STATUS REPORT
INSURANCE INSTITUTE FOR HIGHWAY SAFETY
Vol. 37, No. 9, October 26, 2002

NOT YOUR FATHER'S

head restraint. Not your mother's either.

New Institute research finds that innovative designs of vehicle seats and head restraints are reducing neck injuries in rear impacts.

Head restraints have been required in cars since 1969, but until recently most of the restraints weren't high enough or close enough to the backs of many occupants' heads to provide effective protection against neck injury in rear-end crashes. This is changing rapidly. Auto manufacturers are improving the designs of head restraints, partly in response to the Institute's consumer ratings of restraint geometry by vehicle make and model

The geometry of the head restraints in many cars, including the 1999 Ford Taurus, is inadequate. In a rear-end crash, the unsupported head lags behind as the torso is accelerated forward. This differential motion can lead to whiplash injuries. To reduce such injuries, some automakers are introducing new seat and/or head restraint designs. Ford improved the head restraints in 2000 Taurus models, positioning them higher and closer to the head so they're in position to reduce neck injuries. Ford also installed locks to make sure adjusted head restraints stay adjusted.

(see *Status Report*, Oct. 6, 2001; on the web at www.highwaysafety.org). Some manufacturers are doing more, adding features designed to reduce neck injury risk dynamically during crashes.

Nationwide, Progressive, and State Farm insurance companies have supplied data for a new study of the improved seats and head restraints. Institute researchers analyzed the data, finding that many of the designs are benefiting occupants in rear-end crashes. Neck injuries are being reduced.

The potential of the dynamically responding seat/head restraint designs introduced by Volvo and Saab was demonstrated in crash tests conducted a few years ago (see *Status Report*, May 22, 1999). The new study is the first in the United States to measure the effectiveness of the redesigned components in real-world crashes.

The Institute studied three approaches used to redesign seats and head restraints:

1. A straightforward approach is to improve the geometry of the restraints so they can be positioned behind and closer to the backs of most occupants' heads. This way, the restraints can protect more people in crashes. A number of manufacturers have made such improvements. Among them is Ford, which improved the geometry of the restraints in 2000-02 Ford Taurus and Mercury Sable models compared with earlier models of the same cars.

2. Saab introduced an active head restraint. As an occupant's torso sinks back into the seat during a rear-end crash, a mechanism in the seatback pushes the restraint up and toward the back of the head. Besides Saabs, some General Motors and Nissan models are equipped with these restraints.

3. Volvo and Toyota focused on seatbacks, designing them to yield in rear-end crashes to reduce the forward acceleration of occupants' torsos. Volvo dubs its design a whiplash injury prevention system (WHIPS), which includes a specially designed hinge at the bottom of the seatback allowing it to move rearward to reduce forward torso acceleration. This system includes head restraints with good geometry — that is, high and close to the back of the head. Toyota's seat design, which the automaker calls a whiplash injury lessening (WIL) system, allows an occupant's body to sink farther into the seatback during a rear impact.

Three approaches, same goal: These approaches are different, but they reflect the common goal of reducing the differential motion of an occupant's head and torso in a rear-end crash. Unsupported, the head will lag behind as the torso is accelerated when a car is hit from behind. This differential motion will cause the neck to bend backward in a motion that resembles the lashing of a whip — the higher the torso acceleration, the more sudden the motion.

The key to reducing whiplash injury risk in rear-end crashes is to keep the head and torso moving together. The redesigned seats and head restraints are all intended to do this by reducing the differential motion. The question addressed in the Institute's new research is whether these redesigned seats and head restraints are doing a better job of reducing neck injuries in real-world crashes, compared with older designs.

"There's evidence they're doing a better job. In some cases the reductions in insurance claims for neck injuries are dramatic," says Institute chief operating officer Adrian Lund, an author of the research report.

The researchers identified 2,641 property damage liability claims for rear-end crashes of the cars included in the study — Taurus and Sable models with and without improved restraint geometry, Volvo S70s with and without WHIPS, Toyota and Lexus models with and without the WIL system, plus a number of Buick, Nissan, Pontiac, and Saab models with and without active head restraints. The rates of insurance claims for driver neck injuries in the rear-end crashes were compared before and after the seat and head restraint design changes. Then the comparisons were adjusted to account for differences in crash severity and driver gender.

Only cars with similar rear-end structures before and after the manufacturers introduced the new seat/head restraint designs were included in the study. If a car underwent substantial rear-end structural changes at the same time, it was excluded. Thus, the changes in neck injury claim rates revealed by the research can be attributed to the seat and head restraint design changes instead of to differences in how the cars' structures managed the forces of the rear impacts.

Comparative neck injury reductions: A main finding is a 43 percent reduction in neck injury claim rates for the Saab, General Motors, and Nissan models with active head restraints, compared with similar cars before such restraints were introduced.

"The movement of this active restraint in a rear-end crash is very small, a matter of inches. However, the small movement makes a very big difference in terms of reducing the differential motion of the head and neck. A 43 percent reduction in neck injury claims is a huge improvement," Lund points out.

Similar before/after comparisons of Volvos and Fords also yielded reductions in claim rates — a 49 percent reduction in the Volvos with WHIPs, compared with earlier models without WHIPS, and an 18 percent reduction for the Fords with improved restraint geometry. However, these results weren't definitive because they weren't statistically significant.

Findings for Toyota's WIL system aren't as good. Neck injury claim rates didn't decrease. "There was too little data on the Toyota system, and the data were inconsistent across the insurers. But what we do know from this study is that the WIL system isn't reducing the injuries," Lund explains.

Gender differences: Where reductions in neck injury claim rates were found, they were greater for women than for men. Saab's active head restraint design produced a 55 percent reduction in claim rates for women, compared with a 31 percent reduction for men. The effects of Ford's improved restraint geometry were a 37 percent claims reduction for women compared with a nonsignificant 8 percent increase for men. Volvo's WHIPS was associated with a nonsignificant 69 percent reduction in neck injury claim rates for women, while the change for men was negligible.

Even after the women in the study reaped virtually all of the benefits of the innovative designs, their neck injury claim rates weren't lower than the rates for men.

"This isn't surprising because the women's rates were so much higher to begin with," Lund says. "Throughout whiplash injury research, the finding has been that women are at greater risk of neck injury, so it's good that they seem to be enjoying more of the benefits of the improved designs."

Dynamic testing is on the way: The next step in evaluating the new restraint designs is to figure out what it is about each design that makes it perform better or worse than the others. To do this, the Institute will conduct dynamic tests of the seat/head restraint combinations. In the controlled conditions of the tests, the researchers hope to determine the specific differences in performance.

"Of course, we won't ever be able to prevent every whiplash injury claim from being filed, no matter how effective the restraint designs become," Lund also says. One reason is that some of the whiplash claims involve exaggeration of the symptoms or even fraud.

Still, the steps manufacturers are taking "do look promising. They can reduce the instance of bona-fide neck injuries," Lund concludes. "This is important because the injuries can be painful, and the symptoms can last a long time. Whiplash injuries also can be expensive to treat, so reducing them would be welcome from a financial as well as a public health perspective."

For a copy of "Effects of head restraint and seat redesign on neck injury risk in rear-end crashes" by C.M. Farmer et al., write: Publications, Insurance Institute for Highway Safety, 1005 North Glebe Road, Arlington, VA 22201.

NEW GENERATION

of seat/head restraint designs:

Percent change in neck injury claim rates for new designs compared with old designs

Saab's active restraint	**–43%**
Ford's improved restraint geometry	**–18%**
Volvo's WHIPS	**–49%**
Toyota's WIL system	**+15%**

Automatic crash notification wouldn't make a difference in most cases

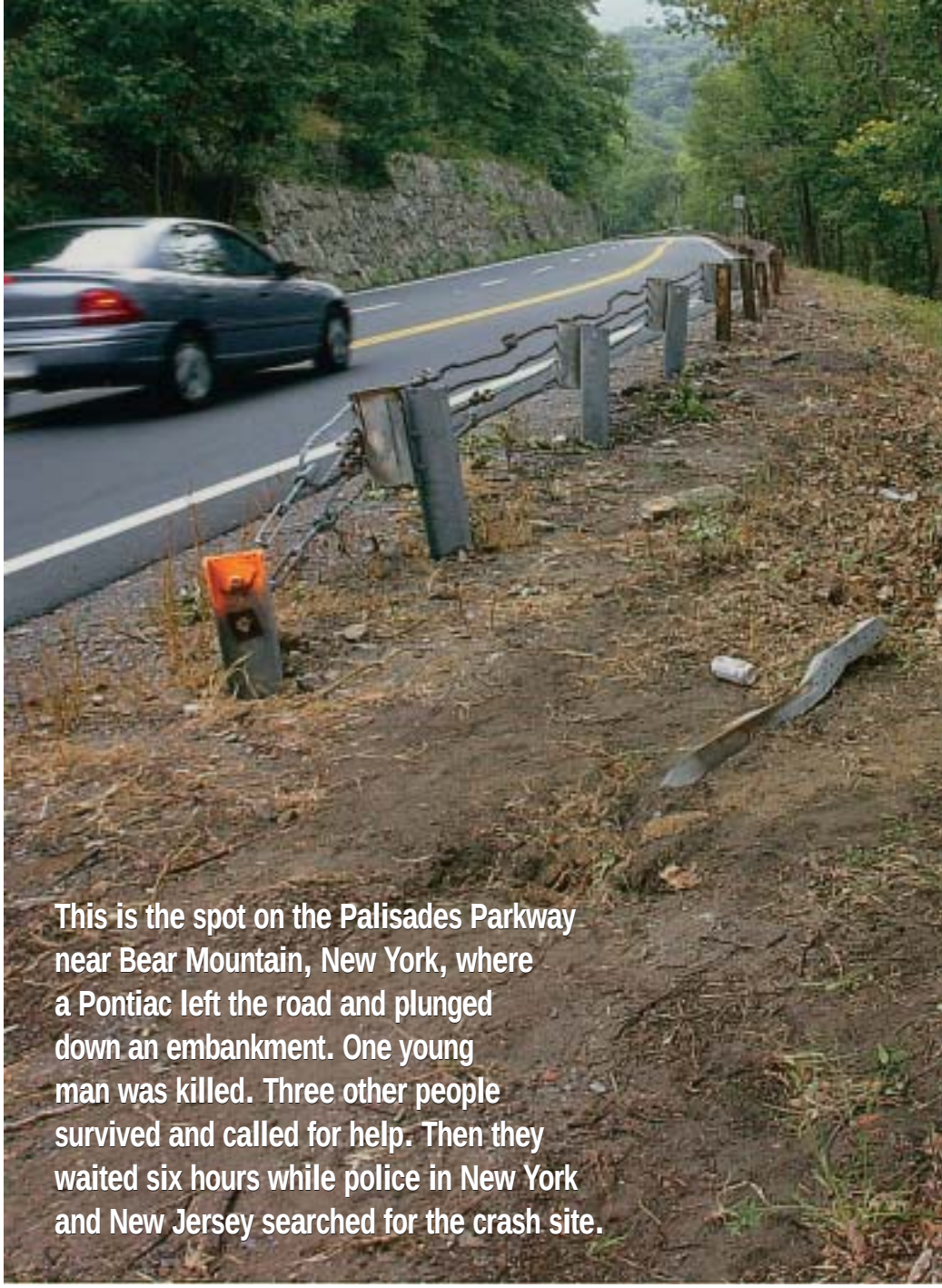
Just after midnight on August 29, 2001, a white Pontiac missed a turn and plunged 400 feet from New York's Palisades Parkway into a swamp below. One of the four young men in the car died instantly. The other three would end up waiting six hours for help to arrive, despite having reached a 911 operator on a cellular phone.

Automatic crash notification (ACN) systems such as General Motor's OnStar might have brought help sooner in this case. An automatic call for help with location information would have gone out as soon as the crash was detected.

ACNs, which consist of a global positioning unit and a cell phone, do help to report and locate isolated crashes. But how great a benefit would we reap if all cars had ACNs? After all, it's rare for any crash site to go unnoticed for hours.

Fatality reduction would be small: Researchers at the Maine Medical Center and the Harvard Injury Control Research Center developed a mathematical model linking mortality risk to crash notification and response times. Based on data from more than 30,000 fatal crashes, the model predicts that shortening the notification times to a minute or less would reduce crash deaths by about 1 to 6 percent. A total of 400 to 1,700 lives would be saved each year, assuming perfect functioning of the ACN systems.

"It's a tangible and important benefit. At the same time, these results show the limitations of ACN," says Adrian Lund, the Institute's chief operating officer. "Emergency workers already find out about most crashes within a few minutes, and some of the crashes are so severe that the people are killed instantly. Besides, the predicted benefits depend on perfect functioning of the ACNs, which isn't likely."



This is the spot on the Palisades Parkway near Bear Mountain, New York, where a Pontiac left the road and plunged down an embankment. One young man was killed. Three other people survived and called for help. Then they waited six hours while police in New York and New Jersey searched for the crash site.

Current ACN systems detect serious crashes by using information about frontal airbag deployment. Soon sensors for rear and side impacts will be added. When a crash is detected, a call is automatically placed to a service center, which then tries to contact the driver of the crash-involved vehicle. If there's no response or the driver verifies the crash, the call center notifies emergency personnel, providing the details and location of the crash.

A national ACN system is being advocated by the ComCARE Alliance, a nonprofit organization supported by medical nonprofits and the automotive and telecommunications industries. These and other advocates view ACN as a way to get patients to hospitals sooner. But in fatal crashes for which notification times are known, 75 percent of the urban events were reported within 4 minutes. Rural crashes were reported within 9 minutes. And even when ACN does reduce the time it takes for rescuers to be notified of crashes, the response times won't be any shorter. In remote areas, response times can be lengthy because rescuers can be stationed long distances from crash sites.

"The modesty of the mortality reductions predicted by the researchers' model

can be attributed to the fact that, even without ACN, most notification times are short, especially relative to response times," Lund points out. "In the case of the Pontiac that crashed on the Palisades Parkway, ACN might have helped bring rescuers sooner, but even in this case no lives would have been saved."

Help also might have arrived sooner if another system — so-called enhanced 911 for cell phones, or E911 — had been in operation. Under this system, the location of a cell phone is displayed to 911 operators during an emergency call. Such technology is scheduled for phase-in starting in 2003.

'Golden hour' might not be relevant: ComCARE Alliance, which supports both E911 and ACN, bases its recommendation of speedier notification times on a medical concept known as the "golden hour," according to which many trauma deaths can be prevented if appropriate medical treatment is applied within an hour of the injury. Based in part on common sense and in part on the experiences of trauma surgeons, this concept justifies much of the way injury is treated in this country. However, the "golden hour" might be less valid for car crash injuries than for other trauma cases.

Much of the basis of the concept comes from experience with the penetrating injuries sustained in wars. Quick medical attention to such injuries is important. In contrast, many crash injuries result from blunt trauma, for which quick medical treatment might not make much difference in the outcome.

Flawless performance isn't likely: The fatality reductions predicted for ACNs depend on the systems functioning perfectly. But when the National Highway Traffic Safety Administration tested a system over a five-year period in New York, a main finding was failure to notify emergency personnel of crashes in 5 out of 21 cases. There also were 31 false alarms.

"This means there would be 22,000 false alarms per year in a city with a million ACN-equipped vehicles," Lund points out. OnStar's reliability should be better, if only because the service center should eliminate many of the false alarms. All of the successfully completed ACN calls in the test resulted in notification times of 2 minutes or less, but most of the times for the control group also were short. Eighty percent were less than 5 minutes, but 2 of the 25 notification times were longer than 30 minutes.

Another obstacle could be the cost: Automakers are installing ACNs as part of several telematics packages on high-end cars and SUVs. Besides some General Motors models, OnStar with its ACN component is in Acura, Audi, Lexus, and Subaru models. Some packages also include navigation systems, hands-free phones, and concierge services, each of which requires a monthly fee.

Ford recently announced that Sprint PCS VoiceCommand will provide similar services in Lincolns.

OnStar reports that 56 percent of its customers renew their subscriptions after the free trial period. The majority opt for the basic package, which includes ACN. If half of the owners of cars with systems in place aren't willing to pay the monthly premiums, the benefits will be lessened.

State auditor reports

California's red light camera programs are reducing crashes, but administrative oversight is lax

California's auditor released a report in July on the effectiveness and structure of seven red light camera programs operating in the state. Cameras "have contributed to a reduction of accidents; however, our review of seven local governments found weaknesses in the way they are operating their programs," the auditor reports.

In general, the audit is more important for what it doesn't find than for

what it does. For example, it doesn't find that camera programs are generating large amounts of revenue. Nor is there evidence that yellow signal timing has been changed, as some critics have charged.

The financial status of only two of the state's seven camera programs is break-even or better, the auditor reports. This contradicts charges that raising revenue is a main purpose of installing cameras.

At the same time, the auditor found inadequate governmental oversight of the contractors and vendors responsible for the day-to-day operations of the programs. Citing a lack of legislative leadership, the auditor called for more detailed requirements on how local governments should supervise their programs.

Red light camera programs are authorized by California law. However, the state leaves it up to officials in local jurisdictions to decide how to run their individual programs. The result is widely disparate oversight of the programs.

The auditor recommends stronger oversight to avoid further legal confrontations, such as the San Diego case that resulted in the dismissal of about 300 tickets. In this case the court found the red light camera law constitutional but ruled that the city wasn't effectively controlling the operation of its program by a contractor. The program subsequently was suspended, but the city council voted to reinstate it and is addressing the issues raised by the court.

The auditor suggests the development of guidelines for selecting red light camera sites and for addressing traffic engineering and light timing issues as alternatives to camera enforcement at problem intersections.

The findings of the report on the effectiveness of camera programs are similar to the Institute's. The auditor found crash reductions of 3 to 21 percent. This compares with two Institute findings — a 7 percent crash reduction according to a study conducted in Oxnard, California, and a 20 percent reduction according to a follow-up analysis that focused specifically on signal violation crashes in Oxnard (see *Status Report*, May 4, 2002; on the web at www.highwaysafety.org).

For the text of the auditor's report, go to www.bsa.ca.gov/bsa/summaries/2001125.html.

Biggest problem at stop signs isn't running through; it's stopping but then failing to yield

One-third of all intersection crashes in the United States, and more than 40 percent of the fatal ones, occur at intersections controlled by stop signs. This amounts to about 700,000 crashes at stop signs each year.

About 70 percent of all crashes at one- and two-way stop signs involve the same basic pattern — a vehicle that's required to stop doesn't, or it stops and fails to yield, and then it collides at an angle with another vehicle going across the intersection. This is the main finding of new Institute research that looks at the specific patterns of crashes at one- and two-way stop signs to determine what's causing the collisions and what can be done to prevent them.

About two-thirds of the stop sign violation crashes involved drivers who said they stopped before proceeding. Only 17 percent of the crashes involving violations (12 percent of all stop sign crashes studied) involved drivers who ran through the signs. Another 12 percent of the crashes studied were rear-end collisions.

For the study, the Institute and Preusser Research Group analyzed about 1,800 police-reported crashes at stop signs in four U.S. cities — Oxnard, California; Westfield, New Jersey; Springfield, Missouri; and Germantown, Tennessee. The study excluded intersections where traffic from all directions is required to stop, because these intersections tend to have different traffic flow characteristics and fewer crashes than at one- or two-way stops.

Drivers didn't see conflicting vehicles: At stop signs drivers are required not only to stop but also to look for vehicle conflicts and judge whether it's safe to proceed. The findings of this study indicate that drivers don't always judge correctly.

"The most common situation we found was that a driver just didn't see the other vehicle coming," explains Richard Retting, the Institute's senior transportation engineer and lead author of the study. This is how 44 percent of the crash-involved drivers who stopped explained what happened. Another 16 percent said their views were obstructed. Only 6 percent saw the other vehicle but failed to avoid the collision.

In some cases, the shape or design of a roadway can make it hard for drivers to see approaching traffic. Parked vehicles, shrubbery, or even glare can obstruct

drivers' views. However, the extent to which these environmental factors contribute to crashes isn't clear, in part because such information typically isn't noted in police reports.

A relatively small proportion of the crashes (12 percent) involved drivers who failed to stop, but these collisions were more likely to result in injury. They were twice as likely to happen at night, and they occurred more often at cross-type intersections than at t-intersections. Young drivers, particularly young men, were more often found to be at fault in these crashes.

Both older (65 and older) and younger drivers were disproportionately at fault in stop sign crashes. This finding is consistent with previous studies showing that older drivers generally are overrepresented in intersection crashes (see *Status Report*, Sept. 8, 2001; on the web at www.highwaysafety.org). Problems include age-related visual impairments and loss of flexibility, which can make it hard to turn to look both ways when crossing intersections.

Ways to reduce the crashes: Retting says the focus needs to be on improving the designs of intersections or replacing them with safer forms of traffic control. "To the extent that failure to see stop signs is a problem, the solutions can be fairly simple. Intersections can be checked periodically to make sure obstructions aren't blocking drivers' views. The signs themselves can be checked for luminosity. Pavement markings that warn drivers of stop signs ahead can help, and even adding extra signs at problem locations can get drivers' attention.

Installing all-way stops at appropriate locations can be beneficial. Compared with one- or two-way stops, the all-way signs can reduce overall crashes by 40 to 60 percent and injury crashes by 50 to 80 percent (see *Status Report*, May 2, 1998; on the web at www.highwaysafety.org).

Another effective measure is to convert stop sign-controlled intersections to roundabouts. This can reduce crashes by 40 percent and improve traffic flow at the same time (see *Status Report*, July 28, 2001; on the web at www.highwaysafety.org).

"A main benefit of both roundabouts and four-way stops is that they slow the traffic," Retting says. "With the traffic moving more slowly, crashes are less likely to occur, and when they do occur they're less likely to be serious."

To obtain a copy of "Analysis of motor vehicle crashes at stop signs in four U.S. cities" by R. Retting et al., write: Publications, Insurance Institute for Highway Safety, 1005 North Glebe Road, Arlington, VA 22201.

The most common situation was that drivers just didn't see other vehicles coming. In some cases, the drivers' vision was obstructed.

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Vol. 37, No. 9, October 26, 2002

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