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Case report

Case report: Survival after an unwitnessed deep and long avalanche burial



Andreas Bregenzer^{a,b,*}, Emilis Simeliunas^{c,d}, Benjamin Zweifel^e, Peter Fiala^f, Peter Paal^g, Oliver Reisten^h, John Ellertonⁱ, Evelien Cools^{d,j}

Case description

On February 15, 2025, two backcountry skiers (male, 30 and 31 years old), intended to climb the Augstbordhorn, a peak of 2973 m above sea level (asl) in Valais, Switzerland. In the days prior to this accident 15–30 cm of new snow had fallen.¹ The avalanche bulletin for that day reported a considerable avalanche danger (level 3 on a scale of 5). Wind slab and a persistent weak layer were the main avalanche problems; the bulletin said “single winter sport participants can release avalanches”.¹ At about 10:30, the two backcountry skiers triggered a slab avalanche during their ascent of a northern-orientated, 35–40° slope at an altitude of 2825 m asl. The two men were completely buried by the avalanche; however, both had an air pocket. One victim describes that he initially had breathing problems because he had inhaled a lot of snow in his airways; he managed to stay calm and the snow melted in his mouth. He moved his head to create a small air pocket. Both victims could speak with each other and they realised that they were located above each other. They didn't have physical contact with each other and they couldn't extract themselves (Fig. 1).

Later, another group of 6 ski tourers were trying to reach the Augstbordhorn by the same route. During their ascent, at about 11:35, they discovered a slab avalanche with ski tracks disappearing into the avalanche. They didn't suspect that anyone was in the avalanche but they, nevertheless, performed a search with their avalanche transceivers. To their surprise, the transceivers indicated that there were two persons in the avalanche. The group were trained in avalanche search techniques. At 11:37, one called the emergency dispatch centre, while the others continued searching

for the victims. A dog of one of the group members, a German long-haired pointer, who had been trained in avalanche rescue during the preceding 3 years also participated in the search. During the search, one member of the group heard one of the victims shouting from under the snow – the victim had heard footsteps of a rescuer and started to shout. The group started shovelling and found the first victim at a depth of 1.5 m under compact snow at approximately 11:49. He was conscious, still wearing his skis, and told the rescuers that the second victim was just underneath him. The rescuers continued shovelling and found the second victim at 11:54 under another half metre of snow (i.e. at a depth of 2 m).

Two rescue helicopters with two emergency physicians arrived at the incident place at 11:55. Neither victim had evidence of external trauma. One victim was not orientated, had a GCS of 14/15 (E4V4M6) and was shivering. The GCS improved to normal within 10 min. Insulation from the cold and external rewarming with a chemical heat pack was applied and both victims were transported by helicopter to the nearest regional hospital. The flight time was 4 min.

In hospital, the first patient had a core temperature of 35.4°C (rectal measurement); his vital signs, clinical examination, and Extended Focused Assessment with Sonography in Trauma (eFAST) were normal. The second patient had a core temperature of 32.4°C (rectal measurement); he had a sinus tachycardia of 120/min, a blood pressure of 160/95 mmHg, and eFAST and full body CT were normal. Venous and arterial blood gases (not temperature corrected) are reported in Table 1. No supplemental oxygen had been given to the patients.

The first blood gas samples were taken immediately after the patients' hospital admission (Table 1). Both patients had a severe mixed acidosis, and suffered from profound hypoxia and hypercar-

* Corresponding author at: Department of Anaesthesiology and Pain Medicine, Inselspital, University Hospital, University of Bern, Bern, Switzerland.

E-mail addresses: andreas.bregenzer@insel.ch (A. Bregenzer), emilis.simeliunas@spital.so.ch (E. Simeliunas), Peter.Fiala@hospitalvs.ch (P. Fiala), Evelien.Cools@hopitalrivierachablais.ch (E. Cools).

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Fig. 1 – Overview of the accident site: ascent track (1), the avalanche site with its crown wall (2), the place where both victims were recovered at a depth of 1.5 and 2 m (3). Sastrugi, a sign of snow having been moved by the wind from the previous days and redeposited as wind slab. (4). Photo credits: Emilis Simeliunas.

bia. To our knowledge, the blood gases, are the earliest taken after an avalanche burial. One patient was not orientated but recovered within 10 min after extrication. These blood gases also show that patients were affected by the tripe H-syndrome unique to avalanche burial.² It is known that a $\text{paCO}_2 > 70\text{--}75$ mmHg can decrease the

level of consciousness, and a $\text{paCO}_2 > 100\text{--}120$ mmHg causes unresponsiveness.³

Forced air rewarming (Bair Hugger®, CE2797, 3 M Germany, GmbH) was started. Both patients recovered completely. The first patient could leave the hospital the same day, patient 2 the next

Table 1 – Arterial and peripheral venous blood gases of both patients (not temperature corrected).

	Patient 1	Patient 2
Burial depth (metre)	2	1.5
Core temperature at admission (Celsius)	32.4	35.4
Admission (peripheral venous)	pH 7.0, paO ₂ 4.1 kPa (31 mmHg), paCO ₂ 10.2 kPa (76 mmHg), BE –11.6 mmol/l. Lactate 18mmol/L	pH 7.0, paO ₂ 4.7 kPa (35 mmHg), paCO ₂ 10.6 kPa (80 mmHg), BE –10.9 mmol/l. Lactate 15mmol/L
40 min after admission (arterial)		pH 7.25, paO ₂ 12.8 kPa (96 mmHg), paCO ₂ 6.1 kPa (46 mmHg), BE –6.3 mmol/l, Lactate 5.1 mmol/l
75 min after admission (arterial)	pH 7.37, paO ₂ 9.0 kPa (68 mmHg), paCO ₂ 5.5 kPa (41 mmHg), BE –1mmol/l, Lactate 2.2 mmol/l	
2 h after admission (arterial)		pH 7.41, paO ₂ 10.0 kPa (75 mmHg), paCO ₂ 4.9 kPa (37 mmHg), BE –1.4 mmol/l, Lactate 1.4 mmol/l

day. Both patients had no sequelae, and they returned to work and their normal private lives.

Discussion

This case shows that it is possible to survive an unwitnessed, deep (>1.5 m) and long (>60 min) avalanche burial. If one comes across an avalanche with ski tracks leading into but not out of the avalanche, one should check whether anyone is buried. This rescue was undoubtedly facilitated by both victims and rescuers having avalanche transceivers and underlines the importance of being trained in avalanche rescue. Carrying relevant avalanche rescue equipment – an avalanche transceiver, probe and shovel – is essential.

A recent study of avalanches in Switzerland reported that the victim survival rate was 53.4%. Survival is dependent on burial duration and depth.^{4,5} If extrication in a critically buried victim (i.e., burial involving head and chest) occurred the 10 min after an avalanche, survival was 91%. This fell to 76% for those victims rescued within 15 min. For victims rescued between 10 and 30 min the survival rate was 31%. After 130 min of burial, the chance of survival is 7.3%.⁴

Studies describe a difference between immediately initiated rescue by companions and organised rescue organisations.^{4,6,7} Our case report is different, the rescue was not performed by witnesses, nor by an organised rescue organisation but by back country skiers who discovered the avalanche site approximately one hour after burial. Asphyxia (approximately 70%) and trauma (20–30%) are the most important causes of death following avalanche burial.⁴ Though suffering a long burial (>60 min), these victims had an air pocket and no trauma, which explains their survival after 60 min of burial. The longest reported avalanche burial for a patient who survived with a good neurological outcome is 7 h.⁶ Burial depth is another important independent factor for avalanche survival. Persons who are buried more deeply under the snow have less chance of survival. Not only does extrication take longer but victims are more likely to asphyxiate.^{5,6,8} Our patients were located above each other, at a burial depth of 1.5 and 2 m. Could this have been a factor in helping their survival?

Without an air pocket, survival is not possible in victims buried for longer than 60 min.⁶ Severe asphyxia may still occur in the presence of an air pocket.⁶ Even with the presence of an air pocket, there is a rapid decline in arterial oxygen saturation and increase of end-tidal carbon dioxide.⁹ One of our patients was disorientated at extrication and on arriving at the hospital. This disorientation improved quickly within 10 min. This seems very likely to be due to the hypercapnia which developed during avalanche burial.^{9,10}

Survivors of avalanche burial are mostly mildly (35–32°C) to moderately (32–28°C) hypothermic, as were our victims.⁸ The published cooling rates for critically buried victims not in cardiac arrest are variable, ranging from low values of between 0.3 and 0.6°C/h,^{6,11} to extremely rapid cooling rates of between 6 and 9°C/h.¹² If the group of backcountry skiers who rescued the two victims had not have arrived, the family of the victims would have probably alerted the rescue services in the evening when the victims didn't return from their tour. With such a longer burial time – perhaps 6–8 h – not withstanding an increased likelihood of asphyxia, severe hypothermia and most probably hypothermic arrest would have complicated the eventual rescue. It is important to consider all means possible to pass the information that an avalanche burial has occurred at the earliest stage rather than be lucky with the fortuitous sequence of events that occurred in this case.

Limitations

This is a retrospective report of two cases, with some missing data, such as the correlation between blood gases and core temperature. However, in the literature, we didn't find other cases which described an intact survival after an unwitnessed deep and long avalanche burial.

Conclusion

This avalanche accident happened in the Swiss Alps in February 2025. It shows, that surviving an unwitnessed, deep (>1.5 m) and long (>60 min) avalanche burial is possible. Thanks to the reaction of another group of backcountry ski tourers that fortuitous came across to the avalanche site, the buried persons were located and extricated with no sequelae.

This case underlines that an avalanche should be checked for buried victims if ski tracks disappear in the avalanche. Finally, the efficient rescue emphasised the importance of carrying avalanche rescue equipment and having the corresponding training.

CRedit authorship contribution statement

Andreas Bregenzer: Conceptualization, Data curation, Investigation, Resources, Writing – original draft, Writing – review & editing.
Emilis Simeliunas: Conceptualization, Data curation, Investigation,

Resources, Visualization, Writing – original draft, Writing – review & editing. **Benjamin Zweifel:** Investigation, Writing – original draft, Writing – review & editing. **Peter Fiala:** Data curation, Writing – original draft, Writing – review & editing. **Peter Paal:** Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Oliver Reisten:** Supervision, Writing – original draft, Writing – review & editing. **John Ellerton:** Writing – review & editing. **Evelien Cools:** Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author details

^aAnaesthesiology, Klinik für Anästhesiologie und Schmerztherapie, Universitätsspital Bern, Bern, Switzerland ^bAir Zermatt AG, Zermatt, Switzerland ^cAnaesthesiology, LUKS Sursee, Switzerland ^dAir Zermatt, Zermatt, Switzerland ^eAvalanche Forecaster, WSL Institute for Snow and Avalanche Research SLF, Switzerland ^fAnaesthesiology and Intensive Care, Spitalzentrum Oberwallis, Air-Zermatt, Zermatt, Switzerland ^gDepartment of Anaesthesiology and Intensive Care Medicine, St. John of God Hospital, Paracelsus Medical University, Salzburg, Austria ^hChefarzt Rettungsdienst, Solothurner Spitäler AG, Air Zermatt, Zermatt, Switzerland ⁱPresident, Medical Commission, International Commission for Alpine Rescue, Switzerland ^jAnaesthesiology, Hôpital Riviera-Chablais, Rennaz, Switzerland

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