



Risk in Perspective

Airbags: Benefits and Risks

Lisa Green, RMS Media Services



John D. Graham, Ph.D., Director



Maria Segui-Gomez, M.D., M.P.H.

...the best available estimates are that the lives of 75 drivers are being saved for each one that is being lost due to airbags.

The United States is the only country in the world that compels vehicle manufacturers to offer airbags as standard equipment on all new passenger cars and light trucks. This regulatory impetus, in conjunction with consumer interest in safety, has caused 60 million vehicles with airbags to be sold in the USA since 1989. Although half of these vehicles have driver-only airbags, the "dual" airbag technology (i.e., driver plus front-right passenger airbags) is rapidly penetrating the U.S. vehicle market. By the year 1999, it will not be possible for an American consumer to purchase a new vehicle without dual airbags (whether passenger car, minivan or light truck).

An airbag's system is comprised of three elements: a sensor that detects the deceleration rate of the vehicle in a crash, an electronic unit that monitors the operation of the system, and an airbag module that houses the inflator and the bag. The bags inflate within 0.01 seconds after the crash occurs and begin to deflate 0.2 seconds after that. The bags are designed to protect the occupant's head and chest from hitting the vehicle's interior surfaces.

In this issue of **RISK IN PERSPECTIVE**, we summarize what has been learned about the benefits and risks of airbags from real-world crash experience in the USA. We compare the airbag's actuarial record (i.e., the historical counts of deployment incidents and their outcomes) with what it was projected to be by analysts 10-20 years ago. We also discuss how airbag technology might change in the future in order to maximize safety benefits while reducing the unwanted risks to motorists.

Lifesaving Benefits

In 1977 the U.S. National Highway Traffic Safety Administration (NHTSA) predicted, based on experimental testing, that airbags would reduce the overall risk of fatal injury by 40% among unbelted occupants and by 10% among belted occupants. Drivers and front-right passengers were predicted to reap similar benefits and no distinctions were made about occupant characteristics (i.e., age, sex or height).

Based on actuarial data accumulated in the USA since 1986, it appears that the qualitative predictions were correct: airbags are saving lives. Death rates among drivers are lower in cars with airbag systems and these differences are not explainable by other vehicle or behavioral variables. However, the magnitude of the airbags' lifesaving effect for the unbelted driver is much smaller than projected (about 13% instead of 40%). For belted drivers, the 10% safety benefit projected by NHTSA in 1977 has proven to be about accurate. These actuarial findings are based on the plausible (yet unproved) assumption that the presence of an airbag in a vehicle does not cause any change in driver behavior that would modify the frequency of collisions (i.e., drivers of airbag-equipped vehicles getting involved in more crashes).

Through post-crash investigations it has been learned that airbags have caused the deaths of at least 19 drivers who were involved in crashes of low-to-moderate severity. These drivers were predominantly short women over the age of 60 and it should be emphasized that most of

them were not wearing safety belts when the crash occurred.

The actuarial effectiveness estimates reported above account for these unfortunate side effects and thus represent the *net* lifesaving benefit for drivers. Overall, the best available estimates are that the lives of 75 *drivers* are being saved for each one that is being lost due to airbags. Even among female drivers, who tend to be shorter and thus may be at a higher risk of airbag-induced fatality, the actuarial data suggest that more women have had their lives saved by airbags than women have been killed by airbag deployment. Further research on the effects of airbags on short and/or elderly drivers is urgently needed.

Airbags are also saving the lives of adult front-right passengers. The net effectiveness estimates reported for front-right occupants who are older than 13 years old are similar to the actuarial estimates reported for drivers.

There is, however, one subgroup of passengers that is experiencing a net increase in fatality risk due to the introduction of airbag technology. Post-crash investigators have reported that at least 40 children under the age of 10 have been killed by passenger-side airbags in crashes that would not typically have been fatal. Most of these children were either unrestrained or improperly restrained. Although the lives of some children may have been saved by airbags, the best actuarial estimates are that the presence of a passenger-side airbag in a vehicle is associated with a net increase in the risk of child mortality of 21 to 88 percent.

Some of the danger to kids occurs when a rear-facing infant restraint is placed in the front-right seat, near the airbag housing. In this situation the infant's head and neck are highly vulnerable to the forces generated by the inflation of airbags. Toddlers or young children are also in danger when they are unrestrained or improperly restrained. Children may then be thrown forward during pre-crash braking, causing their heads to be situated too close to the airbag while it inflates. There have also been at least two instances where properly belted young children

have been killed in the front-right seat by inflating airbags.

Before airbags were mandated, it was known that, in a rare situation, a child could be harmed by airbag deployment. What has disturbed safety specialists are the frequency and the severity of the injuries that passenger-side airbags have inflicted on young children. Overall, the best estimates are that for every five lives saved by front-right passenger airbags, a life (usually a child) is lost. We are aware of no precedent in the history of preventive medicine where a mandatory measure was sustained with such a poor ratio of lifesaving benefit to fatal risk. Allowing young children to incur the bulk of the risk is particularly questionable.

Non-Fatal Injury Outcomes

It is not yet feasible to conduct a rigorous analysis of the impact of airbag technology on the incidence and severity distribution of nonfatal injuries. The preliminary findings, which have only been reported for drivers, are somewhat puzzling. The good news is that the risk of moderate to serious head injury appears to be reduced significantly by the presence of an airbag on the driver's side. However, both belted and unbelted drivers have experienced an increased rate of injury to their hands, wrists, and arms that is caused by airbag deployment. These injuries are usually minor, but a considerable proportion are moderate or serious. The medical case-report literature also has documented numerous injuries to the chest, eyes and faces of drivers who have been involved in frontal crashes where airbags deployed.

Overall, it appears that about 40% of airbag deployments result in at least one occupant injury (although most of these injuries are minor). Some of these injuries are occurring in low-speed crashes where the airbag protection was probably not necessary. More study is needed to determine the overall impact of airbags on the frequency and severity of injuries to drivers and passengers.

Public Perceptions and Attitudes

In a March 1997 telephone survey of 1,000 licensed drivers, HCRA found that

a majority of USA residents maintain favorable attitudes toward airbags, despite a significant amount of unfavorable media coverage in the year prior to the survey. A substantial majority (64%) favor the current legal requirement that all new vehicles be equipped with dual airbags. Yet, this requirement is being challenged by an increasingly vocal minority of citizens who support consumer choice about airbags. About one-third of the women reported having developed less favorable attitudes toward the technology over the last three years. NHTSA is under some political pressure to allow consumers to either have their airbag system equipped with a manual cut-off switch or to have their airbags disarmed permanently. Pro-choice groups, such as the Competitive Enterprise Institute, continue to make the case that the USA should not compel consumers to purchase cars with airbags if they do not want them.

Some intensification of the opposition to current airbag policy should be expected as more children are harmed and as citizens learn the actuarial facts about airbags. Although most citizens perceive correctly that airbags save more lives than they kill, a majority (60%) harbor the misconception that airbags save more lives of children than they kill. Most respondents (74%) are also unaware that a properly belted occupant (especially one who sits very close to the steering wheel) can suffer moderate to serious injury in a low-speed crash from an inflating airbag. And people do not realize that airbags are designed to deploy even in relatively low-speed crashes where the need for airbag protection is questionable, particularly if people are wearing safety belts.

Strategic Directions

A variety of strategies have been adopted or are under serious consideration to enhance the airbag's ratio of benefit to risk. Some of these strategies are targeted at current owners of vehicles equipped with airbags while other strategies are aimed at enhancing the design of future airbag systems. The remainder of this section describes the options under evaluation.

A massive national public education campaign has been launched by automakers, airbag suppliers, insurers, and NHTSA. It began several years ago with a focus on increasing the rate of child restraint use and safety belt use among adults. More recently it has begun to emphasize the need for children to sit in the back seat. It is too early to assess the precise impact of this national campaign.

Expectations for the national campaign's success should be modest. Human behaviors can be resistant to change, especially when low-probability dangers are balanced against immediate inconveniences and the hassles of lifestyle change (e.g., moving children to the rear seat). It is also unclear whether the current campaign will have adequate resources, longevity, and potency to influence the behaviors of owners of used vehicles who acquire airbag-equipped cars in the future.

Vehicle manufacturers have persuaded NHTSA to allow "depowering" of airbags by 25%–30%. Depowering consists of decreasing the speed at which airbags inflate and/or reducing their volume. The expectation is that this degree of depowering should reduce (but not eliminate) the number of deaths and injuries caused by airbags. It can also be expected to reduce the number of lives saved by airbags in high-speed frontal crashes when rapid deployment speed is essential.

A promising reform that has begun to receive more attention is a legal requirement that all children under the age of 12 sit in the rear seat. Several European countries (e.g., Germany and France) have had such laws since the mid-1970's and now have fewer than 1% of children riding in the front seat. In the USA, anywhere from 30 to 50% of children ride in that seating position. The National Transportation Safety Board has recently recommended that Governors and State legislators consider the value of child-seating legislation.

There are also promising refinements to airbag design on the horizon. For example, the crash speed that triggers an airbag to

Harvard Center for Risk Analysis
Harvard School of Public Health
718 Huntington Avenue
Boston, Massachusetts 02115

617-432-4497
www.hsph.harvard.edu/organizations/hcra.html



100% recycled paper,
all post-consumer fiber.

FURTHER READINGS:

Kahane, C. Fatality Reduction by Air Bags: Analysis of Accident Data Through Early 1996. Washington, DC: NHTSA, USA Dept. of Transportation; 1996.

Ferguson, S. Update on Airbag Performance in the United States: Benefits and Problems. Insurance Institute for Highway Safety; 1996.

Graham JD, Nelson T, Segui-Gomez M. The Airbag's Teflon Image: A National Survey of Knowledge and Attitudes. Harvard Center for Risk Analysis/Harvard Injury Control Center; 1997.

National Transportation Safety Board. Safety Study: The Performance and Use of Child Restraint Systems, Seatbelts, and Air Bags for Children in Passenger Vehicles. Volume 1: Analysis. PB96-917005. Washington, D.C.; 1996.

PEER REVIEWERS:

Lorenz Rhomberg, Ph.D.
Sue Goldie, M.D., M.P.H.

deploy could be raised, thereby making sure that the bag inflates only when it is really needed. Subtle changes in how airbags are shaped and folded may reduce the risk of occupant injury from deployment. Sensor technology may be employed to suppress airbag deployment when young children are occupying the front-right seat. The most ambitious ideas, often called "smart airbags", entail tailoring the characteristics of airbag deployment (e.g., speed and volume) to characteristics of the crash (e.g., low vs. high-speed) and the occupant (e.g., short vs. tall occupants).

Innovation in airbag design may not require an extensive regulatory program since consumer interest in the technology is well developed. Congress should encourage NHTSA to pursue an informational approach to innovations in airbag design while gradually allowing more consumer

choice about whether to buy an airbag and what kind of airbag to buy, given a buyer's safety needs and physical vulnerability to injury.

In summary, although the case for the driver-side airbag remains fairly compelling, the case for the passenger-side airbag is less convincing. The benefits and risks of airbags to adult passengers are in urgent need of careful study. Even if passenger airbags prove to be as effective for adults as driver-side airbags are, the danger to children remains a problem. Unless children ride in the back seat or the technology becomes "child-friendly", there will remain doubts about whether passenger-side airbags are an appropriate public health measure. These doubts are evident outside the USA where there is less interest in passenger-side airbags.

Figure 1. Perceptions among USA residents regarding airbags. Selected findings.

| Statement (<i>correct answer</i>) | True | False | Don't Know |
|--|------|-------|------------|
| Airbags are not a danger to an infant in the front seat if the infant is restrained in an approved, rear-facing child restraint device. (<i>False</i>) | 26% | 67% | 7% |
| If a driver is seated too close to the steering wheel, the airbag can cause serious injury or death to the driver in a crash. (<i>True</i>) | 71% | 19% | 10% |
| The lives of more female drivers have been saved by airbags than have been killed by airbags. (<i>True</i>) | 68% | 17% | 15% |
| The lives of more children have been saved by airbags than have been killed by airbags. (<i>False</i>) | 60% | 30% | 10% |
| If a driver wears his/her seatbelt properly, the chance of being injured by an inflating airbag is minimal. (<i>False</i>) | 78% | 17% | 5% |
| Airbags cause at least as many injuries to drivers as they prevent. (<i>Don't Know</i>) | 27% | 67% | 6% |
| A majority of the lives that have been saved by airbags have been among people who were not wearing seatbelts. (<i>True</i>) | 39% | 51% | 10% |