

## Airbags and Ear Damage

By Jess Dancer, Ed.D.

A 2007 study predicts that airbag deployment in automobile accidents leads to permanent hearing loss in 17 percent of those exposed.<sup>1</sup> The prediction is based upon the Auditory Hazard Assessment Algorithm for the Human (AHA AH), a mathematical computer model of the ear which, according to the author of the study, is "designed to reproduce the ear's physiological response to virtually any intense sounds and to predict hazard from calculated displacements in the inner ear."

These surprisingly high estimates of permanent sensorineural hearing loss, based on a computer model with 95 percent accuracy, bring to the forefront again the dangers of airbag deployment to the ear in the more than 6 million automobile accidents per year in the United States alone. Even minor bumper-benders in slow speed collisions, representing little or no danger of injury to occupants who are safely buckled up, can cause the airbag to inflate.

Rushing toward startled drivers and passengers at speeds of 180 mph and with noise levels of 170 dB or more, airbags can cause many other otologic injuries in addition to permanent hearing loss. For example, researchers at the Michigan Ear Institute conducted a retrospective review of 20 patients who sustained otologic injuries resulting from airbag inflations.<sup>2</sup> The most common symptoms were hearing loss, either sensorineural, conductive, or mixed, and tinnitus in 85 percent of patients; however, 50 percent had disequilibrium, 20 percent had a tympanic membrane perforation, 30 percent complained of aural fullness, and 15 percent experienced chronic pain related to TMJ dysfunction. Ear orientation toward the airbag was found to be associated with hearing loss, aural fullness, and eardrum perforation.

Some of these conditions, such as eardrum perforation and pain from TMJ dysfunction can be medically treated with good success rates; however, tinnitus treatment is a different matter.

Tinnitus is the perception of sound in the absence of external sound stimulation. It may be caused by abnormalities within the cochlea, cochlear nerve, ascending auditory pathways, or auditory cortex. At present, no specific treatment, from diet modification to surgery, gives relief to all patients.

### Post-Traumatic Vertigo

In addition to hearing loss and tinnitus, airbags can cause post-traumatic vertigo often seen in head and neck injuries. In the Michigan Ear Institute study referenced above, benign paroxysmal positional vertigo (BPPV) and endolymphatic hydrops were two specific diagnoses given to patients with complaints of disequilibrium.

In BPPV, which is common after head injury, small calcium carbonate crystals called otoconia may be displaced from the utricle of the vestibular system and migrate to other parts of the ear, causing dizziness. It is diagnosed by observation of a pattern of dizziness that is brought on only when the head is placed in certain positions. There are several particle-maneuvering treatments, such as the Epley, which take just a few minutes to perform. The prognosis for improvement in the hands of competent audiologists is excellent.

Endolymphatic hydrops, which can also occur after head injury, refers to increased pressure of the endolymph within the inner ear system. The increased pressure causes fluctuating hearing loss, episodic vertigo, tinnitus, and aural fullness. Endolymphatic hydrops is often used synonymously with the terms Meniere's disease/Meniere's syndrome. After head injury, bleeding into the inner ear may cause hydrops by interfering with the distribution of fluid transport. Symptoms are persistent and may be delayed for months or even years. Treatments for this disorder range from diet modifications to medications to surgery.

In regards to intratympanic medications for Meniere's disease, a 2007 publication in *Laryngoscope* by Japanese researchers used MRI imaging to trace the progression of gadolinium hydrate, an injectable contrast agent, through the inner ear. The chemical was injected through the tympanic membrane. One day after its injection, it was observed in almost all parts of the organ. The researchers conclude that. "it is important for the development of intratympanic drug therapies for inner ear diseases to investigate how the drugs enter and leave the inner ear."<sup>3</sup>

### More Data

Further data on otologic injuries due to airbag deployment were presented in 2002 at the First Pan-American/Iberian Meeting on Acoustics.<sup>4</sup> A summary of 66 patients ranging in age from 4 to 81 years reported by physicians in the U.S. and Europe showed the following:

- \*52, or 79 percent with permanent tinnitus
- \*47, or 71 percent with hearing loss
- \*20, or 30 percent with vertigo, including benign paroxysmal positional vertigo (BPPV)
- \*6, or 9 percent with perforation of the tympanic membrane
- \*1, or <2 percent with perilymph fistula

A perilymph fistula is a rupture in the oval and/or round window membranes that leaks fluid into the middle ear. It is considered rare but can occur during weightlifting, head injury, and deep-sea diving. Acoustic trauma from the loud blast of a fire engine's siren, a lightning strike and complications from cochlear implantations and stapes surgery have also been reported as causes. Flight crews are particularly vulnerable during take-off and landings and are reminded to "never fly with a common cold," which may cause problems with middle-ear pressure equalization.

Symptoms of a fistula include hearing loss, tinnitus, hyperacusis, and sensitivity to pressure changes. Diagnosis includes a fistula test, which records eye movements in response to air pressure applied to the outer ear canal. Recently, identification of beta-trace protein, a component of cerebrospinal fluid, in the middle ears of most patients with fistula led German researchers to conclude that "beta-trace protein might be a promising marker in the diagnosis of perilymphatic fluid fistulas."<sup>5</sup> Treatments for this disorder include bed rest, drugs, and surgery.

In addition to the ear damage cited above in the literature, airbag deployment can potentially cause transverse fractures of the temporal bone, frequently involving the inner ear. Severe vertigo with severe or total hearing loss is not uncommon in such injuries. Even in milder injuries, labyrinthine "concussions" may cause transitory auditory-vestibular symptoms.

### Involvement of Audiologists

Audiologists are involved in the diagnosis and treatment of hearing loss, tinnitus, and vertigo associated with airbag deployment. Successful outcomes depend upon the careful evaluation and identification of the underlying disorders caused by the design of airbags, which unfortunately produce explosive pressures and noises far beyond what is necessary for safety.

### References

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Jess Dancer is professor emeritus of audiology at the University of Arkansas at Little Rock. He can be reached via email at [jedancer@ualr.edu](mailto:jedancer@ualr.edu)