scenarios which will vary with circumstances such as multiple burials, burial time; burial depth; snow hardness; availability of companion rescue resources, and time to organised rescue and definitive medical care.

- **Normal triage** applies where available resources are adequate to treat everyone simultaneously.
- **Reverse triage** applies where there is a shortage of rescue resources for multiple victims, and hard decisions have to be made to focus on the victims with good survival chances and only requiring moderate rescue resources. (e.g. buried <2m; buried <18 min; responsive and breathing). Prioritisation of the rescue aiming for “greatest good for greatest number of victims” may involve moving on and postponing CPR for a victim in cardiac arrest, to save another victim with better chance of survival. The grey box areas of this basic algorithm can only hint at some of these difficult choices.

## **Organised Rescue and Definitive Medical care**

From the survival curve studies, it is known that in the absence of fatal injuries, resuscitation strategies are determined by the duration of burial and the victim's core temperature.

- **With a burial time < 60 minutes survival depends on preventing asphyxia by rapid extrication, clearing the airway and cardiopulmonary resuscitation CPR – this is the basis of Companion First Aid**
- **With a burial time > 60 minutes tackling hypothermia is of utmost importance, and gentle extrication with core temperature and ECG monitoring is recommended. Pulseless victims buried > 60min with a patent airway and core temperature < 30°C should receive uninterrupted CPR and be transported to a hospital with extracorporeal rewarming facilities – usually needs Organised Medical Rescue**

Organised rescue with a fully equipped medical/paramedical team follows a more complex algorithm aimed at identifying those prolonged burial victims that are profoundly hypothermic and might benefit from prolonged resuscitation techniques including rewarming and Extra Corporeal Life Support ECLS.

The European Resuscitation Council “Guidelines for Resuscitation 2015 - Section 4. Cardiac arrest in special circumstances” gives detailed guidance for physicians and other advanced life support personnel with an advanced Avalanche algorithm (see Bibliography).

The International Commission for Alpine Rescue (ICAR) has also recently produced an **Avalanche Resuscitation Checklist card** (see Appendix 1 below) that attempts to give guidance and aid documentation on Avalanche resuscitation. This checklist was developed primarily for the use of organised rescue teams and rescue professionals and does not detail the specifics of First aid, which is why we have attempted to do so, but it is detailed here for completeness and for those with advanced skills and training.

Finally, the Wilderness Medical Society guidelines of 2017 give the most comprehensive, up to date summary of the evidence base for the prevention and management of avalanche accidents.

## **Bibliography**

**European Resuscitation Council Guidelines for Resuscitation 2015 Section 4. Cardiac arrest in special circumstances**

A. Truhlár et al. / Resuscitation 95 (2015) 148–201 – Avalanche – Pages 177 - 178

**Avalanche Victim Resuscitation Checklist.** ICAR MEDCOM: Kottmann A, Blancher M, Boyd J, Spichiger T, Brugger H. Changing process for saving lives.

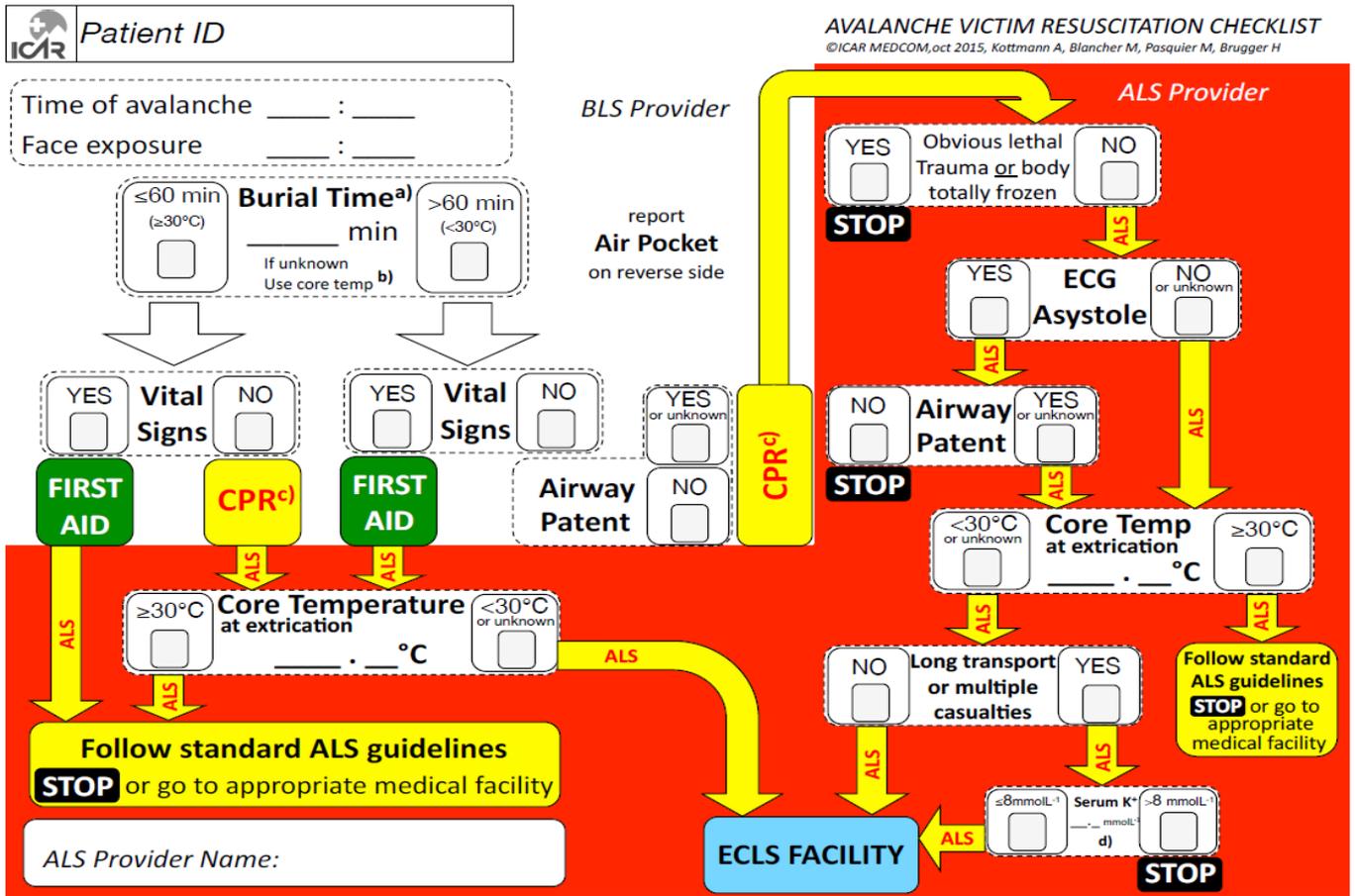
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**Wilderness Medical Society Practice Guidelines for Prevention and Management of Avalanche and Non-avalanche Snow Burial Accidents** Christopher VanTilburg et al; Wilderness & Environmental Medicine 28, 23–42 (2017)

Updated December 2018

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# Appendix 1 – ICAR Avalanche Resuscitation Checklist



**Air Pocket**  
 Yes, \_\_\_\_ x \_\_\_\_ x \_\_\_\_ (cm)  
 No  
 Unknown

**Rescue Service:**  
 Base: \_\_\_\_\_  
 Phone: \_\_\_\_\_

**H** The Checklist is to remain with the patient throughout his/her pre-hospital and in-hospital course until final destination.

**Rescue Service** At Medical Facility delivery, make a copy, a scan or a digital photograph of this checklist and keep it with the copy of your rescue mission protocol.

**Abbreviations:**  
 Patient ID = Patient Identity  
 CPR = Cardiopulmonary Resuscitation  
 ALS = Advanced Life Support  
 ECLS = Extra Corporeal Life Support (CardioPulmonary Bypass / Extra Corporeal Membrane Oxygenation)

- a) Time between burial and uncovering the face.
- b) If duration of burial is unknown, core temperature using an oesophageal probe may substitute in patients in cardiac arrest.
- c) CPR can be withheld if unacceptable level of risk for the rescuer, total body frozen or obvious lethal trauma (decapitation, truncal transection).
- d) If K<sup>+</sup> at hospital admission exceeds 8 mmolL<sup>-1</sup> consider terminating resuscitation (after excluding crush injuries and consideration of the use of depolarizing paralytics).

Patients who present with cardiac instability (ventricular arrhythmias, systolic blood pressure <90mmHg) or core temperature <30°C should be transported towards hospital with ECLS rewarming possibility.