AVALANCHE TRANSCEIVER USE AMONG BACKCOUNTRY TRAVELERS IN SAN JUAN MOUNTAINS, COLORADO, USA

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ABSTRACT: Carrying an avalanche transceiver as part of standard avalanche safety gear during backcountry recreation or travel can increase the chances of rescue while lessening the risks of morbidity and mortality. A current literature search regarding usage practices for transceivers reveals a paucity of published studies. The aim of this observational study was to determine how many backcountry travelers entering a popular recreation area on the east side of Red Mountain Pass on a certain day had a detectable transmitting transceiver.

A trained observer stationed himself 350 meters up trail from the trailhead, and 10 meters lateral to the trail. The observer was visible to each traveler. This site is just beyond the second officially named avalanche path, which has been known to slide many winters, sometimes covering the trail.

There were 62 unique persons who ascended past the observation point over the course of the continuous 9 hour observation period. 54 (87%) emitted a detectable transceiver signal. A 95% Confidence Interval for this proportion is 76.15% to 94.26%.

At this site on this date, the vast majority of backcountry travelers carried avalanche transceivers which were transmitting before the persons passed the observation point. Regarding this one item of the advised winter backcountry travel standard set of equipment of transceiver, probe pole, and shovel, a high rate of use of this safety gear was detected.

KEYWORDS: safety equipment, decision making, recreation, education

1. INTRODUCTION

Over the avalanche seasons of 2009-2010 up to and including 2022-2023, an average of 24 people died in avalanches each year in the United States, while most non-fatal avalanches are not reported (Colorado Avalanche Information Center, 2023). Over those same 14 winters, an average of 27% of those avalanche fatalities occurred in Colorado, the most of any state in the U.S.(CAIC, 2023.) Use of avalanche transceivers is noted as being associated with significantly shorter duration of burial and with a reduction in relative risk of mortality for victims, that reduction in risk of mortality varying from 74% (Brugger et al. 2007) to 50.4% (Hohlrieder et al. 2005), the latter of which was specific to backcountry victims.

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Definitions published in recent years for minimum standard safety gear for backcountry winter travel sometimes include items such as an airbag device (Marengo et al. 2016) or Avalung rebreathing device (Fitzgerald et al. 2016), or behaviors such as traveling with a partner (Silverton 2007), but most definitions first list a transceiver, probe pole, and shovel (e.g., Nichols et al. 2018; Marengo et al. 2016; Ng et al. 2015; Procter et al. 2012).

To ascertain the patterns of use of transceivers carried by backcountry travelers, previous studies have used a wide range of means and methods. These have included interviews conducted by interns (Thomas 2018), written surveys presented either to recruited participants at trailheads and out-ofbounds resort gates (Silverton et al. 2007) or to avalanche training course participants (Margalef and Esteban, 2013), written surveys combined with GPS tracking from units loaned to lift-served out-of-bounds participants (Sykes et al. 2018), combinations of self-report surveying combined with interview-style surveying (Fitzgerald et al. 2016; Procter 2012,

2014), purely online questionnaires using recruitment via a mountain safety nonprofit group's website and social media page (Marengo et al. 2016), and a prototype wireless embedded automatic counting system installed at a resort's lift-served backcountry access gate (Rubin et al. 2012).

While transceiver use has been found to be associated more with reductions of burial time than with actual decreases in mortality, Hohlrieder (2005) surmised that the reduction in mortality would likely be far more pronounced in remote areas than was found in the region of highly efficient rescue service in the Austrian Alps where his team had conducted their analysis of the transceivers' impacts on mortality rate reduction. The site of the study which is the subject of this paper, Red Mountain Pass and surrounding regions, fits the description of being more remote from rescue services. To illustrate this fact, since at least 2021 the four counties (San Juan, Ouray, San Miguel, and Hinsdale) whose borders adjoin in these peaks have jointly erected signs stating "Entering Remote Area…EMS Response May Be Limited."

Literature searches of PubMed, American Institute for Avalanche Research and Education (AIARE), and National Avalanche Center staff resources, all regarding transmitting transceiver use, found no studies to have been performed in the San Juan Mountains of Colorado, USA.

This observational study was planned and performed to determine rates of transmitting transceiver use as avalanche safety equipment on one particular weekend day at this popular, rather remote backcountry entry site, conducted in full view of and within earshot of these winter backcountry travelers.

2. METHODS

As a solely observational study, this purposefully did not involve either photography of persons or any engaging in questioning of them, partly as it was believed that an attempt to first gain consent could possibly alter behavior. The protocol was reviewed by an expert in research ethics and felt not to require Institutional Review Board approval. It was also reviewed by the representative of the San Juan National Forest, on whose county's road this winter trail exists, and was determined by them to not need any permission to conduct as described.

A convenience sample consisted of every person entering the most commonly used access point for winter recreating on the east side of Red Mountain Pass during a continuous nine hour period on Saturday, 18-March-2023, beginning at 9:30 a.m. LT. Inclusion criterion was simply the act of entry onto this trail at this trailhead by any and all persons by any means, whether on skis, snowshoes, snowmobiles, or other trackdriven machines. No person was on foot, as snow conditions precluded that mode of travel.

2.1 Study's design details

This study was designed with the intent of taking place during conditions of CAIC avalanche rating levels and weather elements which would be expected to attract a wide range of backcountry recreationalists, from relative beginners to experts. This date chosen did fit most of such criteria regarding avalanche danger rating, weather, forecast wind speeds below 24 km h^{-1}, and a weekend day preceded by a day of minimal snow and wind, occurring just after a 30-60 cm snowfall.

A day of Moderate danger rating was sought because previous studies have shown that most avalanche fatalities in Colorado, as well as most avalanche accidents in Tyrol, Austria occur during avalanche danger ratings of either Moderate (Level 2) or Considerable (Level 3) (Logan and Greene, 2018; Rainer, et. al., 2008, respectively). A Moderate rating day was preferred over Considerable in hopes of including the aforementioned wider range of participant skill levels.

2.2 Avalanche danger ratings issued by CAIC at 4:30 p.m. LT on day prior to the study

After 30-76 cm of snow were reported by CAIC as arriving two days prior to the study, Moderate was the avalanche danger rating posted as applying to the day of study, for the three elevation bands labeled Below Treeline (BT), Near Treeline (NT), and Above Treeline (AT).

Two problem types were listed as present in the ratings. The first of these was Storm Slab, with

the compass rose indicating Northwest, North, and Northeast facing slopes at all three elevation bands. Likelihood was listed as Possible, with size listed as Small to Large.

The second of the problem types listed for that day of the study was Persistent Slab. Here the compass rose indicated West through North through East at NT and AT elevation bands, with likelihood as Possible, and the size as Large to Very Large.

2.3 Weather forecast issued by CAIC 5:49 a.m LT on day of the study

Within the forecast labeled for Red Mountain Pass, temperature was listed as -8 C to -5 C; wind was listed as 16 km h^{-1}; wind direction as west-northwest; sky cover as mostly clear; anticipated snow accumulation was listed as 0 to 2.5 cm.

2.4 Actual weather conditions on day of the study

Weather conditions can reasonably be expected to significantly impact some recreationalists' decisions regarding whether or not to undertake winter outings in the backcountry. Therefore, the actual weather conditions existing at the trailhead on the day of the study are listed here, as noted by the observer. When the observational study began at 9:15 a.m. LT on 18-March-2023, air temperature at site was measured at -18 C. Wind speed was negligible. Sky was clear. Many parking spaces for the trailhead were available at that time in the morning, which is noteworthy because this trailhead is not within walking distance of any lodging near U.S. Highway 550, which is the only access road in winter, and most or all of these spaces have sometimes been found to be filled by midday on weekend days.

2.5 Regarding exclusion of considering phone apps as substitutes for transmitting transceiver use

Due to unreliability of cellular phone based apps for avalanche victim location (Floyer et al., 2014), this observational study relied solely on searching with the standard 457KHz transceiver to determine whether or not each passing person was carrying a transmitting transceiver.

2.6 Selection of site for observation station

The access trail for this observational study follows what in summer is San Juan County Road 14, and the observer stationed himself 350 meters from the trailhead, and 10 meters lateral to the trail. The observation site is just beyond the second officially named avalanche path (Scott, 2007) which has been seen to slide during many winters, sometimes covering the trail (author's personal observations, annually every winter 1988/1989 through 2022/2023). This avalanche path is clearly visible from the trail, and its slope angle is greater than 35 degrees (CalTopo, 2023), a measurement confirmed by use of an inclinometer (Life-Link Slope Meter) on site.

2.7 Observer, equipment type, and precautions against electromagnetic interference with searching

The observer was AIARE Level 1 and Level 2 trained, and experienced with and using a BCA Tracker3 transceiver, containing a pair of new, identical age alkaline Duracell batteries, showing 99% charge in the transceiver, with

“search” mode continuously activated. As each traveler approached on the trail from below and passed, the observer manually recorded these data: the presence and number of persons; the number of any canines; the presence or absence of transceiver signal; whether any transceiver was visibly attached to any canine; apparent gender of person; apparent number of persons in any group; and mode of travel.

By design, care was taken to insure that the observer's transceiver, being constantly in search mode, was kept much farther away than the proscribed 50 cm distance from all electronics, metals, and magnets, as per CAIC "transceiver interference" images seen on their website 12-February-2023. There were neither heated gloves, heated socks, foil-lined clothing, digital/analog/VHF radios, metal zippers, cameras other than in the cellular phone, nor magnetic jacket closures at the observation site. His only electronic devices at the observation site (other than the searching transceiver) were a vehicle key fob, a Garmin Mini InReach satellite phone, an electronic wristwatch, a headlamp, and his cellular phone, all of which remained in his pack more than one meter away.

3. RESULTS

There were 62 unique persons who ascended past the observation point over the course of the

continuous 9 hour observation period. Of this sample (n=62), it was found that 54 (87%) emitted a detectable transceiver signal. Five (8%) emitted no detectable signal. Three (5%) could not be clearly distinguished as having a detectable signal or not, due to traveling within arm's reach of one another in groups of four to five persons. Group size ranged from one to nine persons. Ten of these groups consisted of a single person. The gender of each of the five persons emitting no detectable signal was male. Four of these five appeared to be traveling solo.

3.1 Statistical analysis

Statistical analysis for a 95% Confidence Interval representing the proportion of all individuals that had a detectable signal is 76.15% to 94.26%. Thus, it is statistically significant that the majority of these backcountry travelers had a detectable transceiver signal. Applying a two-sample proportions test with continuity correction concluded that there is no significant difference comparing men and women transmitting a detectable signal, despite the fact that all five individuals without a signal were men (p=0.5808). 4. DISCUSSION

4.1 Application

A statistically significant number of the observed winter backcountry travelers were found to be carrying a transmitting transceiver in known avalanche terrain at that site on that day. This suggests that the message regarding the importance of carrying and using such a device may be getting through to at least some subsets of the winter backcountry recreation population, some of the time. The design of this purely observational study enabled the gathering of these data without interfering with the travelers in any manner. This was done without slowing them down or delaying their opportunities to fulfill their assumed hopes of getting as much time as possible to be recreating on the snow, as opposed to being asked to give even a few minutes of their time to an interview or written survey.

These high levels of participation in the act of wearing transmitting transceivers may or may not be representative of other regions' populations of current winter backcountry travelers. Practical significance may be present in representing a modicum of encouragement regarding the current effectiveness of this public health advice topic.

Findings of this study can be compared to other published studies involving levels of participation in transceiver use among backcountry skiers and snowboarders, in which rates range from findings of a low of 34% (Margalef and Esteban, 2013) to a high of 98% (Silverton, et al., 2007). Each of those studies gathered its data based on face to face surveys with participants.

A notable finding is that the rate of use of transmitting transceivers showed no statistically significant difference when compared by gender, even though all five individuals without a detectable transmitting transceiver signal were men.

Though on a very small scale, this model of an observational study demonstrates how one element of behavior in user habits can be gathered with existing technology already possessed by backcountry enthusiasts, no or minimal funding, and without needing access to a large group of volunteer interviewers to perform any single study, although those such studies can clearly gather data on many more elements of avalanche rescue preparedness which are important as well.

4.2 Limitations

Other important behaviors and devices do affect the timely finding and freeing of the head and chest of a buried avalanche victim other than the single element about which data were gathered in this study, it is straightforwardly acknowledged. The design of this study purposefully did not include nor permit any attempts to communicate questions to the study's subjects regarding anything about their extent or type of previous backcountry travel experience, any AIARE avalanche training of Level 1 or both Levels 1 and 2, presence or absence of releasable bindings or airbag device or Avalung rebreathing device, commitment to travelling with a partner, nor the regularity of practice (or lack of it) each season with any transceiver.

Neither were any data gathered about the level of knowledge of the study's subjects regarding that day's nor the prior day's CAIC avalanche danger ratings, nor about how much esteem or value any persons place on the CAIC's informational products, whether a little or a lot. By only gathering data on presence or absence of a transceiver signal, large gaps exist about users' awareness of or their routine travel practices in regards to possible electromagnetic

interference when a transmitting transceiver is carried closer than 20 cm to anything electronic, metallic, or magnetic. Similarly, the

ability to employ effective techniques of shoveling or probing were not able to be assessed in a study such as this. How many of them had performed an initial transceiver test that morning with the other members of their group was also an important behavior that was not the focus of this study.

The chosen method of convenience sampling limited the value of this study to one very specific area, albeit the typically most heavily used trailhead for winter recreation in the Red

Mountain Pass area. Sampling of the transceivers of travelers on the opposite side of the pass, or sampling on weekdays instead of the weekend, may have obtained different results.

It is also entirely unknown as to how reproducible these findings from this type of observational study would be in other populations, such as among certain age groups younger or older; or more urban than rural backcountry travelers; or among more- versus less-experienced winter recreationalists; or in the many important winter backcountry areas of other parts of Colorado, the U.S., and other continents.

determination of the presence or absence of shovels and/or avalanche probes, and the subjects' experience with and

5. CONCLUSIONS

This study gathered information on patterns of use of transmitting transceivers by individuals passing below avalanche prone slopes of 35 degrees or more, while entering a winter backcountry area for recreation. An observational study conducted in full view of and within earshot of the travelers, it found that the vast majority of these travelers carried avalanche transceivers which were transmitting before the persons passed the observation point. Regarding this one item of the advised winter backcountry travel standard set of equipment of transceiver, probe pole, and shovel, a high rate of use of this item of safety gear was detected.

6. ACKNOWLEDGEMENTS

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7. DISCLOSURES

No situations and/or relationships exist to create bias on the part of the author.

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