

Status Report



Insurance Institute for Highway Safety | Highway Loss Data Institute

They're working

Insurance claims data show which
new technologies are preventing crashes

**SPECIAL ISSUE:
CRASH AVOIDANCE**
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An early crop of advanced crash avoidance technologies includes some clear success stories when it comes to preventing crashes, insurance claim analyses show.

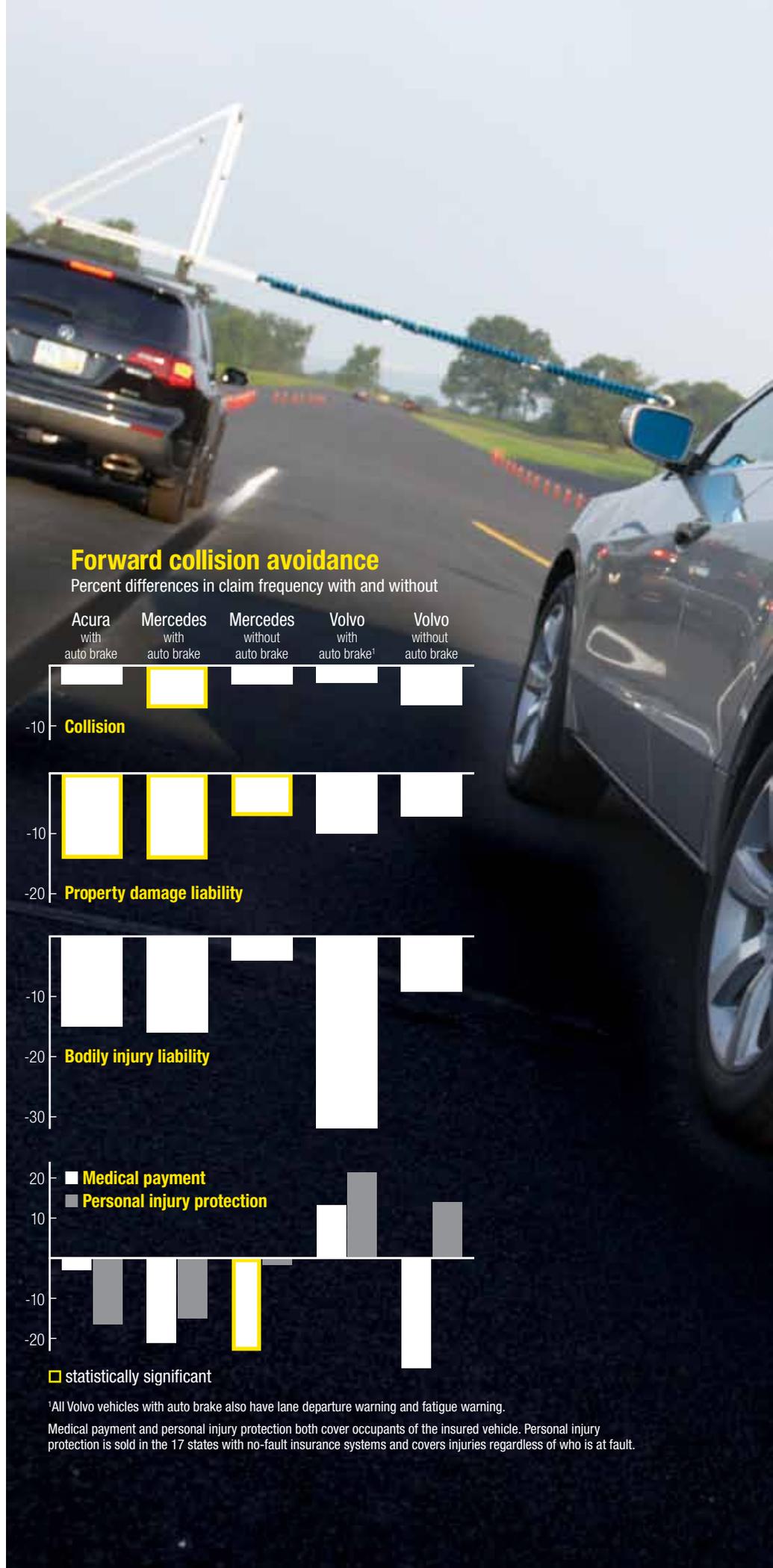
Forward collision avoidance systems, particularly those that can brake autonomously, along with adaptive headlights, which shift direction as the driver steers, show the biggest crash reductions in the studies by the Highway Loss Data Institute (HLDI). One feature, lane departure warning, appears to hurt, rather than help, though it's not clear why, and other systems aren't showing clear effects on crash patterns yet.

"As more automakers offer advanced technologies on their vehicles, insurance data provide an early glimpse of how these features perform in the real world," says Matt Moore, HLDI vice president. "So far, forward collision technology is reducing claims, particularly for damage to other vehicles, and adaptive headlights are having an even bigger impact than we had anticipated."

Last year, HLDI reported a reduction in claims from Volvo's City Safety, a forward collision avoidance system that applies the brakes automatically to prevent or mitigate low-speed front-to-rear collisions. Volvo XC60s with standard City Safety had fewer claims than other midsize luxury SUVs and other Volvos without the feature (see *Status Report*, July 19, 2011; on the web at ihs.org). Now HLDI has data on a wider group of features, including some that could have an impact on more serious crashes than the low-speed fender-benders prevented by City Safety.

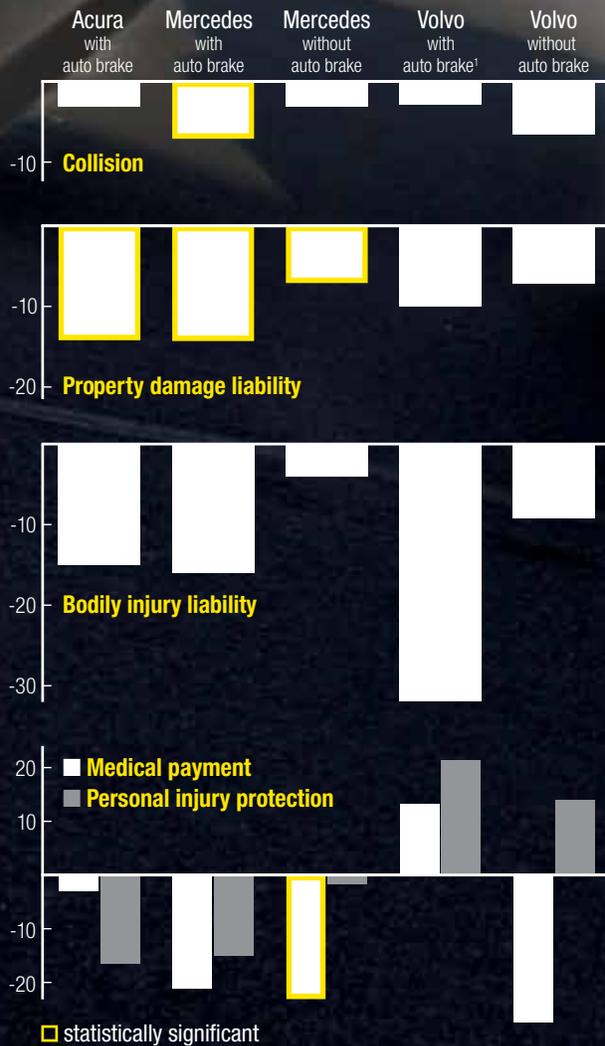
Earlier research by the Insurance Institute for Highway Safety estimated that if every vehicle on the road were equipped with four types of crash avoidance features — forward collision warning, lane departure warning, blind spot detection and adaptive headlights — nearly a third of all crashes could potentially be prevented or mitigated (see *Status Report*, May 20, 2010). That estimate assumes that the systems work exactly as intended and that drivers react correctly to warnings, so it's not surprising that so far the measured benefits from these systems tend to be more modest.

HLDI analysts looked at how each feature affected claim frequency under property



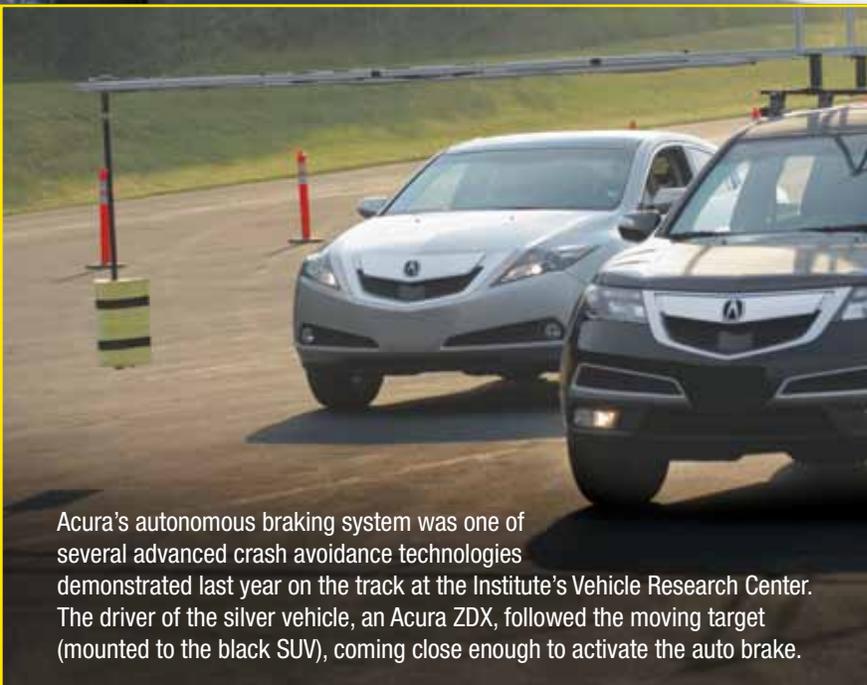
Forward collision avoidance

Percent differences in claim frequency with and without



¹All Volvo vehicles with auto brake also have lane departure warning and fatigue warning.

Medical payment and personal injury protection both cover occupants of the insured vehicle. Personal injury protection is sold in the 17 states with no-fault insurance systems and covers injuries regardless of who is at fault.



Acura's autonomous braking system was one of several advanced crash avoidance technologies demonstrated last year on the track at the Institute's Vehicle Research Center. The driver of the silver vehicle, an Acura ZDX, followed the moving target (mounted to the black SUV), coming close enough to activate the auto brake.

damage liability (PDL) insurance, which covers damage to another vehicle caused by the insured vehicle, and collision insurance, which covers damage to the insured vehicle. They also looked at claims for injuries under three coverage types. Injuries to other road users, including occupants of other vehicles and pedestrians, are covered by bodily injury liability insurance, while injuries to occupants of the insured vehicle are covered by either medical payment insurance or personal injury protection, depending on the state.

Claim frequency is the number of claims relative to the number of insured vehicle years. An insured vehicle year is one vehicle insured for one year, two vehicles for six months, etc. The model years of the vehicles included ranged from 2000 to 2011, depending on when an automaker introduced a feature. Insurance data through August 2011 were used.

The crash avoidance systems studied were all offered as optional equipment. Most of the data came from luxury brands, the first to offer such features,

Forward collision avoidance systems, particularly those that brake autonomously, show some of the biggest crash reductions. Adaptive headlights also are surprisingly effective.

though more and more nonluxury vehicles also offer them now. The automakers supplied HLDI with identification numbers of vehicles that had each feature, allowing HLDI to compare the insurance records for those vehicles with the same models without the feature.

In each analysis, HLDI controlled for a number of factors that could influence claim rates, including driver age and gender, garaging state and collision deductible.

Forward collision avoidance

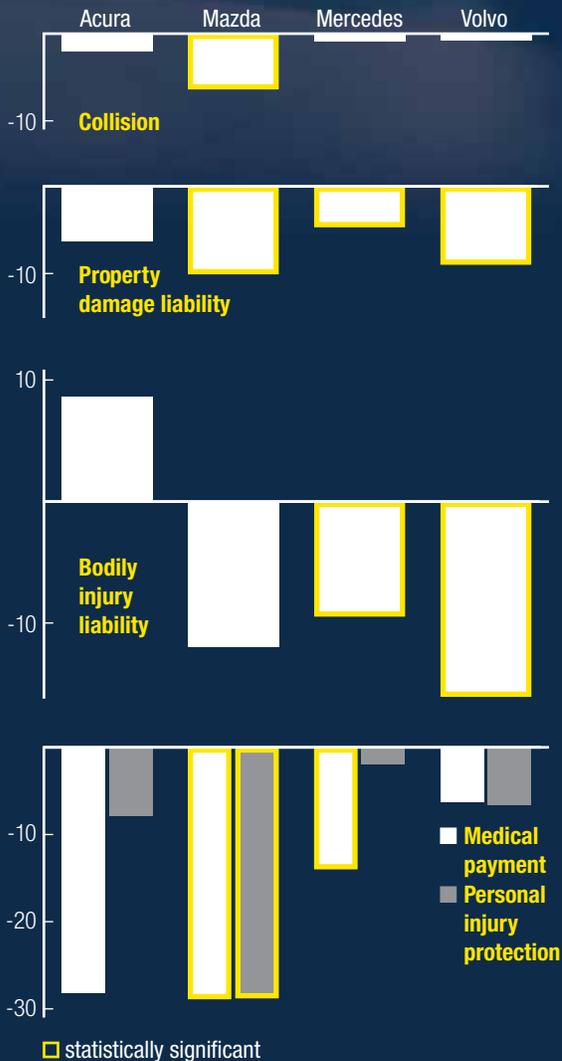
Forward collision warning systems alert the driver if the vehicle is gaining on the traffic ahead of it so quickly that it is about to crash. Some of these systems also are equipped with autonomous braking, meaning the vehicle will brake on its own if the driver doesn't respond in time. These systems operate at higher speeds than City Safety, which doesn't provide any warning before it brakes.

Claims for the front-to-rear collisions that forward collision avoidance systems are meant to address are



Adaptive headlights

Percent differences in claim frequency with and without



Adaptive headlights appear to be helping in more situations than previously anticipated, though it's not yet clear why.

common under PDL coverage, and HLDI found the technology reduces PDL claim frequency. Claim frequency under collision coverage, which includes many of the same crashes that fall under property damage liability but also a lot of single-vehicle crashes that these systems are not designed to address, also was reduced but by a smaller amount.

HLDI examined forward collision systems offered on Acura, Mercedes-Benz and Volvo vehicles. PDL frequencies for Acura and Mercedes models were 14 percent lower when the vehicles were equipped with forward collision warning with autonomous braking than when they weren't. Volvo's autonomous braking system also reduced the claim rate 10 percent, but that finding wasn't statistically significant. The Volvo system comes bundled with lane departure warning and fatigue warning, so that figure may be affected by those features as well.

Front-to-rear collisions also result in many claims for minor injuries like whiplash and back sprains to the occupants of the struck vehicle, and all the systems reduced claims under bodily injury liability insurance. Although those reductions weren't statistically significant, they are encouraging and consistent with the observed reduction in PDL claims. For Acura and Mercedes vehicles with auto brake, claim frequency for injuries to the insured vehicle's occupants tended to be lower as well, while results were the opposite for Volvo. None of these results was statistically significant.

HLDI also examined separate Mercedes and Volvo systems that don't include autonomous braking. These appear to lower crash rates, too, but not to the same extent as the versions that do include it. These systems probably have more modest effects on PDL claims because they rely on drivers to respond appropriately to warnings and can't directly avoid crashes. There also are other differences between systems that do and don't have auto brake. For example, Volvo's system without auto brake is functional only at speeds over 20 mph, while the version with auto

brake starts working at 3 mph. These systems also seem to reduce the frequency of bodily injury claims for other road users, but evidence is mixed for injury claims by the occupants of the insured vehicle. More data are needed to know the effect for certain.

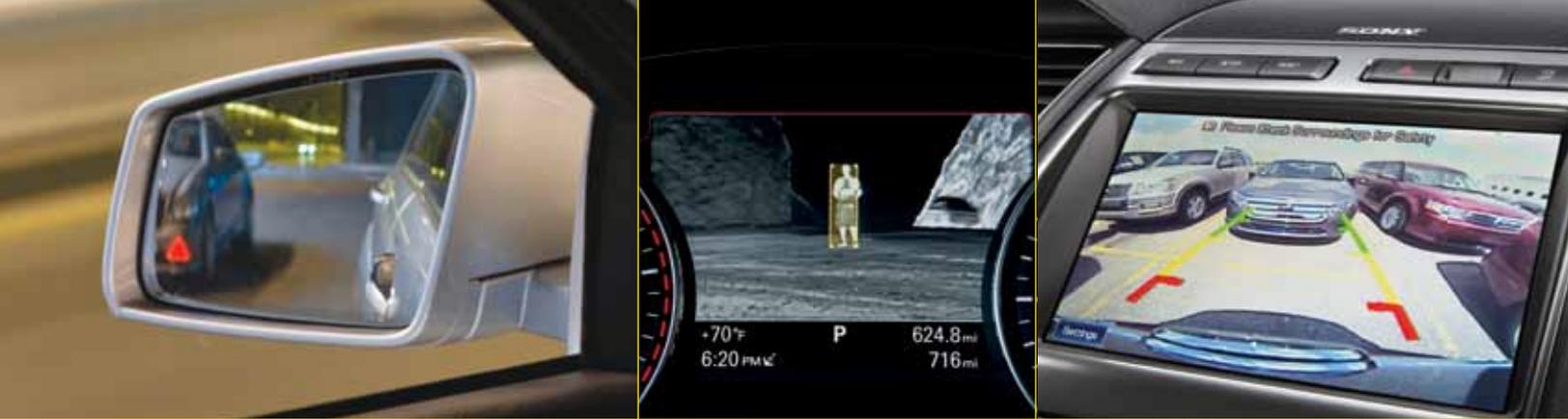
Adaptive headlights

Adaptive headlights respond to steering input to help a driver see around a curve in the dark. The headlights' horizontal aim is adjusted based on the speed of the vehicle, direction of the steering wheel and other factors so that the lights are directed where the vehicle is heading.

When the Institute estimated the potential of this technology in 2010, researchers expected it could reduce single-vehicle run-off-road crashes, which would be reflected in collision claim frequency. However, HLDI's analysis of adaptive headlights offered by Acura, Mazda, Mercedes and Volvo found that of the various coverage types, collision had the smallest claim frequency reductions. The results did show decreases in injury claims for the insured vehicles — some of them large — in support of earlier expectations.

What is surprising is that vehicles with adaptive headlights had reductions in property damage and bodily injury liability claims, which both involve other road users. With the exception of Acura, bodily injury liability frequencies fell 10 percent or more, and all four manufacturers saw decreases in PDL frequencies ranging from 5 to 10 percent. This is a dramatic result, given that only about 7 percent of police-reported crashes occur between 9 p.m. and 6 a.m. and involve more than one vehicle. An even smaller percentage are multiple-vehicle, nighttime crashes occurring on a curve, where adaptive headlights would be expected to have an effect. It's possible that other differences besides steerability between the adaptive headlights and conventional ones, for example, in brightness or range, may have played a role in reducing crashes with other vehicles.

"All four adaptive headlight systems we looked at show benefits for most



Innovations

aim to stave off crash threats from all sides

Automakers are deploying new technology on all sides of vehicles and in every direction to prevent crashes or lessen their severity.

The crash avoidance features highlighted in this *Status Report* — **forward collision avoidance**, **adaptive headlights** and **lane departure warning** — are among the most common of these high-tech detection, warning and intervention devices on the market so far. Other features that the Highway Loss Data Institute (HLDI) is gathering data on include **blind spot detection**, **park assist** and **backup cameras**. All these systems are beginning to make their way into mainstream vehicles, beyond the luxury models where they started out. For example, one of the top-selling vehicles, the Toyota Camry, comes with optional blind spot detection for 2012. The current Ford Taurus has optional forward collision warning and blind spot detection. Chevrolet, Dodge and Chrysler also are among the brands offering advanced technology.

But the list of high-tech features on the market or soon to be available is much longer. Other examples include **cross traffic alert**, which warns a driver if traffic is about to enter the vehicle's path from the side; **curve speed warning**, which uses GPS and speed information to determine if the vehicle is about to take a curve too fast; and **fatigue warning**, which tracks steering and other driver behaviors to determine if the driver is inattentive or in danger of falling asleep. **Night vision assist** uses infrared imaging to produce an enhanced view

of the road ahead, projecting objects on a display before they are visible through the windshield.

Side impact detection, which is not yet on the market, is meant to detect an imminent side collision. The advance warning allows for the deployment of larger airbags, which take longer to inflate but can better protect occupants. Similarly, **rear collision detection** gives the vehicle a chance to adjust seats and head restraints and take other measures to prepare for a crash.

Some relatively common features are being further enhanced. For example, a few forward collision warning systems can recognize a pedestrian and predict whether the person will cross the vehicle's path. These pedestrian detection systems could be expanded in the future to recognize animals or bicyclists.

Many park assist systems provide guidance to help the driver fit into a spot, but some vehicles are actually **self-parking** and can maneuver into a spot automatically, though the driver still controls the throttle.

Lane departure prevention goes a step further than lane departure warning by gently guiding the vehicle back into its lane position if it begins to stray.

Once these other features have been around long enough in enough vehicles, HLDI may be able to examine their effect on claims, too. However, it's becoming more difficult to tease out the effects of individual features because they are increasingly bundled together. This makes it particularly important to develop tests that can evaluate

the performance of each feature. The Insurance Institute for Highway Safety recently launched such work at its Vehicle Research Center. Using stationary and moving targets, as well as a pedestrian rig that "walks"



across a vehicle's path, researchers have begun to evaluate how some crash avoidance features perform. In the future, such experiments will provide valuable information for consumers. They also could help automakers as they decide which of these many technologies to pursue further. ■



Lane departure warning may have the potential to reduce fatal crashes, but so far no benefits from this feature have shown up in insurance data.

Lane departure warning systems

Percent differences in claim frequency with and without



¹All Buick vehicles with lane departure warning also have blind spot detection.

²All Volvo vehicles with lane departure warning also have forward collision warning with auto brake and fatigue warning.

The cost of crashes

For every feature, in addition to claim frequency, HLDI also looked at the average payment per claim, known as claim severity. Claim severity for collision losses increased with most of the crash avoidance features.

This increase wasn't unexpected because many of these technologies eliminate less

severe crashes first, meaning the ones that remain are on average more expensive. However, in some cases, collision claim severity went up sharply even when frequency didn't go down or fell only slightly. For example, with Mercedes' basic forward collision warning system, the frequency of collision claims inched down 3 percent, but severity shot up by \$813. That's probably because the pricey

radar sensors used by the system are mounted right behind the grille and thus are vulnerable to damage in a crash. The same issue applies to adaptive headlights, which are more expensive than regular headlights.

In practical terms, this means that even a technology that improves safety won't necessarily reduce insurance costs, which reflect both claim frequency and claim severity. ■

insurance coverages, and many of these estimated reductions are statistically significant,” Moore says. “These lights appear to help in more situations than we anticipated, though we don’t yet know why.”

Lane departure warning

In the Institute’s 2010 analysis of the potential of crash avoidance technologies, lane departure warning was one of the stars. Researchers estimated it could prevent or mitigate up to 7,529 fatal crashes if all vehicles had it — the biggest potential fatal crash reduction of any of the features studied, primarily due to expected reductions in single-vehicle run-off-road crashes. In the HLDI study, however, lane departure warning systems from Buick and Mercedes were associated with higher claim rates under both collision and PDL coverages. Only Volvo’s vehicles showed a reduction in claim rates under these coverages, as well as bodily injury liability, but Volvo’s system is bundled with forward collision warning with autonomous braking, which more likely accounts for the estimated benefits. In addition, claim frequency for injuries to occupants of the insured vehicle was higher for vehicles with lane departure warning, although no results were statistically significant.

Volvo isn’t the only vehicle make whose lane departure warning comes with another feature intended to prevent crashes. Buick’s system is bundled with blind spot detection. That makes the lack of claim reductions for Buick even more perplexing.

Part of the disconnect between these results and the Institute’s estimates of the feature’s potential probably has to do with the fact that crashes in which vehicles drift off the road aren’t common, even though they account for a large proportion of fatal crashes. This was reflected in the Institute study as well, which found that lane departure warning would be irrelevant to about 97 percent of police-reported crashes. The HLDI results also may point to problems with the current technology, which relies on cameras to track lane markings and thus isn’t effective if the markings aren’t clearly visible.

“Lane departure warning may end up saving lives down the road, but so far these particular versions aren’t preventing insurance claims,” Moore says. “It may be that drivers are getting too many false alarms, which could make them tune out the warnings or turn them off completely. Of course, that doesn’t explain why the systems seem to increase claim rates, but we need to gather more data to see if that’s truly happening.”

Annoyance and false alarms were issues for Infiniti and Volvo owners surveyed by the Institute about crash avoidance features in 2009. Forty-three percent of Volvo owners and 46 percent of Infiniti owners reported receiving false or unnecessary lane departure alerts. Twenty-five percent of Volvo owners and 41 percent of Infiniti owners said the lane departure warning system was annoying (see *Status Report*, Nov. 18, 2009). Although more than two-thirds of owners said they always kept the systems on, false alarms could cause drivers to ignore the warnings or react to them more slowly.

HLDI has yet to look at lane departure prevention, which, unlike a warning system, actively keeps a vehicle in its lane and could have a different impact on claims.

“Just as forward collision warning systems that include autonomous braking cut crashes more sharply than those that don’t, lane departure prevention systems that don’t rely on a driver’s response may hold more promise than the systems HLDI has looked at so

far,” says David Zuby, the Institute’s chief research officer. “The lane departure prevention systems are newer and less common than the warning systems, so we’ll have to wait for more data before we can look for a pattern there.”

Other technologies

This *Status Report* focuses on the three crash avoidance technologies for which HLDI has the most information: forward collision avoidance, adaptive headlights and lane departure warning. The HLDI reports on which the conclusions are based also provide some results for additional technologies. Some of these results are promising: For example, Buick’s rear park assist system appears to reduce PDL claims dramatically. However, the data on these features across brands is inconsistent. As more information becomes available on these technologies, *Status Report* will provide further summaries.

“These analyses are the first to estimate real-world effectiveness of several crash avoidance technologies that have been filtering into the market recently,” Zuby says. “While some results indicate the need for further investigation, it’s clear that certain systems, such as those that help drivers avoid collisions with the vehicle in front or better illuminate the road ahead, can play a role in making roads safer for everyone.” ■



Want to learn more?

The Institute’s website has a wealth of information on crash avoidance technologies. New **animated videos** demonstrate how some of the most common features are designed to operate. Forward collision warning, adaptive headlights, lane departure warning, adaptive cruise control and backup cameras are all illustrated and explained. The videos are part of an extensive **Q&A** on the basics of crash avoidance: what features exist, how they can help and what the future holds. You also can find **information on availability** of crash avoidance features by vehicle make and model. In addition, detailed **reports from HLDI** on the claim analyses described in these pages are available for each of the five vehicle makes studied.

 iihs.org/crash_avoidance



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The **Highway Loss Data Institute** shares and supports this mission through scientific studies of insurance data representing the human and economic losses resulting from the ownership and operation of different types of vehicles and by publishing insurance loss results by vehicle make and model.

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