OBJECTIVES

• Prevention

• Rescue

• Survival probability of an avalanche

• Recommended Resuscitation

• Avalanche victim resuscitation checklist

• Intermittent CPR for Hypothermia
Prevention

• Avoid being caught in avalanche

• Avoid burial if caught

• Minimizing trauma if caught

• Avoid asphyxia if buried
Prevention

• Avoid being caught in avalanche

• **Avoid burial if caught**

• Minimizing trauma if caught

• Avoid asphyxia if buried
Figure 2. Backpack shown with an airbag deployed and inflated, combined with an artificial air pocket device.
Prevention

• Avoid being caught in avalanche

• Avoid burial if caught

• **Minimizing trauma if caught**

• Avoid asphyxia if buried
Prevention

• Avoid being caught in avalanche

• Avoid burial if caught

• Minimizing trauma if caught

• Avoid asphyxia if buried
Figure 3. The artificial air pocket device that diverts expired air away from inspired air during avalanche burial is intended to prolong survival of fully buried avalanche victims. The white arrows show the flow of inspired air, and the gray arrows show the flow of expired air.
Rescue

• Self, partner, small group or professional
• Establish leadership
• Secure scene
• Perform searches
• Shovel strategically
• Notify emergency services
Rescue

• Self, partner, small group or professional
• Establish leadership
• Secure scene

• Perform searches
• Shovel strategically
• Notify emergency services
Rescue

- Self, partner, small group or professional
- Establish leadership
- Secure scene
- Perform searches
- Shovel strategically
- Notify emergency services
1. Touch shovel tips to quickly select the distance between rescuers.

2. Each shoveler should work in one section of the “V” and transport the snow with a paddling motion.

3. The lead shovel should rotate out at least every four minutes to minimize fatigue and maintain motivation.

4. When the victim is seen, more rescuers should move to the front. Continue the conveyor belt with a few rescuers.

5. Carefully shovel near the victim. Cut the sidewalls to expand the tip of the “V” to expose the victim.
Rescue

• Self, partner, small group or professional
  • Probe Lines

• RECCO technology
Rescue

• Self, partner, small group or professional
  • Dog search
  • Helicopters
A STORY
• The victim was found but no signs of life

• BLS with CPR started by friends

• Continued by Helicopter EMS 60 min after time of avalanche
• Resuscitated according to ICAR guidelines

• Meaning…

• CPR

• Intubation

• All based on burial <35min and no snow in patient’s airway
• Rewarmed in the hospital

• Brain scan showed severe hypoxic injury but no other injuries

• Because of high quality resuscitation, organ donation was provided
SURVIVAL PROBABILITY?
FACTORS FOR SURVIVAL

- Duration of Burial (depth and snow pack)
- Airway Patency
- Trauma (terrain)
- Core Temperature
MORTALITY

- 150 killed/year in North America and Europe

**Partial**
- 91

**Complete**
- 59
- 68
DURATION OF BURIAL

Before 18 Min

After 18 Min

Survived

Died
TRAUMA

• About 25% of deaths
• Depends on topography
• In Utah:
  • 5.4% cause of death is trauma
  • 9% major trauma found on autopsy
  • 60% traumatic brain injury

Johnson SM, et al, Avalanche Trauma and Closed Head Injury: Adding Insult to Injury. WEMJ 2001: 12, 244-247.
HYPOTHERMIA

36°C Regular Body Temperature

< 32°C Hypothermia

19°C Lowest Survived Core Temp in an Avalanche

At least 35 min for body to cool to the point of cardiac arrest
RECAP THE RISKS

- Depth of Burial (depth and snow pack)
- Duration of Burial
- Trauma (terrain)
- Core Temperature
Are People Prepared?
ADVANCED AVALANCHE SAFETY EQUIPMENT OF BACKCOUNTRY USERS: TRENDS AND PERCEPTIONS

- 77% carry standard avalanche safety equipment
- 68-94% have taken avalanche safety course
- How many are BLS certified?

AVALANCHE HAPPENED…
NOW WHAT?
INTERNATIONAL COMMISSION FOR ALPINE RESCUE (ICAR)

• 1996- recommendations for management and transport

• 2002 ICAR MEDCOM- official algorithm

• 2011- Literature review
  • Recommendations based on 4 prognostic factors
    • Duration of Burial
    • Airway Patency
    • Core Temperature
    • Initial EKG rhythm
ASPHYXIA

- Most Common Cause of Death
- Related to depth and time of burial
- Occurs in Combination with Hypothermia and Trauma

LOCATE & EXTRICATE VICTIM FAST
AIRWAY PATENCY

- Crucial for burials > 60 min
- No survivors with obstructed airways > 35 min

DETERMINE AIRWAY PATENCY & DIG FROM SIDE OF VICTIM
Trauma

- Can make hypothermia or asphyxia worse
- Suspected c-spine injuries should be managed according to validated guidelines such as NEXUS or Canadian c-spine rules

Assume and treat for traumatic injuries
Hypothermia

- Should be assumed in cold and unconscious victims

Treat Hypothermia per WMS or European Resuscitation Council Guidelines
Assess patient at extrication

Lethal injuries or whole body frozen

YES: Do not start CPR

NO: Duration of burial (core temperature) ≥ 30°C

≤ 60 min (≥ 30°C): Universal ALS algorithm

> 60 min (< 30°C): Minimally invasive rewarming

Signs of life?

YES: Minimally invasive rewarming

NO: Start CPR

Monitor ECG

Asystole

YES or UNCERTAIN: Consider serum potassium

Consider termination of CPR

VF/pVT/PEA

Patent airway

YES or UNCERTAIN: Consider serum potassium

Hospital with ECLS

> 8 mmol L⁻¹

---

1. Core temperature may substitute if duration of burial is unknown
2. Transport patients with injuries or potential complications (e.g., pulmonary oedema) to the most appropriate hospital
3. Check for spontaneous breathing and pulse for up to 1 min
4. Transport patients with cardiovascular instability or core temperature < 28°C to a hospital with ECLS (extracorporeal life support)
5. Withhold CPR if risk to the rescue team is unacceptably high
6. Crush injuries and depolarising neuromuscular blocking drugs may elevate serum potassium
Delayed and Intermittent CPR

- Continuous CPR may not be feasible or safe
- Mechanical CPR devices recommended OR
- Data from Hypothermia induced cardiac procedures and field cases show intermittent CPR may be life saving
- Only applicable in those <28°C
Advanced Life Support

- Ventilation targeted to normocapnia
- IV fluid resuscitation with IV or IO warmed isotonic fluids
NOT UTILIZING ALGORITHM

• Euro Alps

• Initiation of CPR lower than expected

• Reasons for starting and stopping unclear
WHAT ARE THE OBSTACLES?

• Training gaps

• Utilizing Theoretical Knowledge

• Communication from accident site

• Mass Casualty

HOW CAN WE DO BETTER?

- Checklists
  - Practical
  - Based on best evidence and standards
  - Transfer important information from accident to hospital
AVALANCHE CHECKLIST
AVAILANCHE VICTIM RESUSCITATION CHECKLIST

Patient ID

Time of avalanche: __:__
Face exposure: __:__
Burial Time: ≤ 60 min (<30°C) or > 60 min (>30°C)

BLS Provider

Obvious lethal trauma or body totally frozen

 ALS Provider

ECG

Asystole

Airway patent

Airway

<30°C or unknown

Core Temp at extrication: __:__°C

≥ 30°C or unknown

Follow standard ALS guidelines

STOP or go to appropriate medical facility

ALS Provider Name:

ECLS FACILITY

ALS
Should This Card be a part of standard avalanche safety equipment?
Assess patient at extrication

- Lethal injuries or whole body frozen
  - YES: Do not start CPR
  - NO:
    - Duration of burial (core temperature)\(^1\)
      - \(\leq 60\) min (\(\geq 30^\circ C\))
        - Universal ALS algorithm\(^2\)
      - \(> 60\) min (\(< 30^\circ C\))
        - Signs of life?\(^3\)
          - YES: Minimally invasive rewarming\(^4\)
          - NO:
            - Start CPR\(^5\)
              - Monitor ECG
                - Asystole
                -YES or UNCERTAIN: Consider serum potassium\(^6\)
                  - \(> 8\) mmol L\(^{-1}\)
                    - Consider termination of CPR
                  - \(< 8\) mmol L\(^{-1}\)
                    - Hospital with ECLS
            - Patent airway
              - NO: Consider termination of CPR

---

1. Core temperature may substitute if duration of burial is unknown
2. Transport patients with injuries or potential complications (e.g., pulmonary oedema) to the most appropriate hospital
3. Check for spontaneous breathing and pulse for up to 1 min
4. Transport patients with cardiovascular instability or core temperature < 28°C to a hospital with ECLS (extracorporeal life support)
5. Withhold CPR if risk to the rescue team is unacceptably high
6. Crush injuries and depolarising neuromuscular blocking drugs may elevate serum potassium
WHAT TRAINING IS NEEDED?
TRAINING

- Recreationalists- WFR
- Professional Guide- WEMT or EMT or OEC
- Organized Rescue Team- ACLS capabilities
BLS

- High quality CPR
- Bag Mask Technique
- Rescue Breathing
- AEDs
WEMT

- CPR in the remote environment
- Airway obstruction and respiratory arrest
- Common Wilderness medical problems
- Wilderness drug and first aid kits
ACLS/AWLS

- BLS +
  - Drugs
  - Electricity
- Advanced Airway Management


SUMMARY

• We do our best to reduce risk in the backcountry

• We should be as prepared when avalanche strikes

• Avalanche Resuscitation has room for improvement

• Checklist may decrease confusion and increase survival

• The bar for resuscitation training should be raised
QUESTION?
COMMENTS?

Discussion
References (not in slides)

http://beaconreviews.com/transceivers/rescue_shoveling.asp

Wilderness Medical Society Practice Guidelines for Prevention and Management of Avalanche and Nonavalanche Snow Burial Accidents
Van Tilburg, Christopher et al.
Wilderness & Environmental Medicine, Volume 28, Issue 1, 23 - 42