

AVALANCHE RESCUE: THE UNITED STATES EXPERIENCE, 1999/00 TO 2008/09

Dale Atkins\*  
RECCO AB

**ABSTRACT:** Avalanche accidents and fatalities have been increasing over the years, and experience continues to show time as the enemy of the buried avalanche victim. A review of more than 300 buried avalanche victims during the 10-year period of 1999/00 to 2008/09 shows a buried victim's chance for survival also depends on the type and method of rescue, which affect the speed of the rescue. It is well known that most survivors of avalanche burials are found by companions; however, the statistics are discouraging as only 56% of buried companions survived. The number of victims rescued alive by organized rescue teams has increased notably — from 8% to 10% — from the 1990s; however, as companion rescue skills improve, organized rescue is becoming important not only in finding people, but in a new role of providing medical care and evacuation. With faster response times by organized rescue teams and more people recreating in avalanche terrain, more parties having suffered an accident are finding themselves helped by other recreational groups or fast-responding rescue teams blurring the classic roles of companion and organized rescue. Rescue techniques are important for speedy rescues and saving lives. Results from different techniques — beacons, dogs, probes, Recco, etc. — are presented from the 10-year period. With the information learned from actual avalanche rescues, specific recommendations are made to assist both recreationalists and professional (including non-paid) rescuers in preparing for and providing avalanche rescue.

**KEYWORDS:** avalanche, incident, rescue, self rescue, companion rescue, organized rescue, injuries, deaths

## 1. INTRODUCTION

During Hannibal's crossing of the Alps into Italy in late 218 BCE his forces likely arranged the first *organized* avalanche rescues after snow was reported to have dragged many soldiers in to "abysses" and snow "falling rapidly from the high summits engulfed the living squadrons." Two thousand years ago, Strabo wrote about how mountain travelers could use staffs that could be pushed up through the snow when was was buried (Fraser, 1966). It's likely the travelers also figured out the staff could be used as a probe pole to find a buried campion, too. The first rescue service is attributed to Bernard of Menthon (later to become Saint Bernard) who in 962 CE founded a monastery now known as the Great St. Bernard Hospice (Fraser, 1966). In the Middle Ages the populations of alpine valleys swelled and so to did mountain warfare, and avalanche catastrophes occurred in villages and to armies. In 1718 the residents of Leukerbad (Wallis, Switzerland), a village ravaged by avalanches for centuries, used rods to probe for the buried victims after two

avalanches killed 52 people. Organized rescue was likely forced onto Napoleon's generals who no doubt had to coordinate rescue efforts when "whole squadrons" were swept away by avalanches in 1800. In World War I managed and coordinated rescues became a necessity when avalanches became a weapon of war. Today, a century later, the roots of organized rescue can be traced to WWI veteran Christian Jost who in 1927 founded the Parsennendienst, a Swiss ski patrol above Davos. While rescue coordination has changed dramatically over the millennia, the basic tools of avalanche rescue — probe and dog — are centuries old. Today's organized rescue teams still rely on these olden tools to find more than half of their buried avalanche victims!

Recent technologies and new technologies (perhaps not yet even applied or discovered) have created opportunities for rescuers to make a difference. But to appreciate new technologies, rescuers need insight to current technologies. In 2007 Atkins identified how outdated attitudes about organized rescue still guide and affect current avalanche rescue responses. This report summarizes the methods and technologies used in avalanche rescue, and discusses some developing trends and lessons learned from US avalanche rescues.

## 2. RESCUE DATA

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\*Corresponding author address: Dale Atkins  
RECCO AB; 952 Utica Circle, Boulder, CO  
80304, USA; tel, 303-579-7292; e-mail:  
dale.atkins@recco.com

The data used in this report comes from many sources including the Colorado Avalanche Information Center (CAIC), Westwide Avalanche Network (avalanche.org), Cyberspace Snow and Avalanche Center (csac.org), avalanche information and forecast centers, mountain rescue teams, ski patrols, and the author. Sources included official and unofficial accident reports, news media, and first-hand accounts by rescuers and companions.

More than 400 avalanche rescues going back to the winter of 1999/00 were reviewed, and data were collected on 346 buried avalanche victims. Before presenting results a word of caution about the following rescue statistics is necessary.

Most avalanche accident reports contain little detail about the actual rescue. Accurate times are provided infrequently about the actual duration of the search. Documented times tend to be those when the subject was found, not necessarily how long it took to actually search for the subject. Also numerous “organized” search efforts extend into a second or third day (or longer), but the actual time spent searching is much less than the overall incident time. For example, it is not uncommon for a dog or Recco detector to be tried for the first time days after the accident, then to find the victim in minutes. These differences in search times versus incident times, do not always portray an accurate picture of the search effort, but the information can still provide some valuable insights. To ensure better quality statistics all avalanche rescue efforts should be documented and reported to the Colorado Avalanche Information Center.

### 3. RESULTS

#### 3.1 *Type of Rescue*

A buried victim’s chance for survival directly relates not only to length of time and burial depth but also to the type of rescue (Table 1). Obviously, buried victims rescued by party members or by another nearby group have a much better chance

of survival than those found by organized rescue groups. Usually organized rescue teams are at a disadvantage because of travel time.

Of all those found alive, *companions* rescued 80%; an *organized rescue teams* rescued just 10%, which has risen 2 percentage points in the last two years. Of those found by *organized rescue*, five burials were within ski areas or just beyond their boundaries, so rescues were made quickly. One 5-hour burial involved a person buried in their destroyed home. The seven other rescues were in the backcountry, and three had survival times of greater than 6 hours, including 1 for 24 hours, 6 others were in the backcountry.

When read from right to left, Table 1, infers strongly that one’s best chance of live recovery is by their companions. However, when Table 1 is read vertically the statistics become discouraging. Of those *found by companions* only 56% (101 of 180) were found alive. One’s chances of being found alive by their companions are only slightly better than 50/50.

Table 1, also shows that some buried victims are able to *self rescue*. These lucky people tend to incur short-time and shallow-depth burials. Most were buried for 5 minutes or less and covered with 30 cm or less of snow. Two victims were buried for 30 minutes, including one buried a reported 1.2 m, and another victim escaped after 23 hours.

#### 3.2 *Rescue Methods*

Tables 2a and 2b describe the method of rescue for 322 buried avalanche victims during the past 10 years. Both tables present the same data: Table 2a provides an overview; while Table 2b gives detail to the type of rescue.

Sixty-eight percent of victims who were buried with a body part, like a hand or foot, or an attached object, like a ski tip, protruding from the snow were found alive (46 of 68). Of these fatalities some were traveling solo. In several other incidents the visual search was abandoned prematurely to seek

	<i>self rescue</i>	<i>found by companions</i>	<i>found by organized rescue team</i>	<i>total</i>
alive	12 (10%)	101 (80%)	13 (10%)	126
dead	—	79 (37%)	134 (63%)	213

Table 1. Type of rescue for buried avalanche victims in direct contact with snow, 1999/00–2008/09.

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<i>Method</i>	<i>Found Alive</i>	<i>Found Dead</i>	<i>Total</i>
Attached object or body part	46	22	68
Spot probe	5	16	21
Coarse or fine probe	1	52	53
Rescue transceiver	44	68	112
Avalanche dog	1	32	33
Voice	11	0	11
Other (digging, RECCO)	2	4	6
Found after a long time span	–	10	10
Not found, not recovered	–	3	3
Inside vehicle	2	0	2
Inside structure	1	3	4
<b>Totals</b>	<b>113</b>	<b>210</b>	<b>323</b>

Table 2a. Rescue method for buried avalanche victims, 1999/00–2008/09.

<i>Method</i>	<i>Found Alive</i>		<i>Found Dead</i>		<i>Total</i>	
	<i>Companion</i>	<i>Organized</i>	<i>Companion</i>	<i>Organized</i>	<i>Companion</i>	<i>Organized</i>
attached object or body part	42	4	11	11	53	15
spot probe	1	4	5	11	6	15
coarse or fine probe	1	–	9	38	10	38
rescue transceiver	41	3	52	16	93	19
avalanche dog	1	–	–	32	1	32
voice	11	–	–	–	11	–
other (digging, recco)	2	–	–	4	2	4
found after a long time span	–	–	–	10	–	10
not found, not recovered	–	–	–	3	–	3
inside vehicle	1	1	–	–	1	1
inside structure	–	1	–	3	–	4
<b>sub totals</b>	<b>100</b>	<b>13</b>	<b>77</b>	<b>13</b>	<b>177</b>	<b>146</b>
<b>Totals</b>	<b>113</b>		<b>211</b>		<b>323</b>	

Table 2b. Rescue method by type of rescue for buried avalanche victims, 1999/00–2008/09.

organized rescue. When rescue teams arrived they found a skis or hand sticking out of the snow.

The *avalanche transceiver* has been used to find more victims in the past 10 years than any other method, and the use of transceivers reveals both good and bad news. A transceiver is the best method for a companion to find a completely buried victim. But, the bad news is the survival rate in transceiver rescues has dropped from 50% in 2005 to 39% (44 of 112) in 2009. Prior to the introduction of digital-display transceivers the survival rate with transceivers was 38% (Atkins, 1999). The reason for this decline back to 20th-century levels may be the result of inexperienced

users, and users taking greater risks because they are wearing a transceiver. I surmise the latter is the main cause.

Organized probe lines (*coarse and fine*) have recovered the next greatest number of buried victims (53), but because of the time required, nearly all (98%) were recovered dead. Only one person was found alive (by companions, actually from another group) with this method, 52 were recovered dead.

Despite the insulating properties of snow, 11 victims buried shallowly were able to yell and be heard by their rescuers (*voice*).

The *other* category includes victims found by digging, a magnetometer (located a snowmobile and rider was next to machine), and a Recco detector (located a snowmobile and rider was next to machine, found a victim with a turned-off transceiver, and located a buried in-area skier).

The last live rescue in the US by a trained avalanche rescue dog was in 1994. Since then two pets have made live rescues of their masters, including the last one in 2002. The median burial depth of dog rescues is 1 meter, and the maximum depth was 3 meters. It is important to note that rescue dogs were also tried unsuccessfully in at least 19 rescues.

For 10 victims, the rescue was called off after several days. The bodies were recovered weeks to months to more than one year after burial.

In the category *not found, not recovered*, three victims were not found. Each victim was swept down into glacial crevasses.

### 3.3 *Burial Depth*

The majority of buried victims are within 1 meter of the surface. Nearly 97% are within a typical probe pole length – 3 meters – from the surface (Table 4.). Prior to 2004 no one in the US – in direct contact with snow – had survived a burial greater than 1.8 meters. Since 2004, four people have survived deeper burials. Perhaps fast rescues and efficient digging strategies have helped.

	<i>burials</i>
<i>N</i>	278
mean	1.10
stdev	0.77
median	0.91
max	6.10
min	0.30

Table 3. Summary statistics for avalanche burials.

<i>burial depth</i>	<i>frequency</i>	<i>percent</i>
≤ 1	163	58.6%
2	87	31.3%
3	19	6.8%
4	6	2.2%
5	1	0.4%
6	1	0.4%
7	1	0.4%
total	278	100%

Table 4. Frequency distribution of burial depths, both alive and dead, 1999/00–2008/09.

### 3.4 *Burial Time*

It is well known that time is the enemy of the buried avalanche victim, and it is no surprise that people found sooner tend to survive.

	<i>burial (minutes)</i>		
	<i>alive</i>	<i>dead</i>	<i>composite</i>
<i>N</i>	110	147	257
mean	54	258	169
stdev	210	407	349
median	10	90	25
mad	5	75	20
mode	5	15	5
max	1440	1440*	1440*
min	1	5	1

Table 5. Summary statistics for avalanche burials.

(\*Note: the statistics were only computed for rescues up to 24 hours. There were 32 search and rescue efforts that ran longer than 1 day, however only in 14 incidents was the time recorded.)

### 3.5 *Rescue Time – Organized Rescue*

There is a perception that organized rescue is slow; however, of the reported accidents, the data shows 12% of victims are found in less than 30 minutes. Within 2 hours one-in-three buried victims are found, and 50% are found within 4 hours (Table 6).

<i>rescue time (min)</i>	<i>frequency</i>	<i>percent</i>
≤ 30	12	12%
60	4	4%
120	16	16%
180	11	11%
240	8	8%
300	6	6%
360	5	5%
420	4	4%
480	1	1%
540	0	0%
600	1	1%
660	0	0%
720	0	0%
1440	20	20%
2880	5*	5%
4320	3*	3%
>4320 (72 hrs)	6*	6%
total	278*	100%

Table 6. Frequency distribution of rescue time. (\*Note: the actual incident time was not reported for an additional 18 incidents, which are not included in this sample.)

Most (86%) search and rescue efforts are completed within 1 day of the accident. A notable number of accidents, however, required more than 24 hours, with up to 3 days typical. At that point search and rescue teams often suspend the search, usually to the following weekend.

	<i>minutes</i>	<i>hrs or days</i>
<i>N</i>	101	–
mean	1043	17 hrs
stdev	1900	32 hrs
median	250	4.2 hrs
max	10,080+	7+ days
min	3	0.05 hrs

Table 7. Summary statistics for time to rescue in organized rescue.

Table 7 shows that the median time to rescue is just over 4 hours. The minimum time occurred within a ski area where ski patrollers were close by.

### 3.6 Notification Devices

A generation ago, mobile (cellular) telephones were a luxury for city dwellers as mountain service was virtual unknown. In 1990 the US had 5 million cell-phone users and fewer than 5000 towers. By 2009 the US had 277 million users and 246,000 towers (Cellular-news.com, 2009). The numbers continue to grow, and mountain coverage in many areas is good; however, it is not ubiquitous.

In the past 10 years 71% of alerts were made from cell phones; in the past 5 years the percentage is nearly 90%. In at least 3 incidents buried or mostly buried victims used their cell phones to call for help. While cell (and satellite) phones will not move snow or keep someone warm, these devices are the best way to notify quickly and communicate with rescuers.

In recent years Satellite Electronic Notification Devices (SEND) and Personal Locator Beacons (PLB) are being used more often to report emergencies, including avalanche rescues. The SPOT is the best known SEND product. PLBs are more expensive and are much more likely to have false alarms. People that use these devices are urged to register their device with the proper authorities.

These devices are not perfect and have problems that can frustrate rescuers and users. Rescue teams are urged to learn as much as possible. The knowledge will help.

## 4. DISCUSSION

Because of incomplete information and data, it is not always possible to do a statistical analysis to look for valid trends in rescue. So what follows is a combination of insights and opinions based on the US avalanche rescues for the past 10 years, 1999/00 to 2008/09.

### 4.1 Survival

A disturbing trend from Tables 2a and 2b tells that from the reported accidents, survival does not favor the buried victim. The data show survival of all buried victims to be only 35% (113 of 322). When only considering completely buried victims – (no visible body parts or gear) in direct contact with the snow (not inside vehicles or structures) survival drops to 26% (64 of 249). Again, a word of caution about these statistics: the data is biased against survival. However, even if the number of saved lives were increased by 50%, more people would still die in avalanches than survive.

### 4.2 Mobile Telephones

In the past 10 years the combinations of increased winter recreation and cell phones have started to blur – in some cases – the distinctions between *companion* and *organized* rescue. In 19 incidents other nearby groups quickly rushed to the aid of a buried victim. In several of these instances some in the assisting party were trained in organized rescue and took over the search effort. Also, in at least four accidents the organized rescue team – notified by cell phone or even witnessed the avalanche – arrived before companions. In three cases (1 buried and 2 serious injured) the victims survived; in the fourth case a buried victim died. More of these situations can be expected as more people travel in the backcountry and the response by *organized rescue* gets faster. Individuals should always carry their fully-charged cell phone. This provides a group with a variety of options to place a call. Several rescue responses were hampered by people with dying cell phone batteries.

### 4.3 Satellite Electronic Notification Devices

If cellular phone service is unlikely (or unknown) SEND or PLB devices can be effective; however, a satellite phone is preferred as it allows two-way communications. As more people carry electronic notification devices, the reporting of accidents is becoming faster, and in many cases, within minutes of the accident. These devices are essential pieces of rescue gear; however, these devices should *never* be relied upon to save a life,

just as an avalanche transceiver should not be relied upon to save a life.

#### 4.4 Calling For Help

Emergency calls should always be made sooner than later, and this is critical in avalanche rescue. An avalanche accident and especially a burial is a medical emergency (ICAR/Brugger and Durr, 1999, Brugger and Durr, 2002). The International Commission for Alpine Rescue also recommends “early notification is essential, e.g., by mobile phone, satellite phone, or radio, wherever possible” (IKAR, 2006). Mobile phone connections are almost always easier to make from the tops of slopes than down low. Waiting for help after everyone has been recovered causes needless delays, and or someone with potentially life-threatening injuries the delay can be the difference between life and death.

#### 4.5 Saving Lives

Many avalanche workers consider organized rescue as ineffective in saving lives. This view is not correct and is also outdated (Atkins, 2008). Organized rescue provides another chance, and for people where companion rescue failed, organized rescue is better than no chance. Organized rescue can be critical to saving lives, especially for an injured victim, whether buried or not. The increased use of helicopters and more widespread availability of advanced life support saves avalanche victims. Avalanche educators should consider including discussion to recreational programs for how to act and work with responding rescuers and helicopters.

#### 4.6 Looking For Snowmobilers

Today’s snowmobiles can be driven long distances across large, powerful avalanches. Sometimes the riders are completely obscured by the powder cloud, so consider not only where the last seen area was, but where the rider was headed.

#### 4.7 Transceivers

Avalanche rescue transceivers are key rescue devices. However, since only 39% of users were rescued alive (Tables 2a and 2b), avalanche transceivers should not be considered “life-saving” devices. The data also shows that only 35% of avalanche victims were found because of their transceiver. This number gets boosted every year because one or two victims left their device turned off or at home (or vehicle).

#### 4.8 Dogs

Trained avalanche rescue dogs are valuable allies in avalanche search and rescue. However, experience suggests a problem. In a sizable number of rescues, skilled and practiced dogs failed to find buried victims. In addition to the 32 fatalities found by dogs (Tables 2a and 2b), trained dogs failed to find an additional 19 buried victims meaning dogs were only effective 63% of the time (32 of 51). With more than 1 in 3 rescues where buried victims were missed suggests reasons other than weather conditions or a “bad” day were at fault. Many of these dogs and handlers are very good with proven records in practice, but on real rescues, their results were poor. Handlers may want to review training methods and actions taken on rescues to improve performance.

#### 4.9 Air Bags And AvaLungs

Very few actual uses of airbags (3) and AvaLungs (5) were reported during the study period. Both devices do work, and are probably good tools for people that take greater risks. These devices do not increase safety but can reduce consequences, thus reducing risk.

#### 4.10 Recco Rescue System

The system is spreading in use in ski resorts and mountain rescue teams but has little to no support by the avalanche community. Unlike Europe, in the US, at present, 4 people (3 avalanche victims and one “lost” but buried skier) have been found with Recco. The system is effective at searching large areas quickly, especially when the subject has a Recco reflector. When searching for some other type of electronic devices (e.g., cell phones, digital cameras, gps, etc.) the possibility of detection decreases significantly but may still work.

#### 4.11 Probe Poles

Nearly one in three completely buried victims (31%) are found by using probe poles. Rescuers and educators should consider such a result disappointing because rescuers and victims must rely on 2000 year-old technology. Old technology results in long-running search operations.

#### 4.12 Survivors

A few very lucky buried avalanche victims (2%) do survive for long periods under the snow. In the past 10 years 7 victims have survived burials of at least 5 hours (5, 5, 6, 8, 10, 23, and 24 hours). As rescuers we never know when the next long-time survivor might be found.

## 5. RECOMMENDATIONS

### 5.1 *Recreationists*

- Carry mobile (or satellite) telephones or carry a SEND.
- Call for help quickly when an accident occurs.
- Carry transceiver, probe, and shovel.
- Be equipped with RECCO reflectors.
- Get emergency medical care training.
- Embrace technology *but* do not rely on it.

### 5.2 *Professional Rescuers*

- Embrace technology and know how use it.
- Avoid using probe poles, if possible.
- Do a thorough visual search of debris for clues.
- Encourage early, appropriate, notification of avalanche accidents.
- Be ready to travel further and stay out longer on rescue responses.
- Review rescue dog training and rescue responses to improve real-life performance.
- Recognize that some buried victims have survived up to 24 hours.
- Don't change hastily from rescue mode to recovery mode.
- Acknowledge that organized rescue can make a difference.

## 6. CONCLUSIONS

Hopefully information in this study can be used by rescuers and avalanche educators to be better informed when discussing and deciding avalanche rescues.

It is well known that burial statistics do not favor the buried victim – more will die than will live, so the need for fast and competent companion and organized rescue continues. When an accident does occur, speed of recovery is still the critical factor in live rescues. Because a few victims do survive for hours under the snow, no rescue should be abandoned prematurely on the assumption that the victim could not possibly be alive. No avalanche victim should ever be denied this small chance at life.

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## 8. POTENTIAL CONFLICT OF INTEREST DISCLOSURE

I, Dale Atkins, provide services to and receive compensation from RECCO AB.