

Automobile Injuries A National Epidemic

An epidemic is a widely diffused and rapidly spreading disease.' Automobile accident injuries fit this description in every way. The facts concerning cause and prevention of automobile accident injuries are not well enough understood. *Effective* group effort is minimal. If the information already known were applied to automobile safety and accepted by everyone including purchasers and drivers of motor vehicles, the automotive accident death rates and injury rates could be reduced. This paper will present the most recent available information.

Incidence

Slogans and statistics alone make a limited impression on the ordinary driver despite the fact that most of us have had personal experience with death or important injuries due to motor accidents? Nonetheless, the statistics are startling and must be reviewed. There occurs, in the United States, from automobile accidents, one death every 14 minutes and an injury every few seconds. Our Air Force losses are much greater for personnel on the ground than in the air. The story of 40,000 yearly deaths is not the most important story. More grim is the fate of more than a million permanently mutilated survivors each year. Estimates of the number vary, primarily because of inadequate reporting. Official sources indicate that five million people each year are injured sufficiently to miss a day of work or seek medical care. Such injuries have replaced infectious diseases as the fourth ranking cause of death in the United States for all ages, and are now number one for children ages live through 14 years. More than 114 million people have died from automobile injuries in the United States since the invention of the automobile. Most accidents occur within 50 miles of home at driving speeds under 40 mph. In the United States, on one single day, July 4, 1961, there were 504 deaths and 51,000 disabling injuries resulting from automobile accidents, including pedestrian injuries.

Sources of Information

Statistical evaluation provides information for future planning. Governmental agencies routinely use accident reports for this purpose. A new technique, now being used by Moseley⁷ and others,⁶ consists of extensive analysis by a trained team of experts including physicians, engineers, psychologists, mechanics, and others to learn the complete case history of each accident in consecutive automobile fatalities. This includes thorough analysis of the backgrounds of the decedents, circumstances of the accident, role of the automobile, highway, climate, and motivating factors. Extensive sociological investigation of decedents and survivors, with psychological testing of the latter, minute

dissection of the automobiles, extensive autopsy studies, analysis of hundreds of photographs of the accident scene and equipment involved are all carefully performed. Very startling information is forthcoming about automobile failures, psychological causes, need for highway improvements and, on occasion, suspicion of suicide or homicide by automobile. Information can also be pieced together to show who was driving, the path of projection of all occupants, and the structural components of the automobile that caused or contributed to death.

Another approach is by planned collision to learn about the structural integrity of the automobile as well as passenger dummy and cadaver acceleration and deceleration forces. There have been reviews of patterns of automobile injuries relative to specific parts of the body, human motivation, and projection patterns of occupants. Finally, this information is disseminated publicly and among interested professional people in the form of conferences by leaders in the field. Another statistically insignificant but sometimes emotionally powerful tool is the old fashioned testimonial, commonly used to promote sales of a commercial product. It is being used more and more to tell the story of automobile crash survival by prominent people?

One unique area that yields crash information is the sport of automobile racing. This has been a fertile field for testing protective devices and automotive structural integrity. Proper inspection and maintenance of equipment is followed fanatically by most racing drivers. Oddly enough, as Mirkin has pointed out and my experience confirms, no matter how intelligent or competent race drivers may be, the majority never voluntarily used proven devices for their own safety. All current improvements, such as seat belts, helmets, roll bars, flame retardant clothing, proper suiting and shoeing, have been forced on them. Pre race examination of drivers at a professional midget automobile race track proved to have only one purpose—to eliminate the driver who was drunk. On one occasion at an “Indianapolis type” race, a driver had a full-blown grand mal seizure while driving, sustaining severe injuries. It was later revealed that this was not the man’s first seizure; some of his competitors knew this but did not disclose it.

Role of Alcohol

The alcohol factor must be treated as a special point of interest because of its important statistical ranking. In a controlled study in New York City, it was shown that 73% of drivers responsible for accidents in which they had died had been drinking. A control group of comparable drivers not having accidents showed 26% had been drinking. The person under the influence of alcohol is the major offender. He repeats and repeats the “near miss” until his catastrophe occurs, as statistically it must. Professional people informed about the problems of chronic alcoholism have learned the futility of attempting to change this pattern by the use of slogans and advertisements. It is becoming obvious that more than half of the fatal and injury-producing accidents are caused by drinking drivers. If there were such clear-cut evidence about the cause of cancer, there would be a public demand to put an end to it?

Where does the difference lie between drinking “just a little,” having driving performance affected, and being drunk? This has been studied extensively. There is general agreement. Though individual differences do exist in the rate of alcohol absorption and performance deficit, there is almost complete agreement about the

physiological significance of the blood alcohol level and its relationship to performance. Yet, legal definitions differ. Generally, a blood alcohol level of 0.15% is accepted as proof of significant intoxication caused only by rapid ingestion of large quantities of alcohol which, in all cases, severely affects performance. This figure is undoubtedly liberal—extending individual leeway to a point beyond any shadow of a doubt. In New York, the top figure is 0.10% and in Norway, since 1926, it has been 0.05%. Oddly, in the United States, a figure of 0.05% exonerates the individual although it is known that, at this level, extensive ingestion of alcohol must have occurred and some performance impairment can be measured in almost all people. On the average, 5 oz of 70 proof whiskey produce blood alcohol levels of 0.05%, 7½ oz, 0.10%, and 10 oz, 0.15%. There is evidence to show that impairment begins at 0.03% to 0.04%. A marked increase in personal injury accidents has been reported in people with blood alcohol levels of 0.03% to 0.05%. Alcohol as a major cause of automobile injuries is not limited to the driver. In a study of 200 fatal pedestrian accidents in New York City, increasing age and consumption of alcohol were the two major identifiable characteristics. About half of those involved had measurable blood or brain alcohol levels.

What Can Be Done

Better Control of Drivers.—About 80 million automobiles are driven today. Seven out of ten people will have an important accident within the next ten years, a surprisingly low estimate in view of the kinds of diseases to which drivers are subject—impaired vision and hearing as well as fatigue and the effects of alcohol and drugs.

Drivers may be angry, old and infirm, young and inexperienced, or motivated by aggressions which cause them to use automobiles as lethal weapons. Another group of drivers are simply inattentive and unimpressed with safety devices.

Restrictive programs which have met with some success have been devised in an effort to select drivers who may be safe. Since driving is a necessity in the pursuit of gainful occupation for most people, drivers do not readily submit to examinations that might disqualify them; physicians are caught in the middle in attempting to keep unfit drivers off the road, for such patients merely find other physicians promptly.

Driver examination and legislation concerning fitness are tragically inadequate in most states. Epilepsy is a case in point. Many drivers cannot obtain driver's permits after a blackout spell although they are on adequate suppressive medication and have had no recent seizure; yet others with Meniere's syndrome, periodic paralysis, or narcolepsy, etc are unexamined and unrestricted. Uniformity of laws and individualization of applications are sorely needed.

Packaging People for Safety.—Physical restraint of the automobile occupant seems to be the most fertile field for changing injury patterns. The physician can play a prominent role by advising his patients to install and use safety belts just as he advises prophylactic vaccinations. Not satisfied with influencing his patients alone, a Corvallis, Ore, physician has supplied the spark which resulted in the installation of 1,700 seat belts in a city of 21,000 people.

What the Air Force Is Doing.—Since more Air Force personnel were being injured and killed from auto accidents than from aircraft mishaps, an accident prevention program was begun by the Air Force. It included mandatory basic driver training for

those under age 25 with special training for those assigned driving as part of their duties. Local orientation was begun, discussing factors peculiar to the area, such as climate and highway factors. Helmets were made mandatory for all cycle and scooter drivers. Efforts were made to reduce early morning accidents by encouraging personnel to return to the base earlier and more slowly. This involved telephone calls to the homes of personnel toward the end of leave time. There was also an extensive investigation of each fatality. There was an immediate 37% decrease in fatalities. In the last three years, it is estimated that the lives of 400 Air Force personnel have been saved through this program.

Present Status of Safety Progress

Colonel Stapp pointed out that the human body cannot be redesigned, so we must turn to change of automobile design. The automobile can be sold without restriction or inspection (despite the fact that it kills thousands and injures millions of its customers every year, a dismal and probably unmatched record. A motorist should have no greater opportunity of buying a car without proper safeguards such as safety belts than he should of buying uninspected meats. Driving carefully is not enough. Moseley noted, after a crash investigation, that one particular tree was the object struck in several serious accidents—and each time, a tree surgeon repaired the tree. Cars and roads must be made safer.

Four-wheel and hydraulic brakes appeared in the late 1920's; safety glass, all steel bodies, and improved steering appeared in the 1930's. From that time on, emphasis has been on comfort, power, performance, and appearance. Finally, in 1956, safety latches were used, the last significant standard improvement until very recently. The Ford Motor Company did produce and advertise some devices such as seat belt attachments and recessed steering wheels, but sales dropped over the next year, making it apparent that safety did not sell, so these ideas were dropped, generally. There are already many proven practical safety devices not used by the automobile industry but there have been important strides made by the industry in 1962 and 1963.

Dr. Horace Campbell pointed out that education takes time, but that automobile designs and structure can be changed quickly. For two generations, the automobile industry has been redesigning its product every year but with almost no consideration of performance in crash situations although one half the automobiles made will be involved in injury-producing crashes. Minimal efforts in 1956 produced door locks that will not easily open in a collision, preventing passenger ejection. More recently, holes were drilled or punched in the floor to make seat belt installations for the front seats a trifle easier. What is really needed is complete redesign. The weirdest fins are harder to make than the safest instrument panel; the fanciest grille is more expensive than the safest automobile seat.

The Seat Belt Story—Fact and Fiction

It has been proved without doubt that a restraining device will, if properly used, decrease the injury rate and usually minimize the extent of injury. These devices are readily available and inexpensive; yet, only about 2% of the driving population has them, less than that use them, and very few of these have complete protection devices for all

passengers despite the fact that crash studies fully document the protection offered. Movies of human and dummy demonstrations with and without restraints demonstrate the value of such devices. Belts are particularly important in roll-over accidents, which constitute a fifth of all fatal rural accidents, and in ejection accidents where an otherwise modest collision is transformed into a lethal one when the occupant flies out of the door, strikes his head on the road, or is run over by his own or another automobile. The question is continually raised—what about fire? This is rare in accidents; escape from a belt can be accomplished easily and instantly. What if the occupant is unconscious? Then, of course, he cannot escape unaided with or without a restraining device. This one additional fact is often overlooked: In case of fire, there has usually been a severe accident. If the passenger has been restrained, then, he minimizes his danger of unconsciousness or inability to move because of severe injury.

What type, make, and grade of seat belt device is best? It is generally agreed that a combination of lap belt and diagonal strap is the best compromise between safety and ease of use. Sweden uses these extensively—in fact, belts are never sold singly. Recent studies have shown that a diagonal chest strap without a lap belt will not restrain sufficiently; it is possible to slither out underneath it. It has been shown further that the diagonal chest strap is best attached to the roof or door post rather than to the floor. This type of protection is particularly important in the small car where the head might strike the windshield or dashboard despite adequate hip restraint. Many people strongly advocate “going all the way” in the United States and not permitting the sale of lap belts without diagonal supports. Most experts agree that lap belt protection alone in the larger American cars offers nearly as good protection and is probably much easier to “sell.” Belts can be of various materials, shapes, and descriptions. Present standards should require a 5,000 lb test load and no failure of attachments or fabric to tear loose. In recent tests, many belts now being sold have proved inadequate? However, even if a belt should break, it may have already absorbed sufficient energy to prevent important personal injury. Perhaps the most important consideration of all is complete passenger protection. Back seat passenger projection in crashes may be more important than front seat passenger projection. Often, the back-seat passenger flies into the back of the front seat, over the front seat, or out the front window, or strikes the front seat passenger, causing the latter his only injury. A youngster standing on the back seat is particularly unstable. Back-seat belts and infant harness supports are commercially available. Great emphasis is placed on child health; yet children are permitted the unnecessary lethal exposure of unrestrained back-seat riding.

Practically all seat belt users agree that restraining devices add to comfort rather than detract from it. The devices give a feeling of security and stability and permits relaxation. No effort need be made to prevent buffeting from bumps, turning of corners, or sudden stops. The mother driving with her children in the back seat is more comfortable than when the children jump about, crawl over her, and fight with each other.

Have seat belts helped reduce injury? The duPont experience is an example. By 1960, the E. I. duPont de Nemours & Co. had made the use of seat belts mandatory on all 1,792 company cars. In that year, no time was lost from automobile accident injury.

Design for the Future

It has been demonstrated with human subjects 19 that a properly restrained person can decelerate from 60 mph to full stop within three feet without personal injury. Less is known about impact survival levels of head acceleration in man. Protective head gear is being made more and more effective. When an automobile comes to a crash halt, a second collision occurs within the car milliseconds later. Initial force propels the occupant forward with an impact equal to the deceleration rate times his own weight. If he weighs 150 lbs (68 kg), he may strike with an effective weight of 15 tons. Instruments have shown readings of 200 g at peak deceleration. The body is hurled at a straight course toward the collision until all motion is stopped. All this may take a fraction of a second or may last a few seconds.

Analyses have been made of 45,000 automobile injuries, showing the major causes of injury within the automobile. Evaluation is difficult because a frequent cause of injury may be less important than an infrequent but more serious injury-producing obstruction. In the order of importance, injuries are due to: instrument panel, ejection, windshield, steering assembly, door structures, flying glass, backrest of front seat, rear-view mirror, front corner post, and top structures. No studies of this nature have been reported with the use of seat belts.

Professor Ryan, pioneer in automobile safety, built his own car with the following devices added: seat belts, hydraulic bumpers independently hinged that would absorb and diffuse impact energy, recessed dashboard that could not be hit by the knees or head, padding under the dashboard, and padded and receding steering wheel. Others have added padding of all interior surfaces with energy absorbing materials; frame, engine, and body structure designed to absorb much of the impact energy of a collision; recessed control knobs and door handles; removal of protruding ornaments inside and out; roll-over bars; air intake and blow by exhaust eliminators to decrease the chance of carbon monoxide leaking into passenger compartment; collapsible steering shaft to give way under the impact of two and a half g's; blowout proof tires; antiskid brake system; ash trays and glove compartments which, when popped open, will not inflict fearful facial injuries; cushions and seats which cannot fly about; uniform position of control knobs with handles of distinctive design so that, even at night, they can be identified by touch. An example of such a revolutionary car is the Survival Car II outfitted by the Liberty Mutual Insurance Co.

Other publications have stressed additional equipment to include padded head-rests to prevent whiplash types of injury, removal of tinted windshields, use of tempered rather than laminated glass, better engineering to prevent interference between use of brake and accelerator, steering wheel too close, and so forth. Use of moving rather than blinking directional signals; standardization of rear lamp position, color, and relative intensity; use of separate brake light; colored rear-light indicator when foot leaves gas pedal; gas pedal pressure speed control device without forced governing of speed; visual and auditory speed warning devices; brake pedal to be used by either foot; rigid bumper back-up plate with energy absorbing material between it and the bumper; complete wrap-around bumpers rigidly attached to frame and having energy absorbing padding; fuel-monitor light to warn against inadvertent stopping on high-speed highway, 180° forward visibility from driver's seat; no headlight shades (to minimize pedestrian injury); rounded

hoods to protect pedestrians; no sharp hood ornaments; red light night illumination of dashboard; recessed ceiling lights; rear windshield wipers and defrosters; recessed package shelf; roll-over strength in roof; roof padded on inside to protect against head injuries; inertia reel seat belts; constant radius of curvature in windshield to prevent distortion; fuller sweep design of windshield wipers; and design of seats moulded to persons' natural pressure distribution.

What Kind of Glass to Use

The first true safety glass appeared in the 1920's. This laminated glass consisted of two sheets of glass bonded to a tough sheet of plastic. It undoubtedly saved many lives but can be broken. When penetration occurs, the resulting lacerations can be extensive. Tempered glass is harder and requires greater force to break, but, when it does break, it disintegrates into myriads of pea-sized round particles that will not lacerate. It has been used in the back window since the 1930's, and, for several years, in side windows. The primary objection to its use in front is that, if it is struck but does not break up and fall apart, it may become completely opaque. This could occur from a flying stone in ordinary driving and would be an obvious hazard. In addition, glaziers do not like this glass because it cannot be cut into various sizes. Entire windows made to specifications must be used for replacement. The automobile industry is influenced by the facts that it is cheaper to make and less likely to break.

Special Studies

Extensive, costly studies have been performed duplicating crash conditions using various makes of automobiles with planned engineered collisions at specified rates of speed, angle, and position of impact and outfitted with anthropometric dummies. Careful analysis of all crash forces is made, and extensive pictorial measurement is made by at least 25 high-speed cameras inside and outside the automobiles, taking pictures at the rate of 1,000 or more frames per second. These studies have been daring, imaginative, and have provided information of incalculable value. A normal speed picture of dummy movement in a collision may reveal nothing of great interest. Upon review of the same picture under extreme slow motion, it can be seen that, often, the dummies leave the back seat, fly into the front seat under the dashboard, and back again to a sitting position on the back seat. These dummies are tested with and without restraints, vary in weight and size, and are fully instrumented with accelerometers. These studies confirm the facts that safety door latches on all cars since 1952 afford considerable protection against ejection. In addition, roll-over accidents have decreased since there has been a lowering of the center of gravity.

What Else Can Be Done

Physicians Can Help.—Health advice regarding automobile safety should be part of medical care in the doctor-patient relationship and by public forum to encourage better car design and set an example for better driving, decreased alcoholic intake before

driving, and to encourage legislation where indicated. The special problems of automobile safety are being treated as a special course in one medical school—which is realistic since automobile fatalities outrank infectious diseases as a major cause of death.

What Can Be Done By Insurance Companies.—It has been suggested, with some wisdom, that insurance companies could benefit themselves as well as help promote safety measures by lowering insurance rates or increasing benefits for cars with proper safety devices, especially seat belts, and by insisting on their use in public carriers such as taxicabs. They might recognize, by some sort of merit award, accidents involving automobiles where safety devices appeared to minimize personal injury.

What Can Be Done by Government.—Strong encouragement can be given free enterprise to promote existing safeguards. Legislation can be pushed where it seems necessary; law enforcement can recognize the merit of use of safety devices and consider such use a basis for leniency in dealing with offenders; and all government vehicles could set a standard for practice in safety device utilization as well as in automobile selection. One slightly helpful trend is “Good Samaritan” legislation, holding the physician harmless from malpractice suit when he stops to help an injured motorist or pedestrian.

How Bad Are the Injuries

There is much written and gossiped about the “Green Poultrice Treatment” of spine injuries. This actual phrase was used publicly in a paper by a leading physician at a medical convention, recently. Engaging in irresponsible statements and petty debate will not help the injured driver nor prevent accidents. False claims can be expected. So prominent are the doubters that almost the only group of physicians who really understand the symptoms produced by spine injuries are those who have had them. Evidence is abundant showing the frequency with which severe fractures are missed in physical examination and by x-ray! The fantastic gyrations and forces applied to the neck region in unrestrained subjects undergoing rapid acceleration or deceleration can be appreciated only through observation of high-speed motion pictures. These devastating events can occur with modest impact forces causing very little monetary damage to the automobile and no immediate signs of injury. Personal accounts by responsible people involved in these accidents are legion.

Summary and Conclusions

A comprehensive review of the present status of knowledge of factors relating to automobile injuries is presented. The general disregard of proved safety measures is emphasized. Suggestions for significantly lessening the incidence and degree of injury and frequency of fatality are presented. Most prominent among these is the immediately available, reasonably inexpensive, proved method of passenger restraint—the seat belt. Almost as important, but much less easily achieved in view of past failures, is the need for better automobile design, inside and out.

PETER FISHER, MD
500 Wall St
Seattle, Wash 98121