

Avalanche

August 2025

OHSU Outdoor Medicine Conference

Lindsey Fell, MD





Agenda

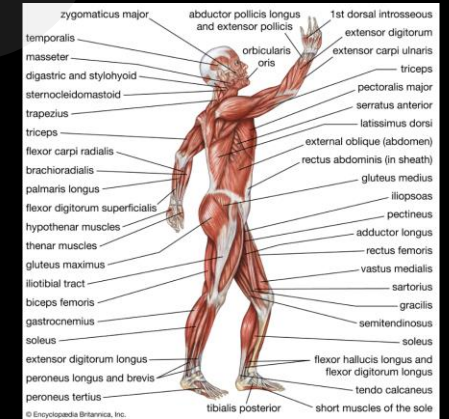
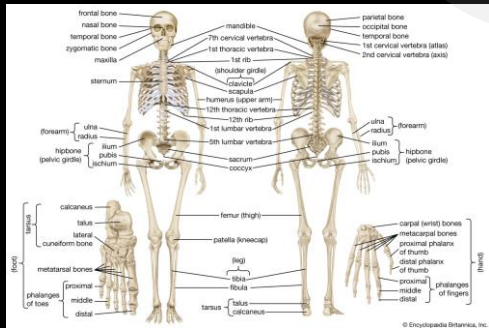
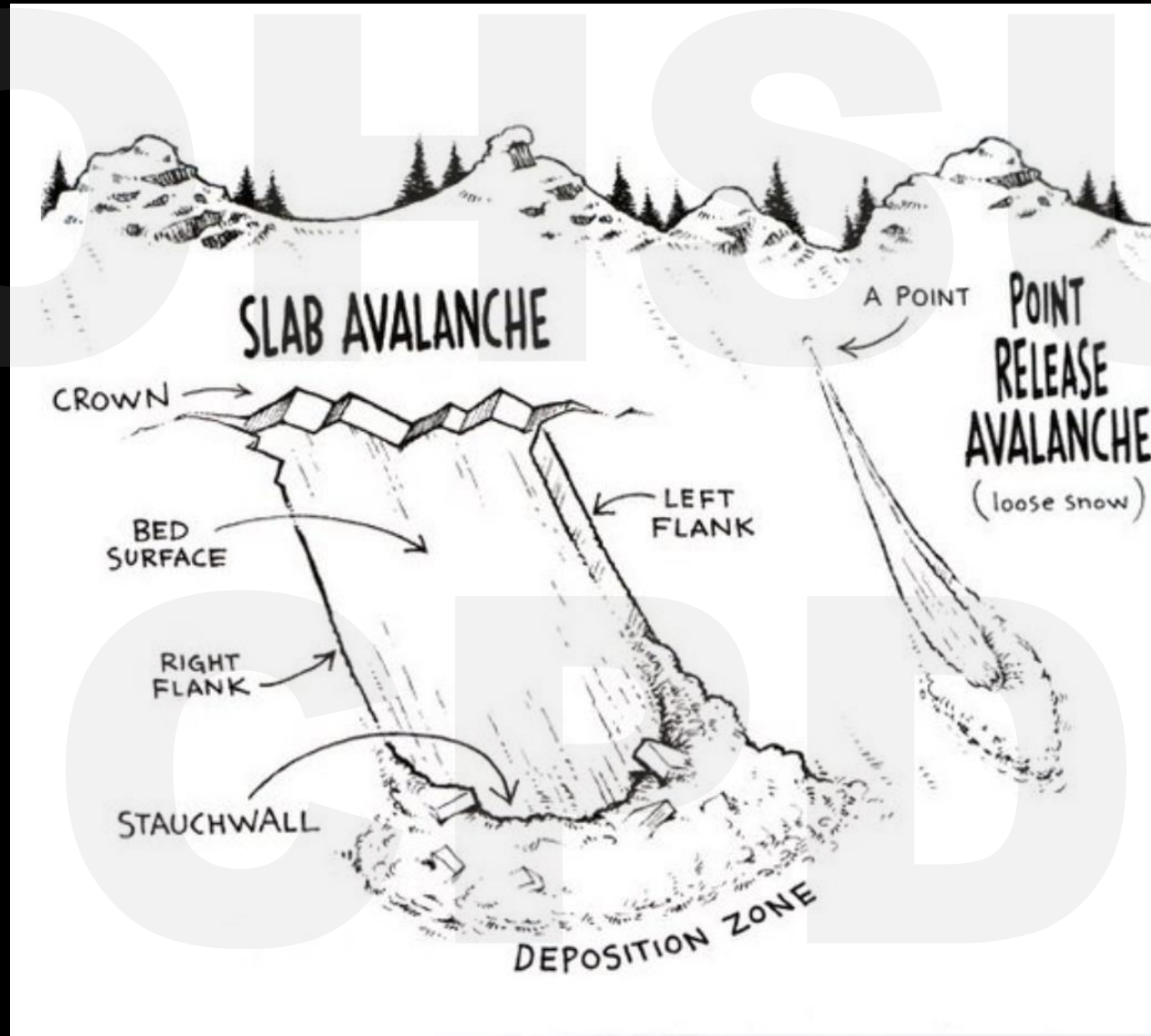
- Avalanche basics
- Prevention
- Rescue
- Medical logistics
- Q&A

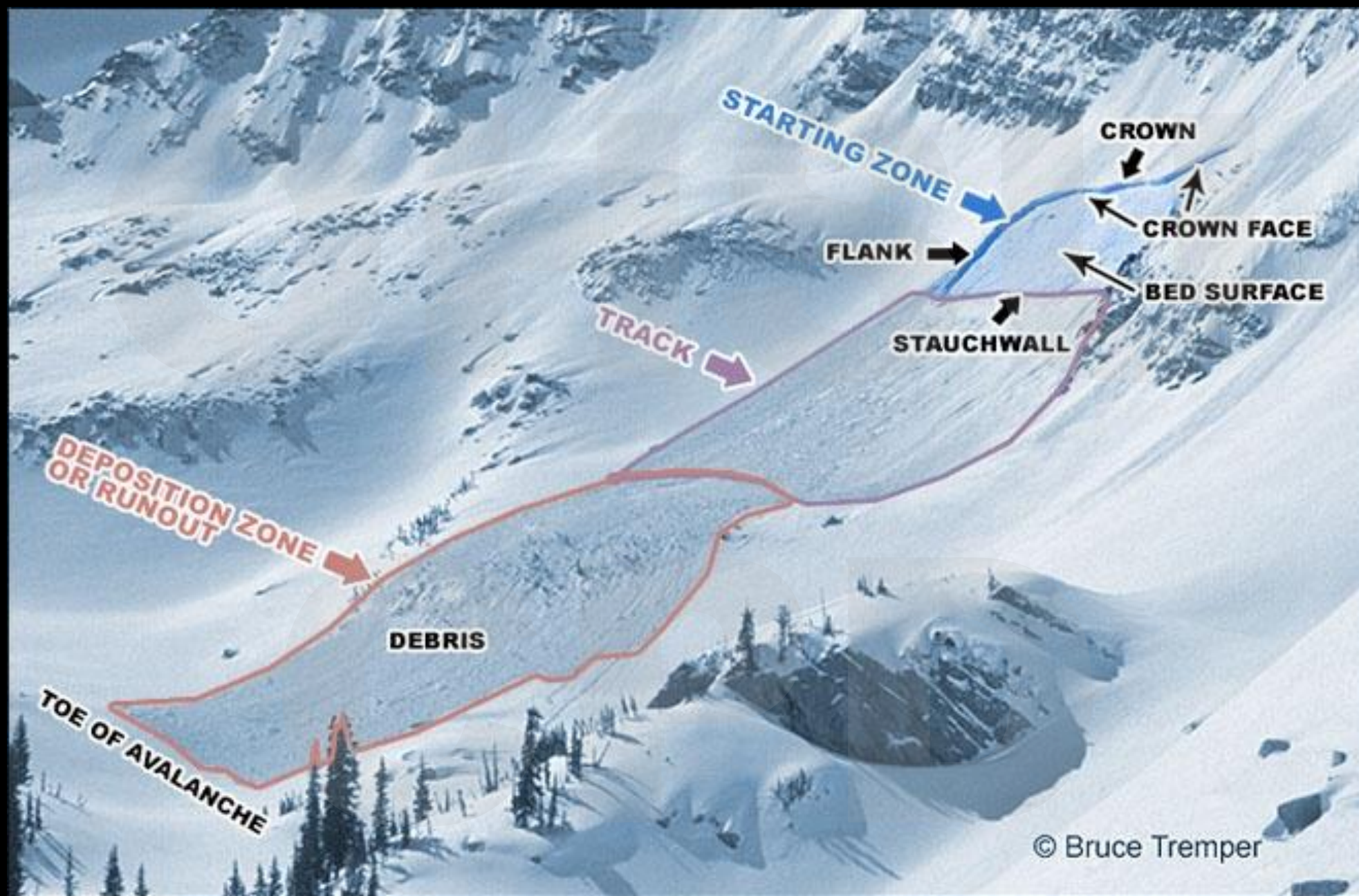




What is an Avalanche?

Anatomy of an Avalanche





Avalanche Problem Type



Loose Dry



Storm Slab



Wind Slab



Persistent Slab



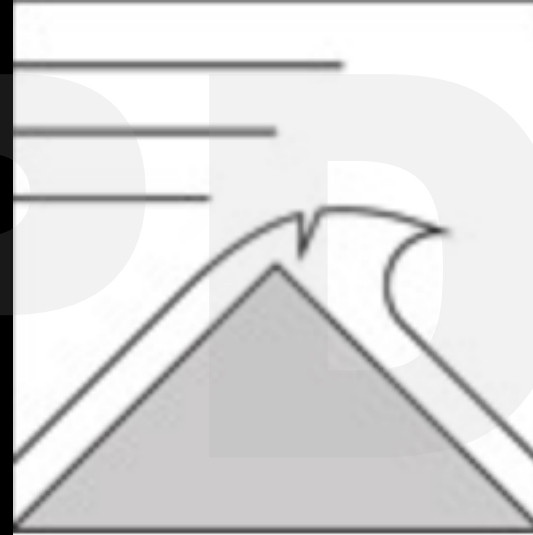
Deep Persistent Slab



Loose Wet



Wet Slab



Cornice Fall



Glide

Loose Avalanche



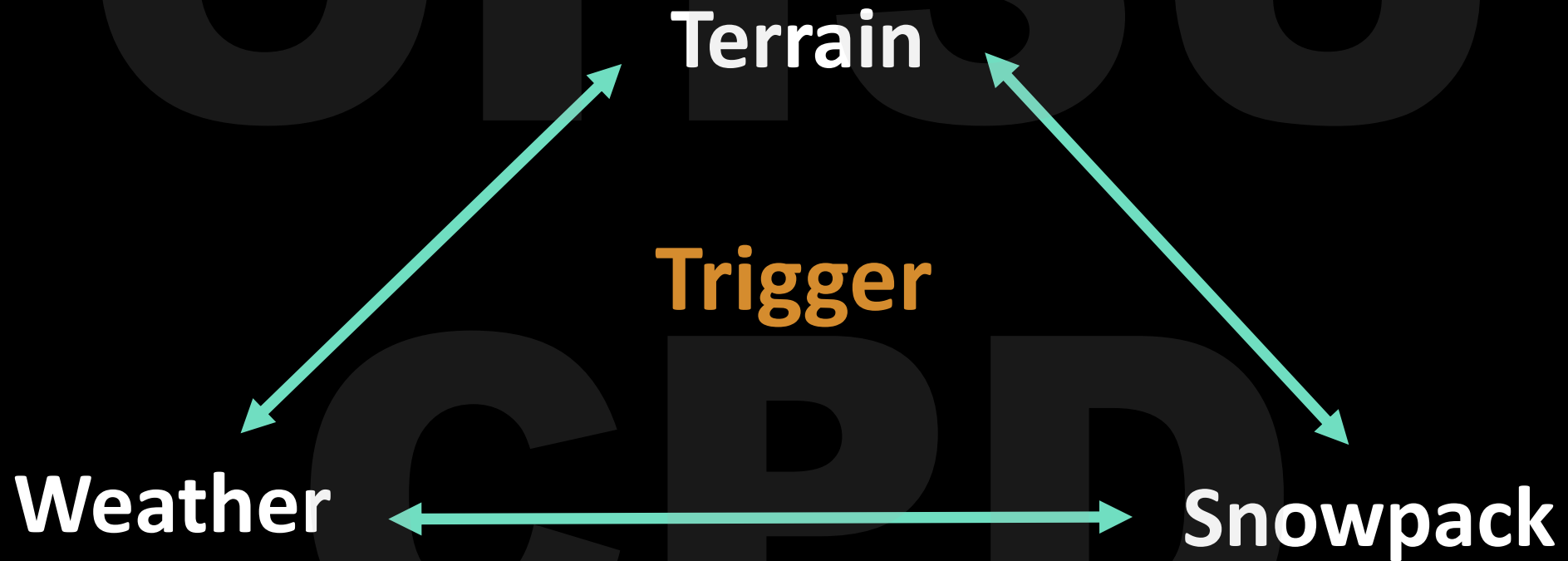
Slab Avalanche (dry)



Wet avalanche (dry and loose)

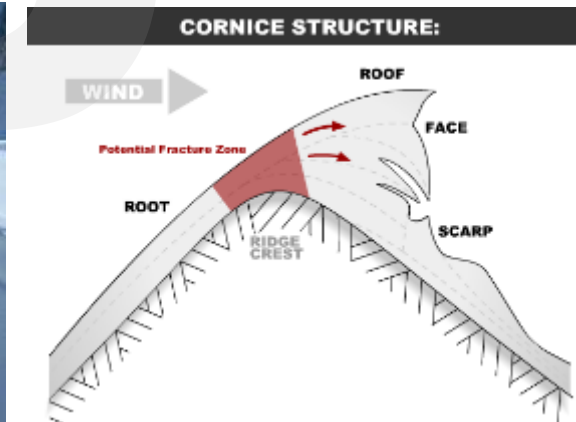
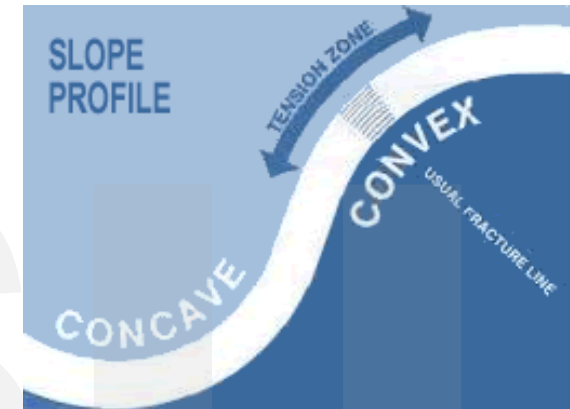


Recipe for an Avalanche



Terrain

- Slope angle
 - 35-45 degrees
- CONVEX shape
- Underlying rock bands
- Cornices
- Terrain Traps

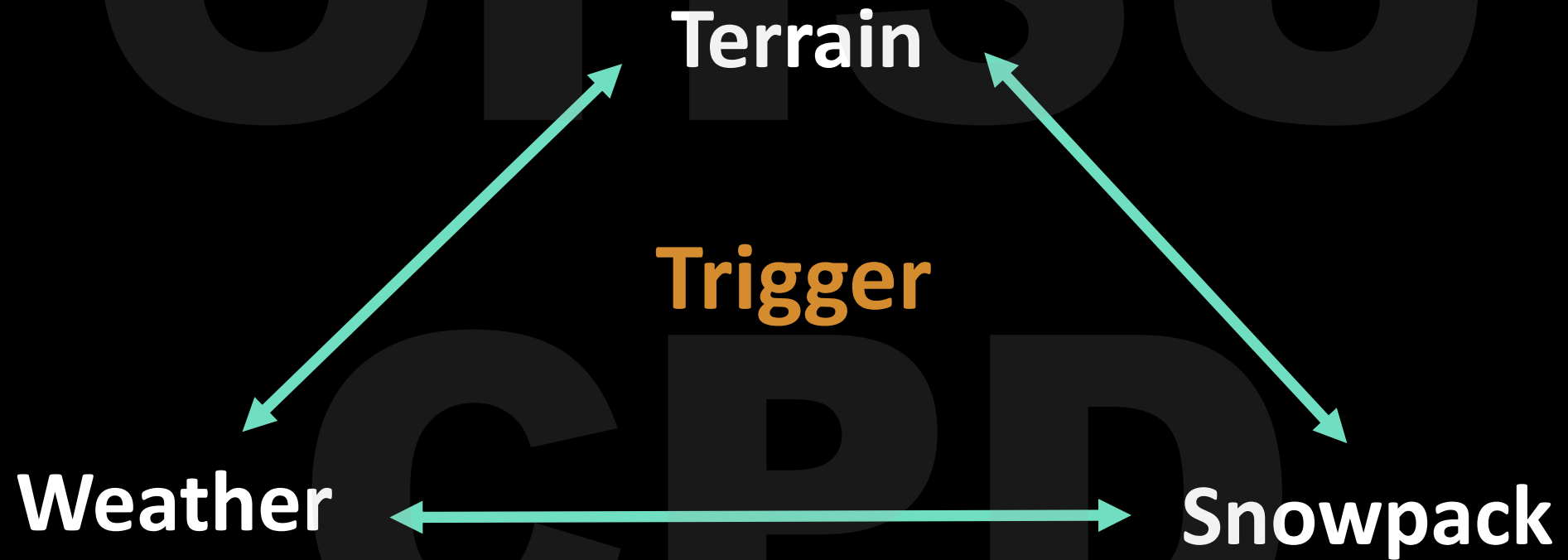


TERRAIN TRAPS:

Even a small avalanche can leave a victim buried deeply in a terrain trap.









Snowpack

- Slab
- Weak Layer
- Bed Surface



Weather



Precipitation

- Type
- Rate
- Amount



Wind

- Speed
- Direction
- Duration



Temperature

- Rapid warming
- Cold snap
- Solar effect







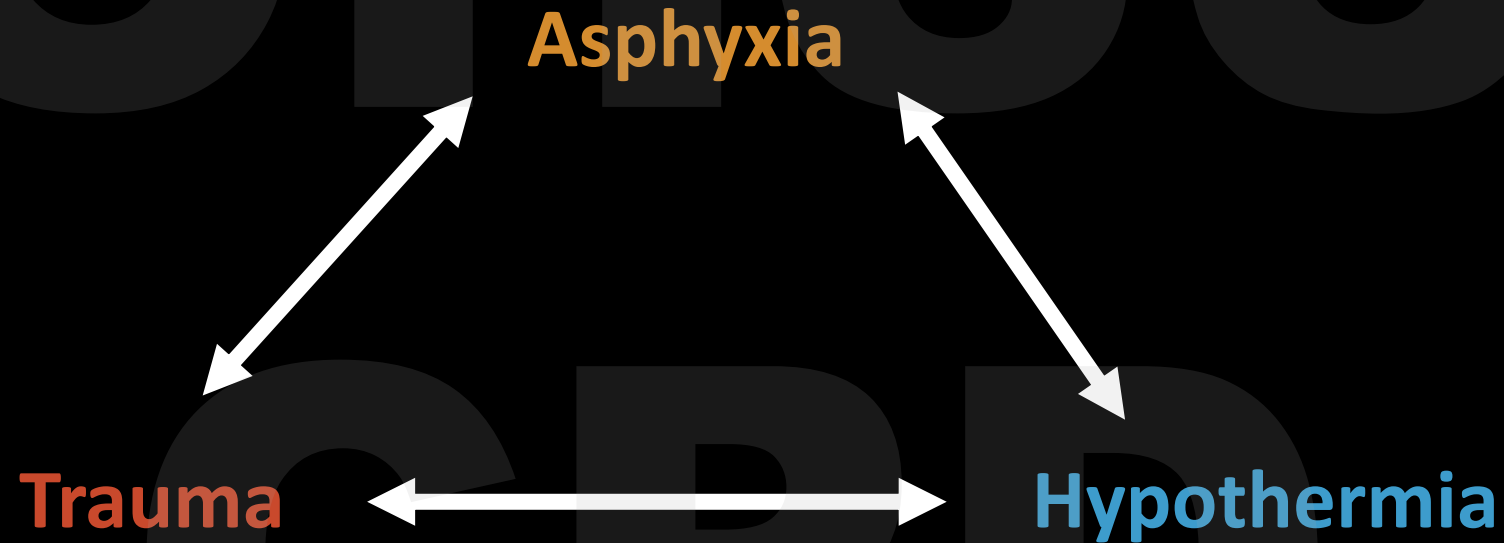








Avalanche Burial: complications

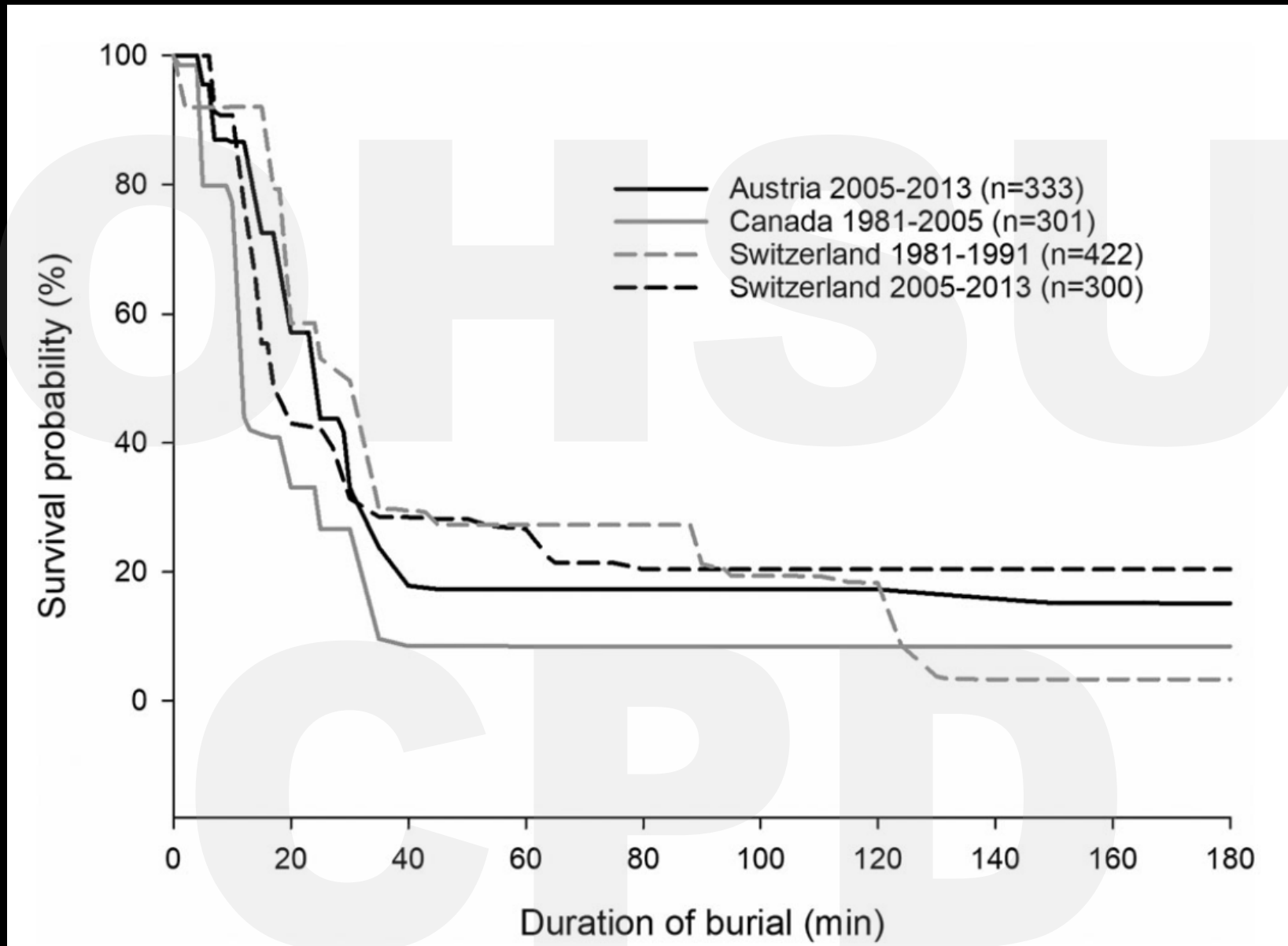


Asphyxia

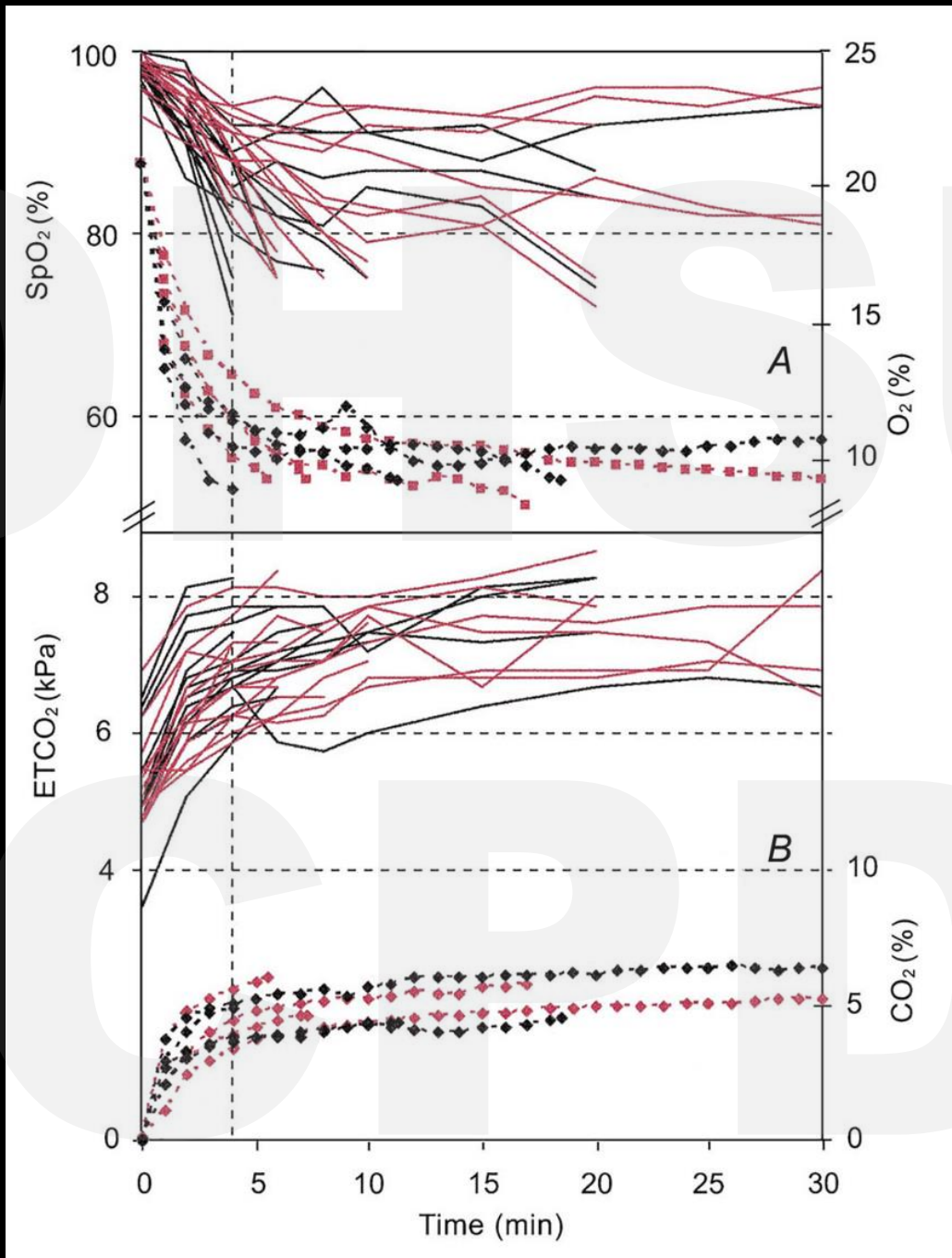
(oxygen deprivation)

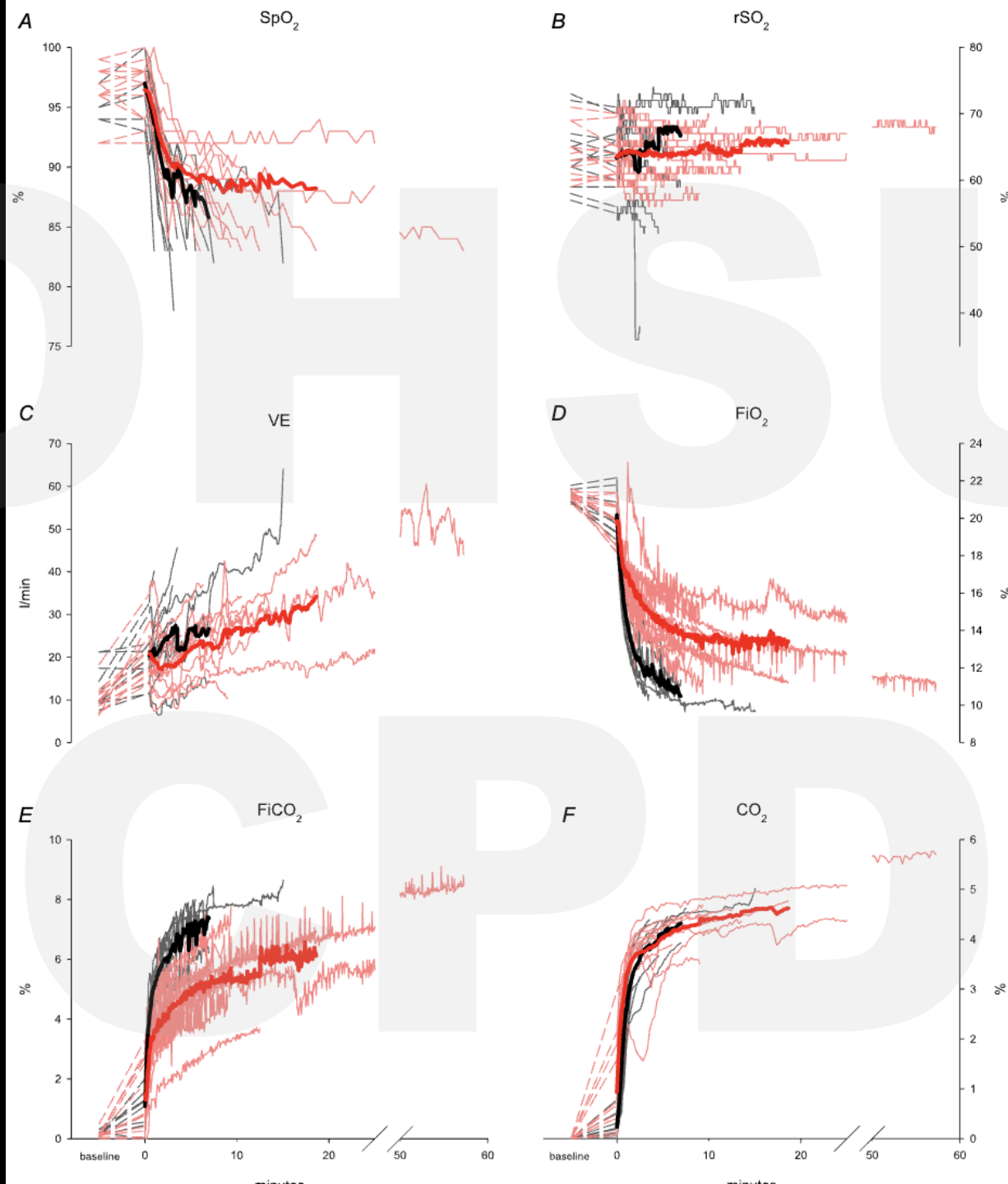
- ~75% deaths
- Time = important
- Considerations:
 - Air pocket
 - Physical Blockage
 - Ice Masks
 - Weight of snow on chest











Trauma

- ~ 25% North America, Europe
- North American > Europe
- Head, chest injuries most common

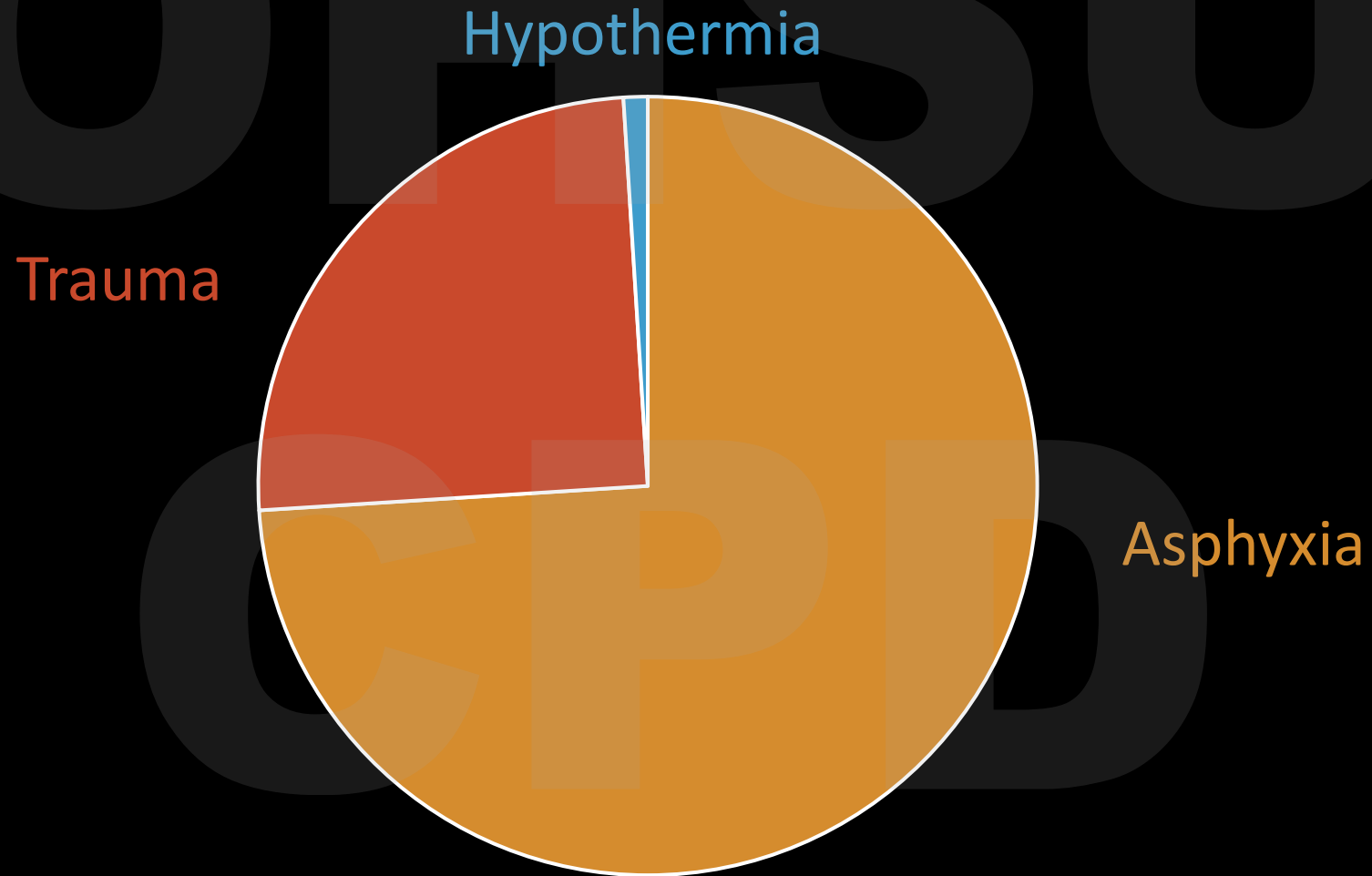




Hypothermia

- Less common
- Long burials, good air pocket
- Core temperature
- Afterdrop
- Complications
 - Coagulopathies
 - Cardiac arrhythmias

Avalanche burial: mortality review





Avalanche Prevention

- **Education**

- Formal classes
- Community events
- Academic research

- **Public Safety**

- Department of Transportation
- Avalanche Information Centers
- Ski area avalanche departments

- **Avoidance**

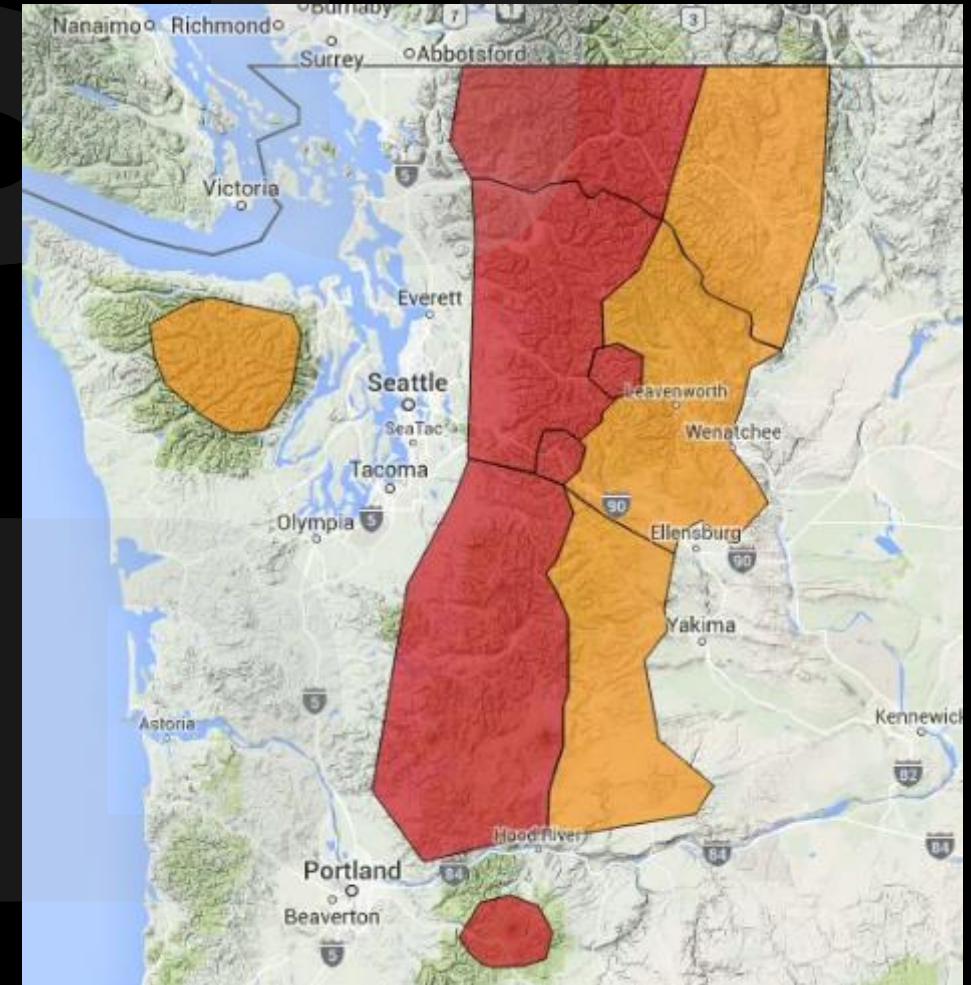
- Terrain, weather, snowpack

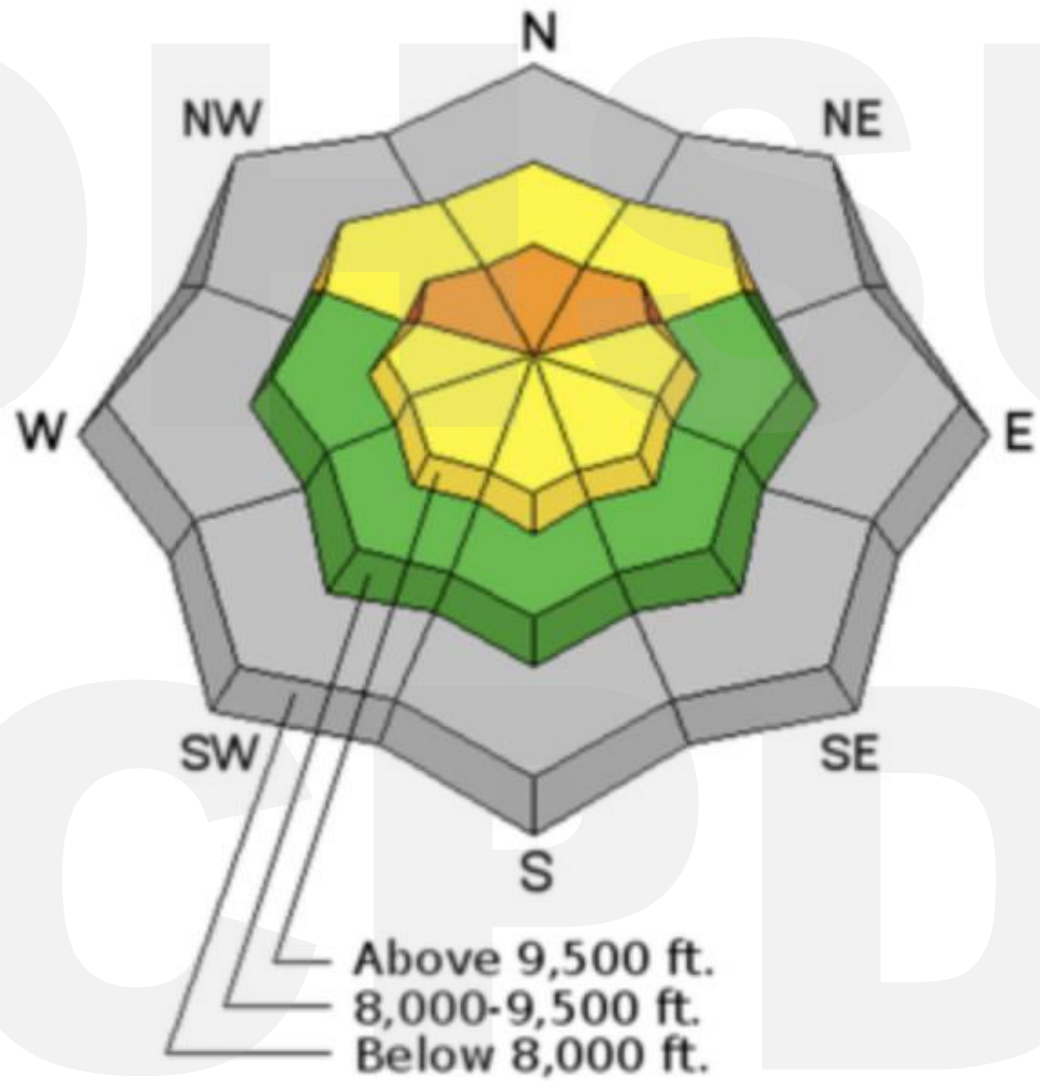


<https://www.caledoniacourier.com/news/snapshot-avalanche-rolls-over-snowshed-tunnel-on-highway-1-east-of-revelstoke-6113500>

North American Avalanche Danger Scale

North American Public Avalanche Danger Scale				
Avalanche danger is determined by the likelihood, size and distribution of avalanches.				
Danger Level		Travel Advice	Likelihood of Avalanches	Avalanche Size and Distribution
5 Extreme		Avoid all avalanche terrain.	Natural and human-triggered avalanches certain.	Large to very large avalanches in many areas.
4 High		Very dangerous avalanche conditions. Travel in avalanche terrain not recommended.	Natural avalanches likely; human-triggered avalanches very likely.	Large avalanches in many areas; or very large avalanches in specific areas.
3 Considerable		Dangerous avalanche conditions. Careful snowpack evaluation, cautious route-finding and conservative decision-making essential.	Natural avalanches possible; human-triggered avalanches likely.	Small avalanches in many areas; or large avalanches in specific areas; or very large avalanches in isolated areas.
2 Moderate		Heightened avalanche conditions on specific terrain features. Evaluate snow and terrain carefully; identify features of concern.	Natural avalanches unlikely; human-triggered avalanches possible.	Small avalanches in specific areas; or large avalanches in isolated areas.
1 Low		Generally safe avalanche conditions. Watch for unstable snow on isolated terrain features.	Natural and human-triggered avalanches unlikely.	Small avalanches in isolated areas or extreme terrain.
Safe backcountry travel requires training and experience. You control your own risk by choosing where, when and how you travel.				
No Rating		Watch for signs of unstable snow such as recent avalanches, cracking in the snow, and audible collapsing. Avoid traveling on or under similar slopes.		





If you trigger an avalanche:

- Get off the slab
- Avoid burial
- Minimize trauma
- Avoid asphyxia





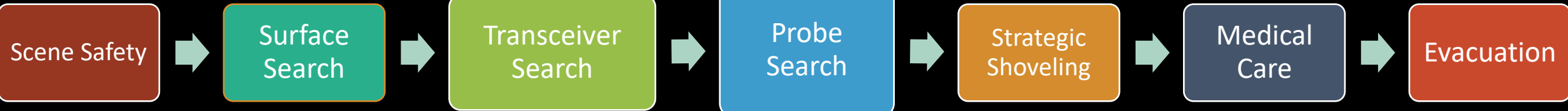
Avalanche Rescue

Goals of Avalanche Rescue

- Locate victims
- Medical evaluation/treatment
- Evacuation

OHSU

CPD

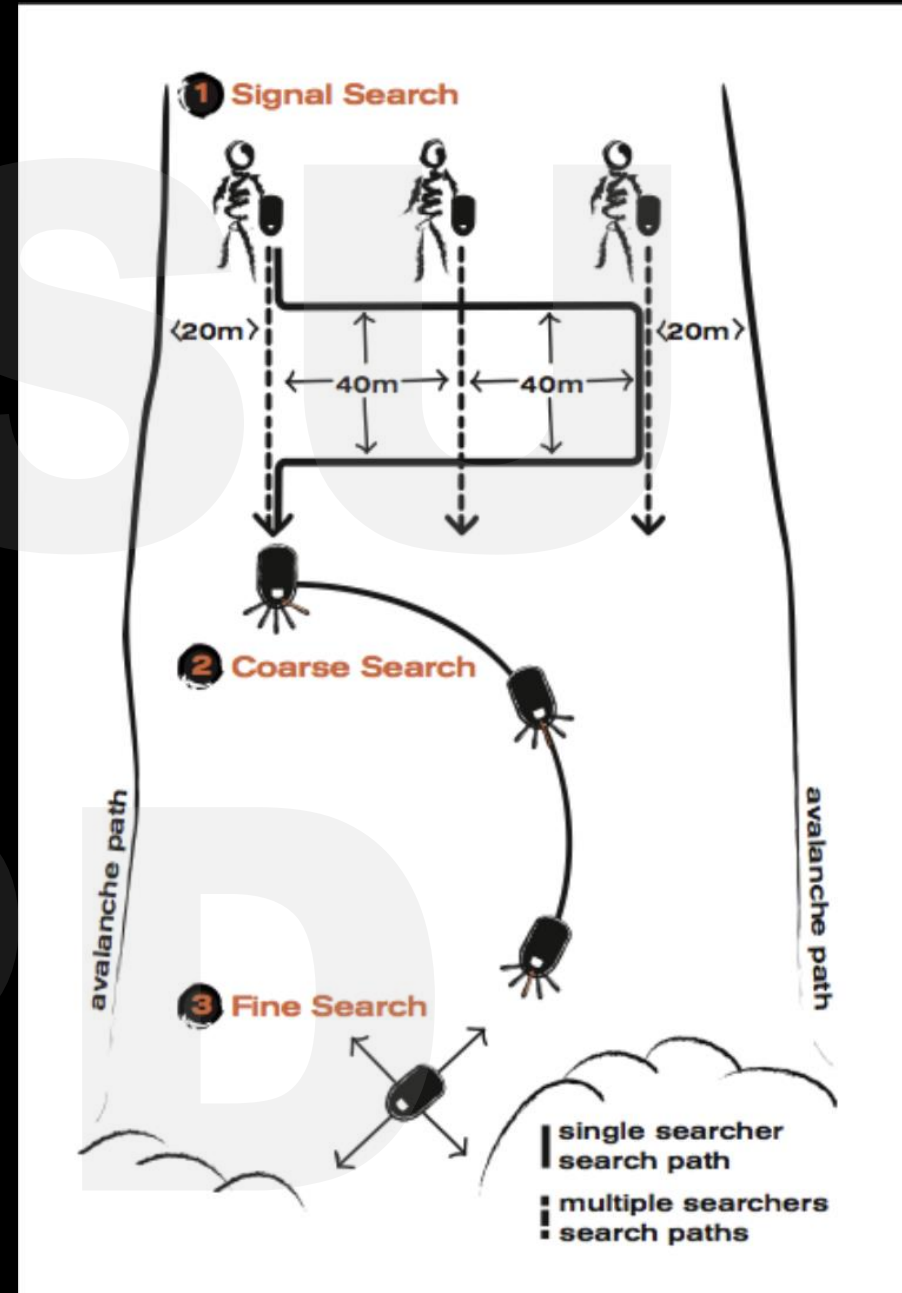






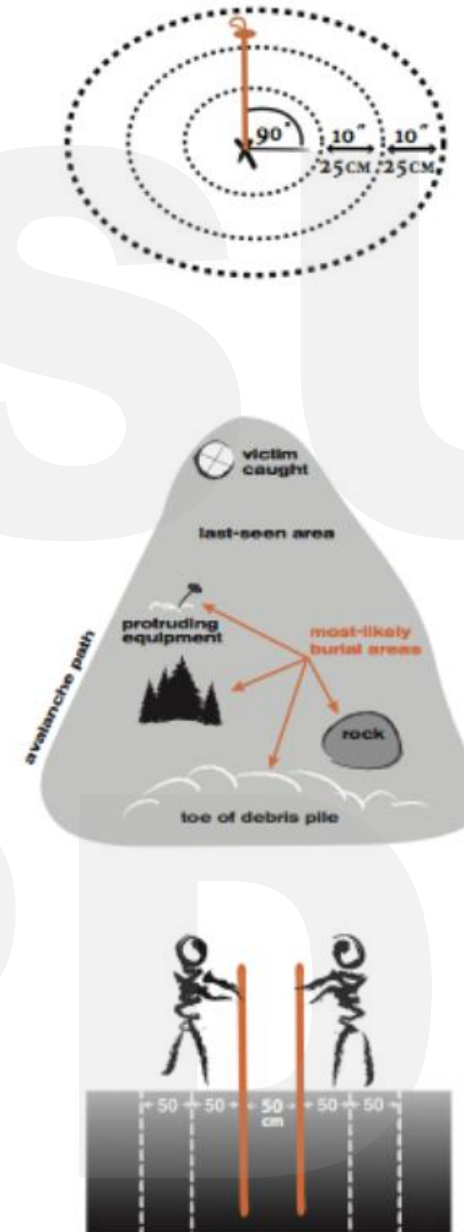
Transceiver Search

- “Run, Walk, Crawl”
- **Signal Search**
 - Last seen area / entire debris
 - 40m switchbacks
- **Coarse Search:**
 - Brings rescuer to within 3m
- **Fine Search:**
 - Lowest distance readings in both x- and y-axes

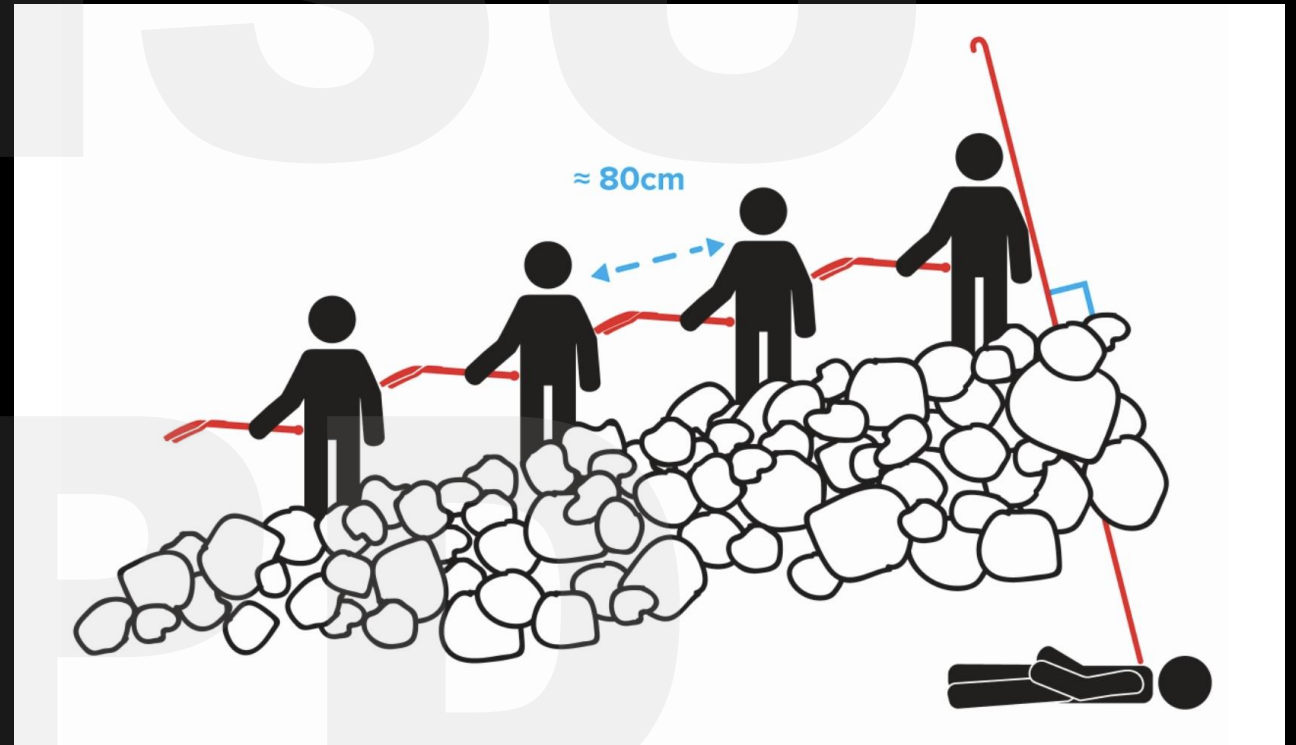
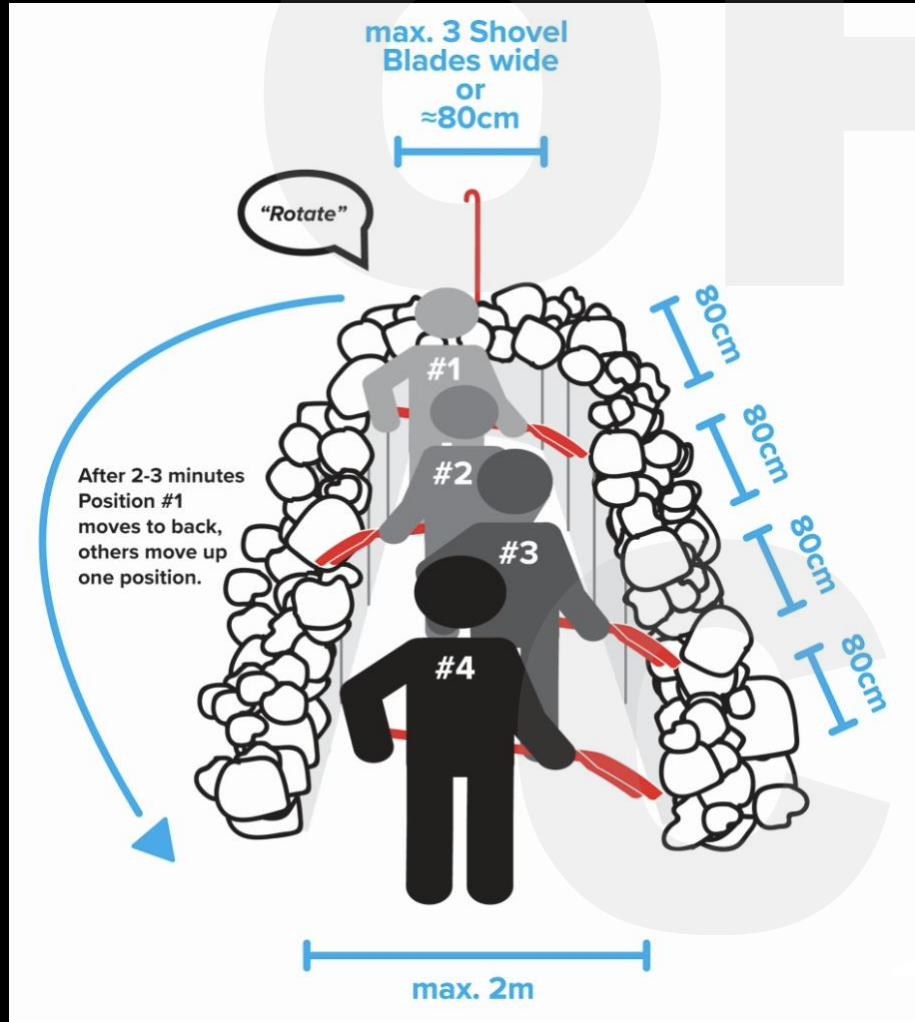


Probing

- **Search probing:**
 - Concentric circles
 - 25cm spacing
- **Spot probing**
 - Likely burial spots
 - Up to 1.5m deep
- **Probe Lines**
 - Rescue groups
 - Wrist-to-wrist line-up
 - Three holes per rescuer



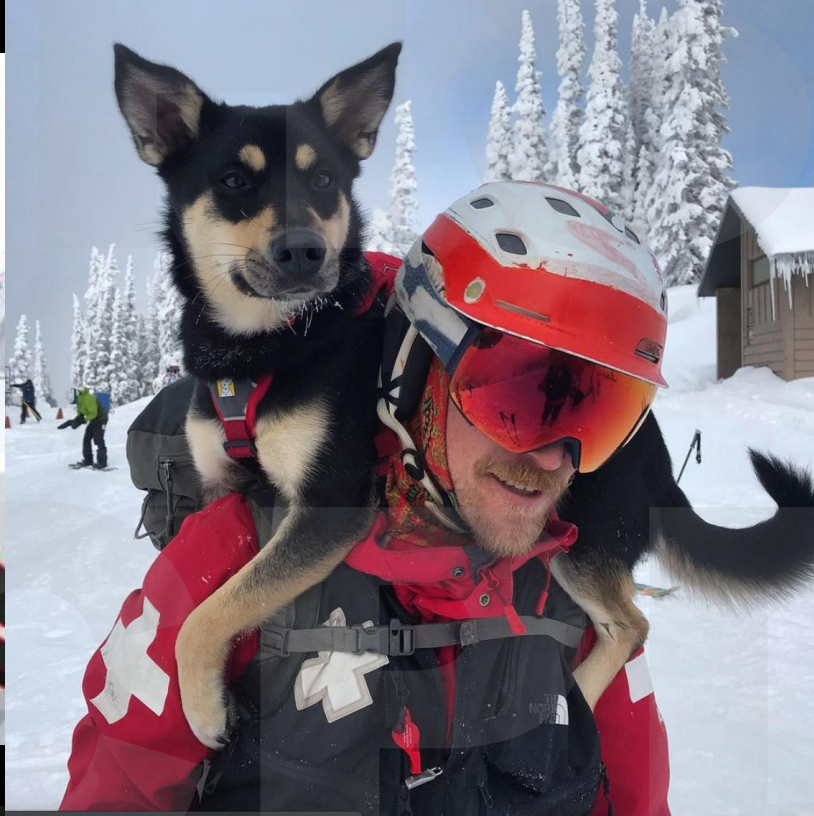
Shoveling



Organized versus companion rescue

- Companion rescue:
 - 4x survival
- Organized:
 - Usually > 35min response time
- Rescue team resources:
 - Dogs
 - Probe lines
 - Medical
 - Air/ground transport

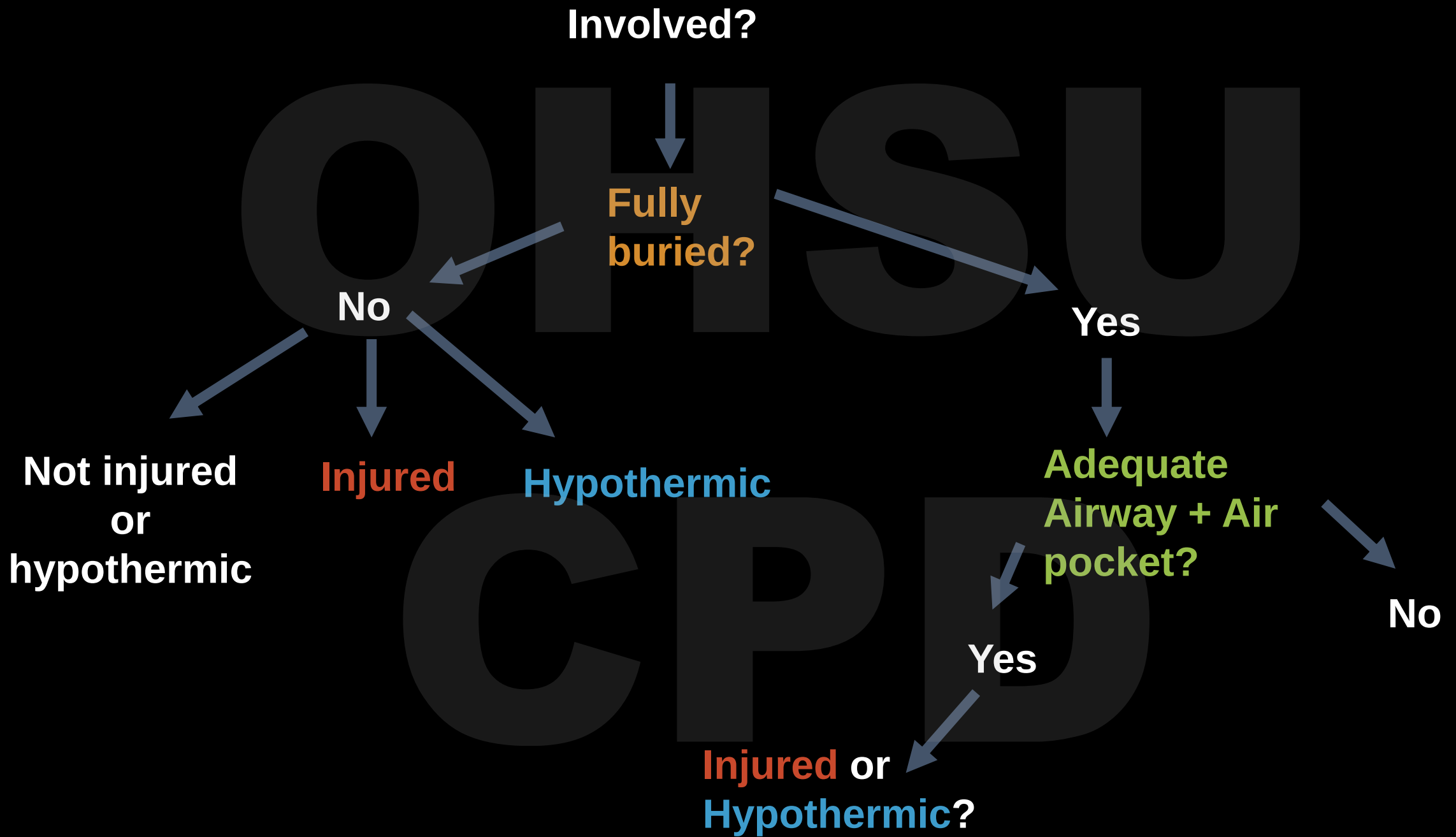








Avalanche Resuscitation



Trauma: management

- Early hemorrhage control
- Airway management
- Spinal immobilization
- Limb splinting
- Analgesia
- Tension pneumothorax



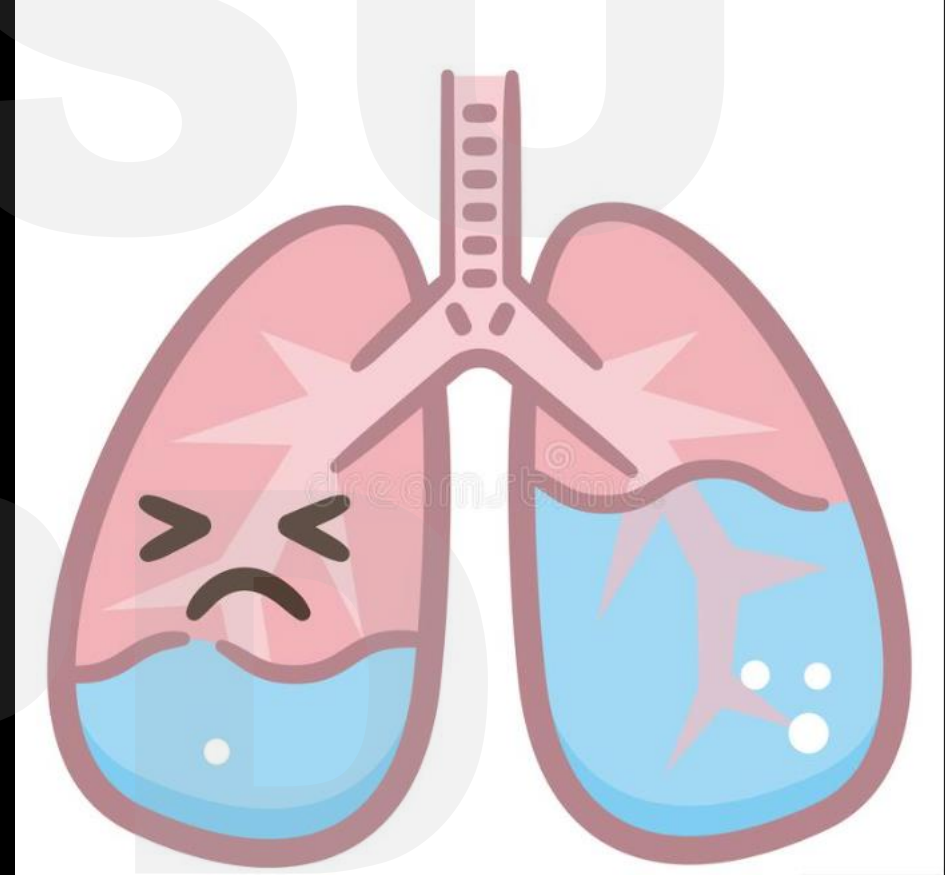
Hypothermia: management

- Suspect in any avalanche patient
- Afterdrop
- Heat packs/ warm blankets
- Handle carefully
- ECLS facility



Hypothermia: complications

- Coagulopathy: bleeding and clotting
- Pulmonary edema
- Dysrhythmias → cardiac arrest

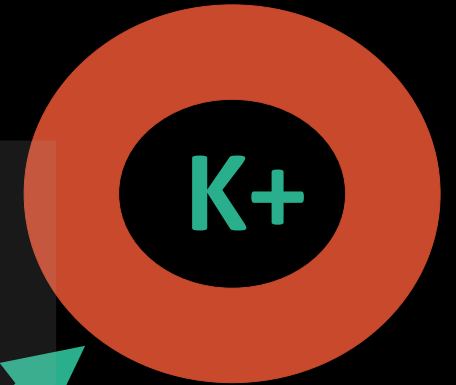
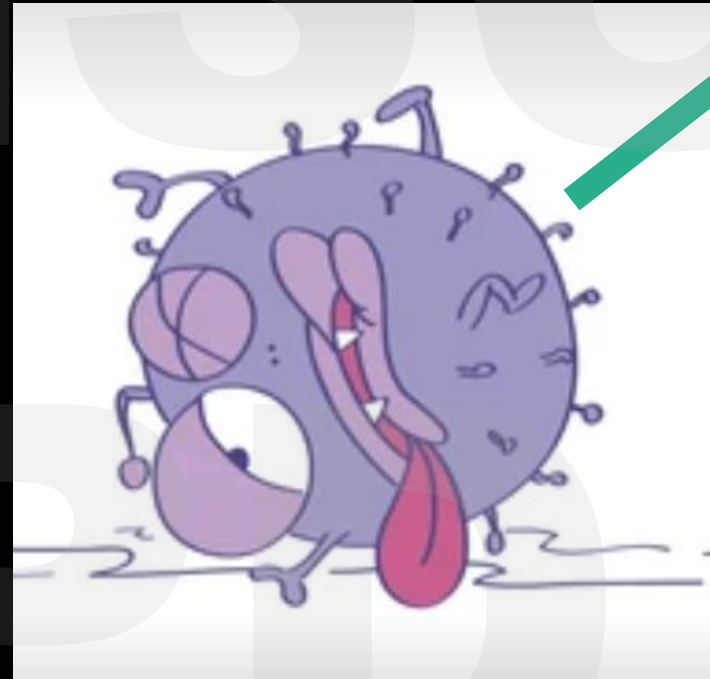


Cardiac Arrest

- Quick initiation of CPR
- Defibrillation considerations
- Advanced Life Support
- Mechanical chest compressions
- Intermittent CPR
- Withholding/Termination of efforts

Potassium?

- Strong survival predictor
- Helps determine resuscitation efforts
- 2019: 7.0 mmol/L cutoff











Patient ID

Time of avalanche ____ : ____

Face exposure ____ : ____

Burial Time^{a)} min

☐ ≤60 min (≥30°C) ☐ >60 min (<30°C)

If unknown Use core temp ^{b)}

BLS Provider

report
Air Pocket
on reverse side

☐ YES ☐ NO **Vital Signs**

FIRST AID

☐ YES ☐ NO **Vital Signs**

FIRST AID

☐ YES or unknown ☐ NO **Airway Patent**

CPR^{c)}

Core Temperature at extrication

☐ ≥30°C ☐ <30°C or unknown

____ . ____ °C

Follow standard ALS guidelines

STOP or go to appropriate medical facility

ALS Provider Name:

AVALANCHE VICTIM RESUSCITATION CHECKLIST

©ICAR MEDCOM, oct 2015, Kottmann A, Blancher M, Pasquier M, Brugger H

ALS Provider

☐ YES ☐ NO **Obvious lethal Trauma or body totally frozen**

STOP

☐ YES ☐ NO or unknown **ECG Asystole**

☐ NO ☐ YES or unknown **Airway Patent**

STOP

☐ <30°C or unknown ☐ ≥30°C **Core Temp at extrication**

____ . ____ °C

☐ NO ☐ YES **Long transport or multiple casualties**

Follow standard ALS guidelines

STOP or go to appropriate medical facility

☐ ≤8 mmolL⁻¹ ☐ >8 mmolL⁻¹ **Serum K⁺**

____ mmolL⁻¹ ^{d)}

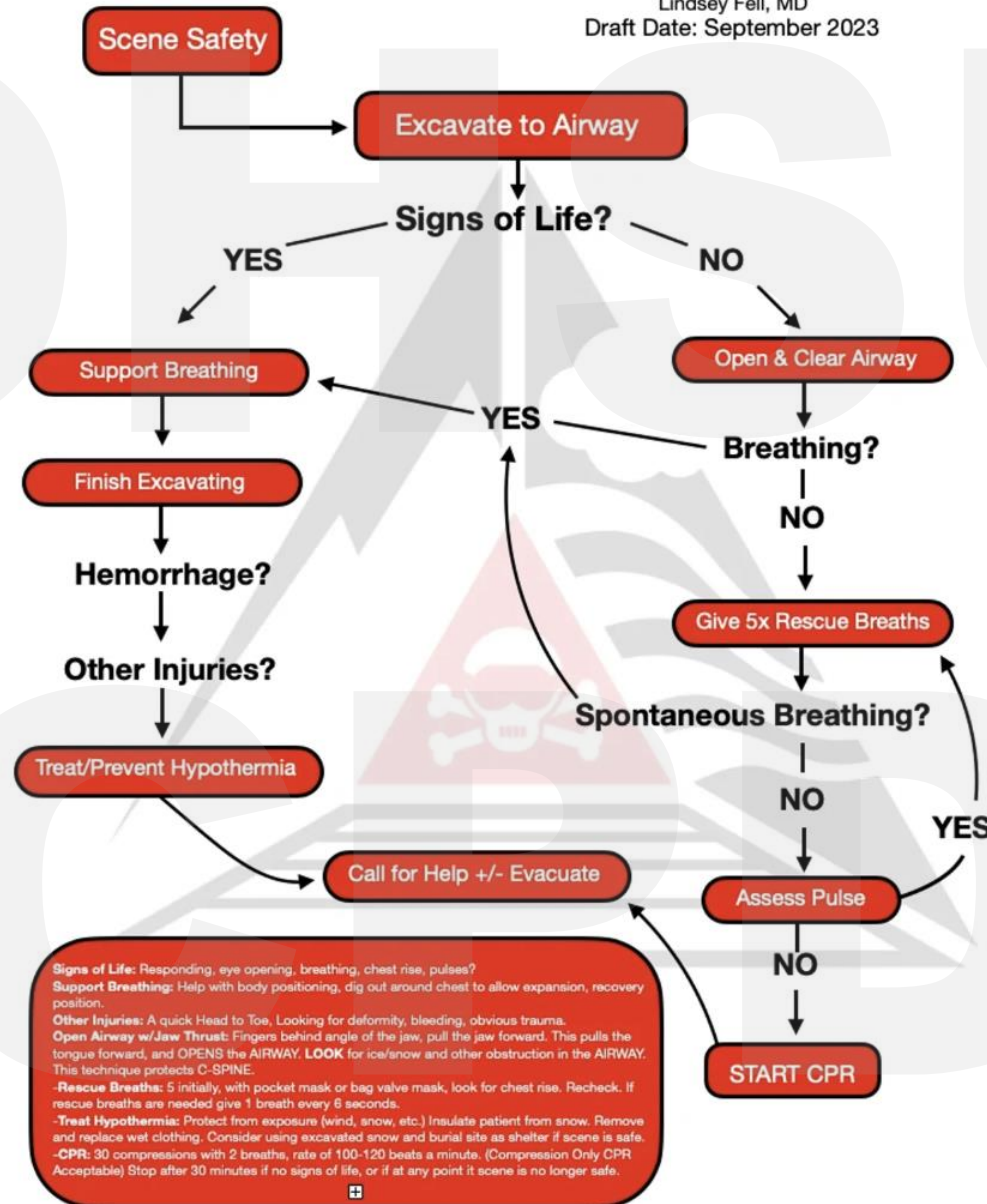
ECLS FACILITY

STOP

Single Avalanche Victim Medical Response

Drafted by: TJ Hartridge, DO FAWM
Lindsey Fell, MD

Draft Date: September 2023





Summary

- Call for Resources early
- Scene safety
- Asphyxia > trauma > hypothermia
- Companions are lifesavers
- Do they have an airway / air pocket?
- Hypothermic patients are fragile
- Intermittent CPR is OK, limited defibrillations
- ECLS candidate?

Proceedings, International Snow Science Workshop, Bend, Oregon, 2023

UNDERSTANDING METEOROLOGICAL CONTROLS ON WIND SLAB PROPERTIES

Nathalie de Leeuw¹, Karl Birkeland^{2,3}, Jordy Hendrikx^{4,5}

¹ *Department of Earth Sciences, Montana State University, Bozeman MT, USA*

² *National Avalanche Center, Bozeman, MT, USA*

³ *Birkeland Snow and Avalanche Scientific, Bozeman, MT USA*

⁴ *Antarctica New Zealand, Christchurch, New Zealand*

⁵ *Department of Geosciences, UiT the Arctic University of Norway, Tromsø, Norway*

Proceedings, International Snow Science Workshop, Bend, Oregon, 2023

SNOW CONVEYOR BELT – SUMMARY AND UPDATES ON THE MOST LIFE- SAVING AVALANCHE RESCUE EXCAVATION STRATEGY

Manuel Genswein^{1*}, MountainSafety.info Workgroup for Avalanche Rescue¹

¹ *MountainSafety.info*

REVIEW-SYMPOSIUM

Avalanche burial pathophysiology – a unique combination of hypoxia, hypercapnia and hypothermia

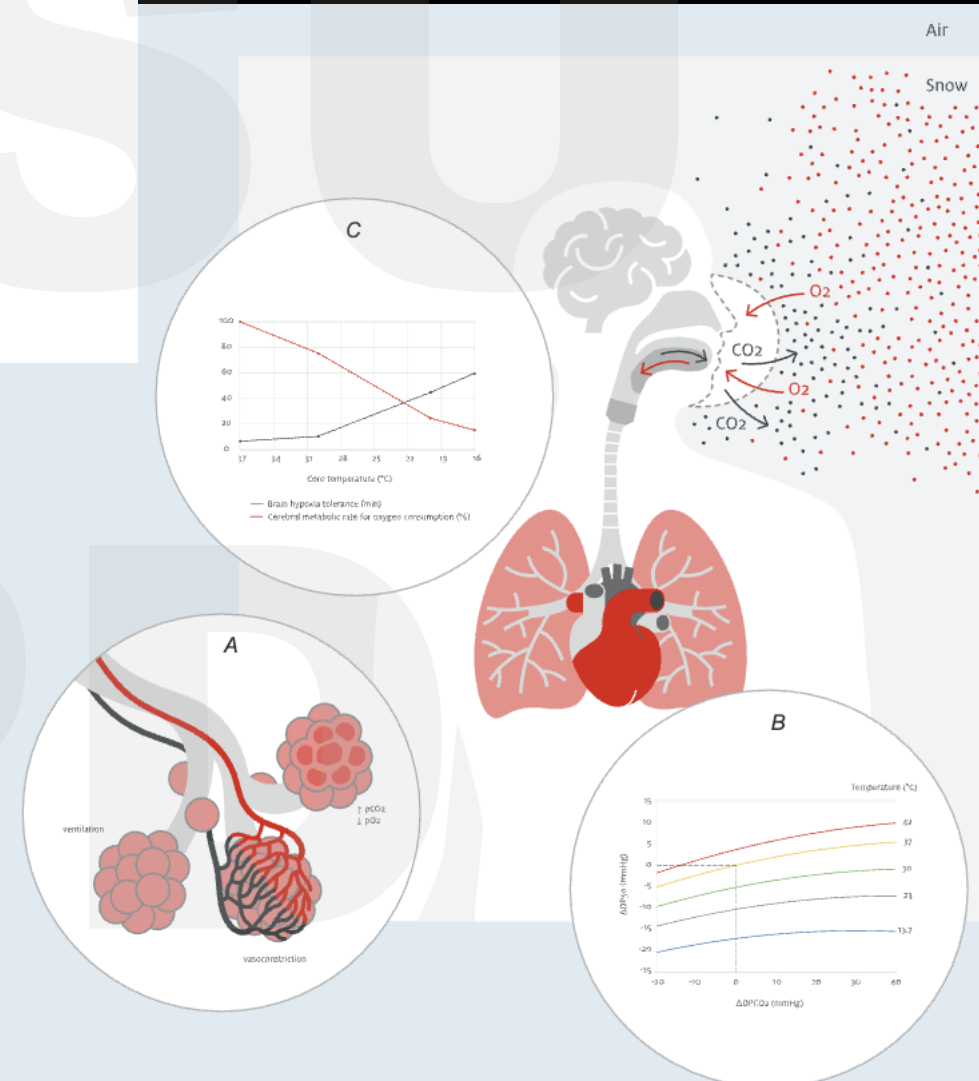
Giacomo Strapazzon^{1,2} , Anna Taboni¹ , Erik Sveberg Dietrichs³, Andrew M. Luks⁴ 
and Hermann Brugger¹ 

¹Institute of Mountain Emergency Medicine, Eurac Research, Bolzano, Italy

²Department of Medicine – DIMEM, University of Padova, Padova, Italy

³Institute of Oral Biology, University of Oslo, Oslo, Norway

⁴Division of Pulmonary, Critical Care, and Sleep Medicine, Department of Medicine, University of Washington, Seattle, WA, USA



2023 ICAR Updates

REVIEW | [VOLUME 184](#), 109708, MARCH 2023

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On-site treatment of avalanche victims: Scoping review and 2023 recommendations of the international commission for mountain emergency medicine (ICAR MedCom)

[M. Pasquier](#)   • [G. Strapazzon](#)  • [A. Kottmann](#)  • ... [M. Blancher](#)  • [C. Jaques](#)  • [H. Brugger](#)  •

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