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Air Bags: Saving Lives at Any Cost? A Public Health Perspective

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"An air bag takes another young life," laments a polished anchorwoman on the local TV nightly news. Sensational and heart-rending, stories like this are the grist of the media. But for the public, it's caveat emptor; we're usually on our own to make sensible judgments based on what we see on TV or read in the paper. Broadcasts such as these have actually sent panicked car owners to their local auto dealers to have their air bags disabled. Are such rash measures really warranted?

According to the latest National Highway Traffic Safety Administration (NHTSA) data,[1] air bags are effective in preventing fatalities in 11% of all crashes; 31% in purely frontal crashes, and 19% in all frontal crashes. Based on the 11% overall figure, they have saved 1,198 lives between 1987 and 1995, with 475 lives saved in 1995 alone. With an increase in the number of installed passenger side air bags from 1.4 million in 1993 to 21.6 million in 1996 (and with new federal motor vehicle requirements mandating them in light trucks by the year 1999), this life saving trend can only be expected to continue.

In other cases, it's complacency, rather than panic, that consumers experience. Thanks in part to creative advertising, such as the TV commercial that displayed survivors of high speed, head on collisions seemingly unscathed, many of us have come to regard air bags as a convenient excuse to forget about the restraint belts once and for all. Yet statistics paint a different picture.

Air bags alone provide only a 13% reduction in fatality risk. If you combine the air bag with wearing seat belts and shoulder harnesses, you add an additional 9% reduction in fatality risk. Compare that to the 45% risk reduction for restraint belts alone. Combined, however, they offer an estimated 50% fatality-reducing effectiveness. How about the risk of serious injury? Restraint belts, again, are clearly superior -- 60% reduction compared to a meager 7% reduction for air bags alone. And again, for moderate injury, combined use reduces risk about 60%. The unambiguous conclusion is that combined use, as was intended by the

manufacturer, is the most effective method:[2-6] The initials SRS, usually found on the passenger module cover, stands for supplemental restraint system.

Currently, only a few manufacturers have fitted cars with side air bags, but these can be expected in more cars in the near future, along with a corresponding offer of improved safety in side impact crashes. Mercedes Benz has an experimental vehicle with no less than 19 air bags and, while this seems rather fanciful, knee bolster air bags will be a likely addition to frontal and side systems in the near future. TRW is even planning to introduce a head restraint air bag to prevent whiplash injuries.

The Problems

With all of the hoopla generated by the media, we have forgotten to ask an important question: what is the risk/benefit ratio of air bags? It is certainly true that serious injuries and, in fact, several fatalities have been blamed on air bag deployment. And minor abrasions and ocular injuries are common. In one study,[7] 96.1% of all injuries were classified as minor, with facial injuries accounting for 42%, followed by the wrist (16.8%), forearm (16.3%), and chest (9.6%). Most of us would agree, however, that recovering from a broken arm beats a reverse view of daises any day. In truth, many of the injuries associated with air bags are seen in those who might not have survived without them.

Some of the most common injuries reported from air bag deployment are ocular lesions. Corneal abrasions are most common and are usually not serious.[8,9] More serious injuries reported include retinal detachment,[9] corneoscleral laceration,[10] lenticular subluxation and blindness,[11] corneal rupture,[12] alkali keratitis from chemical burns,[13] retinal hemorrhage,[14] and vision-compromising injuries from broken eyeglasses.[15]

Other common, but not life threatening injuries include burns from the hot gas exhausted from the air bag and injuries to the upper extremities related to the deployment of the air bag. When the bag mechanism is fired, a sodium azide propellant burns to create hot, but inert, nitrogen gas which inflates the bag so quickly that it deploys at 165-210 mph. In the ideal scenario, the occupant is riding down against the restraint belts as the bag deploys fully, and strikes the bag only after it is fully inflated. Exhaust vents then allow a controlled deflation on contact, providing further ridedown.

If the driver’s hands are over the plastic module cover when it opens, serious injuries can result, including traumatic amputations of fingers, degloving, and fractures. These latter can be multiple and bilateral creating

severe disability. Similar lower extremity injuries have occurred when passengers had their feet over the passenger module covers when they inflated. In other cases, flailing injuries result from the deploying bag or module cover, where the hand is thrown into the face or strikes other hard parts of the car's interior. Objects in the mouth, such as a tobacco pipe,[16] or in the hands present special risks. Temporomandibular joint injuries have also been reported.[17]

In a landmark report by Dalmotas et al.,[18] it was demonstrated that in areas with a high seatbelt use, such as the U.S. and Canada, air bag deployments at low speeds serve no useful purpose and, indeed, due especially to upper extremity injuries resulting from direct air bag contact, can actually negate the cost effectiveness provided by these systems in their life saving role in higher speed collisions.

Apart from the risk/benefit cost analysis issue, the most pressing concern for those of us in the health care, research, and public health fields, are the fatalities directly attributable to air bag deployment. Most of these, paradoxically, have occurred at low speeds where air bag deployment would not have been necessary. The most frequent picture is that of a female driver of short stature who has adjusted her car seat in a far forward position.[19] When the bag deploys, it strikes the driver at full deployment speed (165-210 mph) resulting in violent shear and tensile forces through the spine, often causing severe hyperextension of the neck. Most deaths have been instantaneous, with fracture through the occipital condyles and traumatic rupture of the spinal cord or medulla. In other cases, elderly women have expired due to chest and cardiac trauma.[20] And finally, the deaths that have stirred the greatest controversy are the infants and children killed by the deploying passenger side air bag.

As of October 1, 1996, NHTSA1 had identified 31 crashes where air bags caused critical-to-fatal head or neck injuries to children. Eleven involved infants in rear-facing child seats, including seven deaths. All but one of the other 20 children (19 deaths) were determined to have been unrestrained or improperly restrained at the time of the crashes. All of these crashes involved pre-impact braking which brought the children into close proximity of the module covers.

The Solutions

Due to the high cost of air bag replacement and the injuries reported in children, TRW and other companies have developed sensors that will allow more sophisticated air bag systems (the "smart air bag") to determine whether the passenger seat is occupied.[21,22] If not, the air bag is deactivated. This saves greatly on needless replacement repair bills. Future child car seats will have onboard transmitters that will emit a signal to

deactivate the passenger side air bag. However, for parents driving cars with no rear seats, NHTSA continues to allow manual deactivation of these air bags. Be aware that doing so may present unique liability issues in the event that an adult passenger is injured!

This same sensor system will also determine the size, seating position, and proximity to the air bag of drivers and passengers and will allow controlled deployment (i.e., slower burning of propellant gas) of the air bag for those in close proximity. As pointed out by Dalmotas and colleagues, deployment thresholds in low speed collisions will also have to be more carefully regulated so that air bags will activate only in crash situations in which their added contribution can be balanced against the risk of air bag-induced injuries.

Meanwhile, as a public health service, physicians can advise their patients to make sure that all children ride in approved child seats and are wearing appropriate restraint devices for all trips, emphasizing that the back seat is the best place for kids. Infants in rear-facing child seats should never be placed in the front seat of a car with an activated passenger side air bag.

The best place for the hands on the steering wheel (to minimize flailing and other extremity injuries) is now in the 4 o'clock and 8 o'clock positions. Pipe smoking should be discouraged and hands (and feet) should be kept off the module cover at all times. The wearing of eyeglasses made with plastic lenses will offer some protection against eye injury.

In conclusion, air bags are generally safe and can save lives when used in conjunction with restraint belts. Newer system designs currently in development can be expected to reduce unnecessary bag deployment and consequent injuries, and to tune deployment for optimal occupant protection when deployment is necessary. Side air bags and knee bolster air bags will protect occupants in side impacts and offer more lower extremity protection in frontal impacts in the future.

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