BURIAL DURATION, DEPTH AND AIR POCKET EXPLAIN AVALANCHE SURVIVAL PATTERNS IN THE ALPS

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ABSTRACT: An avalanche survival curve is graphical illustration of survival probability of complete avalanche burial as a function of time. The purpose of the study was to calculate the first Austrian avalanche survival curve and update a Swiss curve to explore survival patterns in the Alps and to understand which local factors affect survival patterns in other regions or how they contribute to understanding survival patterns in similar regions. Avalanche accidents occurring between 2005/06 and 2012/13 in Austria and Switzerland were collected. Extrication and survival curves were calculated using the Turnbull algorithm. 633 of the 796 completely buried victims were included (Austria n=333, Switzerland n=300). Overall survival was 56% (Austria 59%; Switzerland 52%; p=0.065). The survival curves were similar and showed a rapid initial drop in survival probability and a second drop to 25–28% at ca. 35 min burial, where an inflection point exists and the curve levels off. Both duration of burial and burial depth had an independent effect on survival. Victims with an airpocket were more likely to survive, especially if buried >15 min. Survival curves resembled those previously published and support the idea that underlying survival patterns are reproducible.

KEYWORDS: survival probability, survival curve, extrication curve, Turnbull estimation

1. INTRODUCTION

An avalanche survival curve represents cumulative survival probability during complete burial as a function of time. The first survival curve was published for a wider audience in English in 1994 (Falk et al., 1994). To explore whether these results were applicable to other regions, the first regional comparison was published in 2011 using updated Swiss data and Canadian data (Haegeli et al., 2011).

Despite widespread interest in the avalanche community, an in-depth explanation of avalanche survival curves has never been published and additional regional comparisons are still in progress. The purpose of the study was to calculate the first Austrian avalanche survival curve and update a Swiss curve to explore survival patterns in the Alps and to understand which local factors affect survival patterns in other regions or how they contribute to understanding survival patterns in similar regions.

2. MATERIALS AND METHODS

Avalanche accidents occurring between 2005/06 and 2012/13 in Austria and Switzerland were collected and completely buried victims (i.e., burial of the head and chest) in open terrain and known outcome (survived or not survived) were included in the analysis. The variables included year, duration of burial, burial depth, presence of an air pocket (i.e. any space no matter how small in front of the mouth and nose with a patent airway) and survival.

Extrication and survival curves were calculated using the Turnbull algorithm for doubly-censored data (Turnbull 1974). Specifically, the Turnbull algorithm is a non-parametric estimation procedure. The minimum requirement is complete data on duration of burial and survival status at extrication

More details about Materials and Methods can be found in the recently published article (Procter et al., 2016).

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3. RESULTS

633 of the 796 completely buried victims were included (Austria n=333, Switzerland n=300). Overall survival was 56% (Austria 59%; Switzerland 52%; p=0.065). The survival curves were similar. Specifically, initially the avalanche survival curves showed a rapid drop in survival probability from 100% to 87-91% (after a burial duration of only ca. 7-10 minutes in the latest curves compared to ca. 18 minutes in the earliest ones). However, after this initial drop, a second drop to 25–28% survival probability occurs after a burial duration of ca. 35 minutes, at which point an inflection exists and the curve levels off until 180 minutes.

Both duration of burial and burial depth had an independent effect on survival. Specifically, mortality was 18 times higher if buried 36–60 minutes and 29 times higher if buried >60 minutes compared to ≤15 minutes; mortality was almost 5 times higher if buried >120 cm compared to ≤40 cm.

A sub-analysis of the Austrian data showed that survival was higher in patients with an air pocket compared to those without. Of the patients buried ≤15 minutes, 95% with an air pocket survived compared to 69% without. Of the patients buried >15 minutes, 67% with an air pocket survived compared to 4% without.

More details about Results can be found in the recently published article (Procter et al., 2016)..

4. DISCUSSION AND MAIN CONCLUSION

Our latest avalanche survival curve from Switzerland (data from the period 2005 and 2013) were similar to both the survival curve published previously using an older data set from the same country (data from the period 1980 and 2005) (Haegeli et al., 2011), and to the one using data from Austria (data from the period 2005 and 2013). Survival curves resembled those previously published and support the idea that underlying survival patterns are reproducible. Overall, the results are in accordance with current recommendations for management of avalanche victims (Truhlar et al., 2015). However, despite the presence of an air pocket a positive prognostic marker for survival, the airway patency is the preferred parameter. Our results showed that survival was higher in patients with an air pocket compared to those without. We could hypothesize that an air pocket may prevent hypoxia and thus a normothermic cardiac arrest due to asphyxia, and its reintroduction should be consider in future update of recommendations.

Our study showed for the first time that avalanche mortality is not only a function of duration of burial, but also burial depth had an independent effect on survival.

Avalanche survival, as shown also by the latest avalanche survival curves, depends largely on the immediate extrication of completely-buried avalanche victims by bystanders before HEMS crew arrival. The expedient companion rescue within a few minutes is critical for survival.

CONFLICT OF INTEREST

None of the authors has a conflict of interest.

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