Epidemiology and treatment of cold injuries in remote areas

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New insights in emergency medicine:
How can we apply evidence-based medicine in European mountain areas?
Bolzano 2011
(Livius 59-17 B.C.) „Hannibal crossing the Alps with sixty thousand soldiers and 37 elephants during the Winter of 218 B.C. ...
„... lost half of troups by snow avalanches (*moles nivium*) and all elephants died, except one“
During the 1st World War, the „Great War“ in the Dolomites in December 1916, 6000 Austrian soldiers lost their lives ...
... within 48 hours, more than victims killed by gunfire!
Epidemiology

Epidemiology

**Primary hypothermia:** accidental

**Secondary hypothermia:** natural complication of systemic disorders (i.e. trauma)

Not defined yet
Epidemiology (I)

Difficult to be determined despite specific situations

Completely avalanche buried patients
Avalanche Mortality

Year:
- 1984
- 1986
- 1988
- 1990
- 1992
- 1994
- 1996
- 1998
- 2000
- 2002
- 2004
- 2006
- 2008

Fatalities:
- Alps
- NA

International Commission of Alpine Rescue, 2009
Avalanche Mortality

Fatalities

Year

International Commission of Alpine Rescue, 2009
Avalanche Mortality

Fatalities vs. Year

- Alps

Lethality trendline

International Commission of Alpine Rescue, 2009
Census of backcountry skiing and snowshoeing in South Tyrol

1 day
1955 groups
6010 persons

Aberer A. et al. Neve&Valanghe 2011
Epidemiology (II)

Difficult to establish the real cause of death

The model of avalanche
## Epidemiology (II)

<table>
<thead>
<tr>
<th></th>
<th>Trauma</th>
<th>Asphyxia</th>
<th>Hypothermia</th>
<th>Total</th>
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<tbody>
<tr>
<td>Tough</td>
<td>1 (6.7%)</td>
<td>14 (93.3%)</td>
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<td>McIntosh</td>
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<td>2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>54 (17.3%)</td>
<td>254 (81.7%)</td>
<td>3 (1.0%)</td>
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Brugger et al. Wilderness Environ Med 2009 modified
Avalanche survival patterns
Canada vs Switzerland

Boyd et al. CMJA 2011
## Epidemiology (II)

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Brugger et al. Wilderness Environ Med 2009 modified
The Triple H Study 2010

Outcry stopped approved pig study of avalanche survival

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Peter Paal Department of Anesthesiology and Critical Care Medicine, University Hospital Innsbruck, Austria
Markus Falk Inova Q Inc., Brunico, Italy
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Oops.. EURAC scientist!
Epidemiology (II)

Difficult to be measured out-of-hospital

No ideal device
On-site core temperature reading

Only thermistor-based ear thermometer correlate well with oesophageal temperature measurements in a cold environment.
On-site core temperature reading

Oesophageal measurement for the intubated patient

Epitympanic measurement for the non-intubated patient
On-site core temperature reading
“The Double Sensor” for non-invasive measurement

(A) heat flux
(B)
AHA & ERC
CoSTR Guidelines ILCOR 2010
In the pre-hospital setting, in patient in cardiac arrest if not:

- lethal injury
- fatal illness
- prolonged asphyxia
- if the chest is incompressible

“no one is dead until warm and dead”
Pre-hospital management of avalanche burial

ASSESSMENT OF THE EXTRICATED PATIENT

- Conscious?
  - Yes: Hypothermia I-II:
    - administer hot, sweet drinks
    - change clothing if practicable
    - transport to nearest hospital with intensive care unit
  - No: Hypothermia III:
    - intubate, ventilate, humidified oxygen
    - transport to hosp with hypothermia exp unit

- Breathing?
  - Yes: Check burial time and/or core temperature
  - No: Obvious fatal injuries?
    - Yes: Start CPR, intubate
    - No: Air pocket and free airway?
      - Yes or uncertain: Hypothermia IV:
        - continue resuscitation
        - VF: apply 3 DC shocks
        - transport to unit with cardiopulmonary bypass
      - No: Pronounce patient dead

- Buried >35 min and in cardiac arrest with an obstructed airway on extrication;
- Buried initially and in cardiac arrest with an obstructed airway on extrication, and an initial core temperature of <32°C;
- Buried initially and in cardiac arrest on extrication with an initial serum potassium of >12 mmol.

Brugger H et al. Resuscitation 2001
ERC Guidelines 2010
Frostbite
A controlled Trial of a Prostacyclin and rt-PA in the Treatment of Severe Frostbite

Table 1. Number of Amputated Digits (Fingers or Toes) According to Treatment, Severity of Frostbite, and Time to Treatment.*

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>No. of Patients</th>
<th>All Stages of Frostbite</th>
<th>All Stages, ≤12 Hr to Treatment</th>
<th>All Stages, &gt;12 Hr to Treatment</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4 or Higher</th>
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<tr>
<td></td>
<td>No. of Patients</td>
<td>Digits with Frostbite</td>
<td>Digits Amputated</td>
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<td>Digits Amputated</td>
</tr>
<tr>
<td>All groups</td>
<td>47</td>
<td>407</td>
<td>47 (11.5)</td>
<td>271</td>
<td>13 (4.8)</td>
<td>136</td>
<td>34 (25.0)</td>
</tr>
<tr>
<td>Buphenedil</td>
<td>15</td>
<td>106</td>
<td>42 (39.6)</td>
<td>48</td>
<td>11 (22.9)</td>
<td>58</td>
<td>31 (53.4)</td>
</tr>
<tr>
<td>Iloprost</td>
<td>16</td>
<td>142</td>
<td>0</td>
<td>79</td>
<td>0</td>
<td>63</td>
<td>0</td>
</tr>
<tr>
<td>Iloprost plus rt-PA</td>
<td>16</td>
<td>159</td>
<td>5 (3.1)</td>
<td>144</td>
<td>2 (1.4)</td>
<td>15</td>
<td>3 (20.0)</td>
</tr>
</tbody>
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* Stage 2 frostbite was defined as having at least one digit (finger or toe) with frostbite, with the lesion confined to the distal phalanx; stage 3 as having at least one digit with frostbite, with the lesion extending just past the proximal phalanx; and stage 4 as having at least one digit with frostbite, with the lesion extending proximal to the metacarpal or metatarsal joint.