Enhanced Avalanche Survival from Airbag Packs:

Why Can We Learn from the Data?

Story by Jonathan S. Shefftz

EXHIBIT 1: ABS Statistics

			(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
			Euro ABS w/airbag inflation:			Non-ABS	Colorado	Swiss 1980-99		Swiss &
(1)	Data set		Full Only	All ABS Incidents	Partial or None	Partners of ABS Users	Atkins Analysis	Reported	Estimated	Austrian (various yrs)
(2)	Caught skiers/riders		262	295	33	67	1224	2301		1469
(3)	Fatalities		7	17	10	17	109	523		278
(4)	Survival rate		97.3%	94.2%	69.7%	74.6%	91.1%	77.3%	87.0%	81.1%
(5)	Avoided fatalities	Caught	N/A		25	20	3	17	7	13
(6)	w/ABS out of 100:	Dead			81	77	35	75	56	70

NOTES:

(1) Data sets are as follows:
a, b, c, d = Compiled by SLF (through August 2010) and published on ABS Web site.
e = Compilation by Dale Atkins from CAIC data (including 205 burials).
f, g = *Avalanche Rescue Systems in Switzerland: Experience and Limitations*, Tschirky et al (2000 ISSW).
h = *The Impact of Avalanche Rescue Devices on Survival*, Brugger et al (Resuscitation 2007), net of ABS users.

(2) "Caught" as defined by data set (often not explicitly).

(3) Fatalities either in the field or after evacuation.

(4) Probability that a caught skier/rider will survive.

Fatalities that would have been avoided with ABS (at average deployment success, i.e., including both user & technical failures) out of 100:

(5) …caught skiers/riders.

(6) …dead skiers/riders.

So when are you going to get an airbag pack?

The question from my touring partner last season was not very surprising, and not only because he runs a company that makes such packs. Yet just a few short years ago, that question – especially in the US – would have been puzzling: only ABS made such airbag packs, and outside of a brief partnership with Dynafit, distribution in the US was somewhat obscure. But now for the current 2011/12 season and the upcoming 2012/13 season, airbag packs are available from four companies: ABS (with partners ARVA, Dynastar, EVOC, Millet, Ortovox, Rock Snake, Rossignol, Salewa, and The North Face), Snowpulse/Mammut, Backcountry Access, and WARY (with partner Mystery Ranch).

Airbag pack saves of avalanche victims, once relegated mainly to detailed data presentations on ABS's Web site, are now publicized on major television network shows. The evidence is compelling that airbag packs work, whether via controlled tests with dummies, the underlying phenomenon on inverse segregation/grading, or the dramatic video footage.

Cost Versus Benefit

If that is good enough for you, then you can stop reading this article right here. But the economist in me is always comparing costs and benefits. In this context, the cost of an airbag pack is not its monetary price (which although significant is nevertheless not out of place given the financial value of all the other gear we take along on any ski tour), but instead the sizable (and immediately noticeable) weight penalty. For example, for the weight differential of an ABS pack, I could bring along an AED. Or a bigger first-aid kit, or a better rescue sled system, etc. The potential benefits of such items are difficult to quantify. But for airbag packs, we do have data that can help to quantity the potential benefits.

The ABS Web site for the 2011/12 season cites a 97% survival rate. But what is included in the underlying numerator and denominator? Since 1991, the Swiss Institute for Snow and Avalanche, or SLF (part of the Swiss Federal Institute for Forest, Snow and Landscape Research), has been compiling data on ABS pack deployments. The most recent compilation is through August 2010, and the next update will be presented at the upcoming September 2012 ISSW in Anchorage.

The ABS dataset is almost entirely European: out of 249 total avalanches in the database, only 10 occurred in the United States and four in Canada. Since more avalanche incidents probably occur truly above treeline in the Alps than they do in the United States – where much of our backcountry skiing and hence avalanches are really *at* treeline and hence present the hazards for more trauma deaths – the ABS advantage might be mitigated by a higher trauma incidence. And ABS claims numerous survival advantages over its competitors. Therefore, the ABS track record in Europe might not be entirely applicable to the United States, or to its competitors' designs. And both the past 2010/11 season and the current 2011/12 season have seen successful ABS saves as well as ABS fatalities, but augmenting the data set without the kind of complete picture provided by a comprehensive SLF update is probably inaccurate. So keep all those caveats in mind throughout the numbers that follow.

Examining the Statistics

Exhibit 1 provides a summary of the ABS data set in columns (a) through (d). Row (1) provides a description of the data set, row (2) lists the number of caught skiers/riders (however "caught" may be defined), and row (3) lists the number of fatalities. (Rows (4) and (5) will be explained in due course, as will the other data sets.)

As shown in column (a), row (4), and as stated on the ABS Web site – yet without much emphasis – the 97% survival rate is only for those 262 deployments in which ABS users successfully deployed the airbags with full inflation. The full number of attempted deployments in the ABS data set is actually 295, for an 88.8% successful deployment rate (as opposed to survival rate), i.e., 262 divided by 295. Of the 33 attempted deployments that resulted in either partial or no inflation of the airbags, four were users who did not properly prepare their packs beforehand, 18 were users who were unable to deploy during the avalanche, two were users who intentionally did not deploy the airbags, seven were technical malfunctions, and two were damaged by the avalanche.

Including the unsuccessful deployments, the actual survival rate is 94.2%, not 97.3% (which is rounded down to 97% on the ABS Web site). That certainly sounds very good – although still not perfect, as almost 6% of ABS users have died when caught in an avalanche. But how much better is it than skiers/riders without airbag packs?

Column (c) addresses that question using the "natural experiment" (as we social scientists like to call it) of ABS users whose airbags failed to inflate fully. Their survival rate was only 69.7%. Another natural experiment is the survival rate of non-ABS users accompanying ABS users who were caught in an avalanche: their survival rate was 74.6%.

These sample sizes though are very small: just 33 and 67 (respectively). Tests can be performed for statistical significance to determine the probability that the survival rate differentials are attributable to random chance, but that still would not address the likely limited representativeness of such a small data set. (And other studies have already verified the statistical significance of the ABS survival rate advantage, although their data sets typically reversed the ratios, i.e., focusing on the survival rate for a small number of ABS users within a much larger population of caught skiers/riders.)

To address the non-ABS survival rate with additional data, turning to column (e), Dale Atkins (the president of the American Avalanche Association, among other qualifications too numerous to list here) has compiled his own analysis of Colorado avalanches over a time span comparable to the ABS data set, but with over four times as many caught as in the ABS data set. Out of 1224 caught skiers/riders (with most likely only a trivial percentage using ABS), Dale calculates a 91.1% survival rate.

Columns (f) and (g) provide the data for a study of Swiss avalanche victims between 1980 and 1999. This study is notable both because of the 2301-person sample size, and also because the authors attempt to estimate

EXHIBIT 2: Automobile Statistics

(1) Year		2009	1965
(2) Vehicle miles driven (millions		2,953,501	718,763
(3) Fatalities		33,808	36,399
(4) Survival rate		98.9%	94.9%
(5) Avoided deaths w/2009	Million miles	N/A	4
(6) Auto safety out of 100:	Fatalities		77
(7) Total population		307,006,550	194,302,963
(8) Miles driven per capita		9,620	3,699
(9) Fatalities per million people		110	187

the survival rate across all avalanches – both reported and unreported – based on the premise that many avalanches with caught yet uninjured skiers/riders are never reported. As shown in row (4), the survival rate among reported avalanche incidents is 77.3%, but the authors estimate that the true survival rate is a much higher 87.0%. Note that this latter figure is roughly comparable to Dale Atkins' 91.1% figure.

Column (h) is from a study of Swiss and Austrian avalanches over a similar time frame, with a higher survival rate than for the exclusively Swiss study, although with no attempted estimate at all avalanches (i.e., both reported and unreported).

The Bottom Line

And now finally for the bottom line, in the form of rows (5) and (6). But first for an excerpt from a Powder Magazine interview with Dale Atkins, which has been widely quoted as well as misquoted:

I posed the following question at the National Avalanche School: Say we had a group of 100 people killed in avalanches. If we were able to go back in time and equip each one with an airbag, how many of those lives would airbags save? The majority of people thought 30 to 50-plus lives would have been saved with airbags. This is a dangerous perception because airbags only give a slight edge to survive, but that is good enough for me. In fact, I have owned and used airbags since the mid-1990s.

When you're able to deploy an airbag it's really quite remarkable how well they do in preventing burials and reducing mortality, but there's still a significant number of people who get killed with airbags. The fact is that airbags are really only going to save three additional people out of 100. That's not really exciting news unless you're one of those three people. Then it's a really big and important deal!

The question posed at the National Avalanche School (NAS) is answered in row (6), although the 3-out-of-100 figure is actually the answer to the question posed in row (5). In other words, for row (5), imagine a region in which 100 people have been caught in avalanches. Had they all been equipped with ABS packs (with their mainly European track record through August 2010), how many fatalities would instead get to live? According to Dale's data set, that is the 3-out-of-100 figure that he cites. Using the other data sets, the figure is as high as 25 people.

But if the question is instead imagining 100 people who died in avalanches (as opposed to 100 people merely caught in avalanches, whatever the outcome), the range of 35 to 81 people actually matches up fairly well with the guessed range of "30 to 50-plus" by the NAS students.

Risk Homeostasis & Other Factors

Now for some additional caveats (as if all the preceding caveats weren't enough). Avalanche beacons over time have become both more prevalent and easier to use. (And yes, the available data and analyses do attribute a noticeable survival advantage to avalanche beacons, despite the occasional "corpse locator" derisive appellation.) Even more recently, shoveling strategies have also become better refined and publicized. All of that would be expected to increase the non-ABS survival rate – as compared to the historical track record reflected in the analyzed data sets – thereby narrowing the survival differential going into the future between non-ABS users (whose survival outside of trauma depends largely on speedy companion extrication) versus ABS users (whose advantage derives from not being buried in the first place, and hence whose survival would not be significantly improved by better beacon searching and shoveling).

Yet what about ***risk homeostasis***? What about what? Perhaps in the past when ABS bags were more rare, their purchasers were more safety conscious. But in the future, as they become more commonplace, their use could encourage more risky behavior. All of this is obviously entirely speculative, but still, as I write this right now, on one airbag company's Web site, large letters proclaim, "GO BIG AND GO HOME."

What Can Cars Teach Us?

Proponents of the risk homeostasis thesis often advance an analogy with automobile safety: automobiles have become safer over time, but we negate that advantage by driving more dangerously. It is easy to claim that, no, just because my car now has all sorts of safety features that didn't exist when I first started driving, I do not drive any faster. But think about it in reverse: picture yourself in an unanticipated early season snowstorm without your winter tires on yet, as the ABS failure light suddenly appears in a not-so-wonderful coincidence. Would you drive any more slowly than you usually do? (Yes, I happen to know the actual answer to this, as that scenario is not merely hypothetical – though the skiing sure was great once we eventually arrived at our destination!)

However, just because individual behavior might become more risky in the presence of additional safety technology does not mean that the behavior is entirely offsetting. Returning to the automobile analogy, in Exhibit 2, rows (1) through (6) provide similar data as in Exhibit 1, but for US automobile safety in 1965 and 2009, as compiled by the Bureau of Transportation Statistics (within the US Department of Transportation's Research and Innovative Technology Administration).

Instead of the figures for caught skiers/riders in Exhibit 1, row (2) in Exhibit 2 uses millions of vehicle miles driven. (Remember, advances in automobile safety prevent crashes in the first places, as opposed to airbag packs, which of course are unable to prevent an avalanche incident.) As shown in row (4), the probability of surviving a million vehicle miles has increased from 94.9% to 98.9%. Out of 100 million miles driven in 1965, that means four lives would have been saved with the 2009 survival rate. And for every 100 automobile deaths in 1965, the 2009 survival rate would have saved 77 lives. *(Note the entirely coincidental similarity of the preceding four and 77 figures with many of those in Exhibit 1.)* Out of all 36,339 automobile deaths in 1965, the 2009 survival rate would have saved 28,171 lives.

Perhaps some of this increased survival can be attributed to improved driver behavior in the form of increased awareness of the dangers of driving while intoxicated, but at the same time the dangers of driving while distracted have increased over this period. Another argument can be made that even if the survival rate has significantly improved, that improved rate just encourages us to drive more.

To address the issue of increased driving (whether more dangerously or otherwise), three additional rows augment the transportation data with population data and related calculations. Row (7) provides the total US population, allowing row (8) to calculate miles driven per capita, which in 2009 was 2.6 times the 1965 figure. Now certainly the dramatic increase in miles driven per capita is attributable to factors other than advances in automobile safety, but still, if automobile safety had not been improving so much over time, then perhaps a consequently rising death toll would have prompted further investments in inherently safer public transportation modes. Regardless, row (9) shows that automobile fatalities per million people in the US have dropped dramatically from 1965 to 2009, translating into a 41% decrease. Therefore, any risk-offsetting behavior (whether in the form of driving more dangerously or driving more miles) has been only partially offsetting, not fully.

So yes Virginia, even if Santa Claus might not really exist, technology can make us safer despite our unsafe impulses…although if I'm assigned to ski tour out to verify Santa's existence or non-existence in some snowy clime, I'm still not sure personally if I'll be wearing an airbag pack.

Jonathan Shefftz is an AIARE-qualified instructor, NSP avalanche instructor, and AAA affiliate member. When he is not searching out elusive freshies in southern New England or trying to convince skiers to run up and down ski areas in the NE Rando Race Series, he works as a financial economics consultant and has been qualified as an expert witness in both federal and state courts. Although he owns many packs, his favorite carries his toddler daughter on his back while ski touring with his wife close to home in western Massachusetts. He can be reached at jshefftz@post.harvard.edu.