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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: August 8, 1986
In reply refer to: H-86-49

To: Associations and Groups
Concerned with Emergency Medicine
(see attached list)

For many years, the National Transportation Safety Board has supported efforts to increase the use of seat belts to protect motorists from severe injury or death in crashes. More recently, however, the Safety Board has felt that it would be useful to undertake a special crash investigation program focused on accidents involving the use of seat belts to learn more about their performance. This view was based on a number of facts. First, the manual belt systems in motor vehicles today are not required to be dynamically tested for crash protection performance (those requirements are limited to passive systems, such as passive belts or airbags). Second, data on real-world performance of belt systems are limited. Furthermore, there have been basic changes in vehicle designs over the years that could affect the performance of belt systems designed for vehicles of the 1970's.

Therefore, in the fall of 1984, the Safety Board embarked on a program to investigate approximately 200 crashes in which the crash performance of seat belts would be thoroughly examined. A careful examination of the case vehicle was carried out in each crash investigation, documenting its "vital statistics" and information about the restraint system available to each occupant. The size, weight, and seating location of each occupant was determined. For each occupant, the investigator determined whether the available seat belt was used, whether it was used correctly, the nature and severity of each injury sustained (expressed in terms of the Abbreviated Injury Scale), and the probable source of each injury. Necessary measurements were made that permitted the Safety Board to estimate the collision severity in terms of the velocity change ("Delta V") experienced by the case vehicle. Based on these data, an analysis could be made of the performance of each belt system in use during the crash, and some overall conclusions drawn about the role of belt restraint systems in the crashes studied.

After about a quarter of the investigations had been initiated, several cases involving lap belted rear seat occupants began to draw the Safety Board's attention to these belt systems in particular. For example, in one case involving a collision of Delta V 25.7 mph, the lap/shoulder belted front seat occupants sustained no injuries, while the lap belted left rear seat occupant sustained three critical intra-abdominal injuries, two severe intra-abdominal injuries, five serious intra-abdominal injuries, one serious hip injury, one moderate intra-abdominal injury, and three moderate hip injuries--all induced by the lap belt itself. This man died after 39 hours in the intensive care unit.

In all, the Safety Board was notified of 26 accident cases involving lap belt restrained occupants that also met the other notification criteria established for the program. The Board has issued a report of its findings on the performance of the seat belts used in these 26 cases--50 lap-only belts, 32 lap/shoulder belts--and on the experience of the 57 unrestrained occupants in these cases and in 3 other cases involving only unrestrained occupants, studied for comparison purposes. In addition, one case involving front and rear seat occupants, all using lap/shoulder belts, was studied, again for purposes of comparison. 1/

It is important to remember that this study is limited in two important respects. First, the crashes examined (with one exception) were all frontal crashes. Results derived from analysis of frontal collisions cannot be applied to other crash configurations. The benefits that may be derived from lap belt use (compared to no restraint) in minimizing the possibility of ejection during rollover or side impact cannot be discovered through analyzing frontal collisions. Second, the small size of the sample in this study means that no statistically valid conclusions can be drawn from it. The Safety Board's study is a case study which emphasizes the collection of accurate, complete data on a number of specific points relevant to the question of belt performance.

The report presents the following:

- o an overview of the findings of the lap belt crash investigation program,
- o brief summaries of several illustrative cases and discussion of their significance,
- o a discussion of why large-scale databases have been inappropriate for assessing seat belt effectiveness,
- o a description of what has been known about lap belts and lap/shoulder belts since their use began in the 1960's, including knowledge of the special problems in diagnosing and treating lap belt injured persons,
- o the relationship of the Federal Motor Vehicle Safety Standards to lap belt and lap/shoulder belt installation, and
- o recommendations for improving occupant restraint systems and for improving the handling of persons injured in motor vehicle crashes while wearing a seat belt.

The Safety Board concluded that, overall, the crash performance of the lap belts in the 26 cases investigated was very poor. Among the 50 persons using a lap-only belt, the Board determined that at least 32 of them would have fared substantially better if they had been wearing a lap/shoulder belt. In many cases, the lap belts induced severe to fatal injuries that probably would not have occurred if the lap belts had not been worn. The occurrence of lap belt induced severe to fatal injuries was not limited to severe crashes: 14 lap belted occupants sustained belt induced injuries of AIS 3 or greater severity (including 6 fatally injured) in crashes of Delta V 28 mph or lower. Even

1/ For more detailed information, read Safety Study—"Performance of Lap Belts in 26 Frontal Crashes" (NTSB/SS-86/03).

correctly 2/ worn lap belts induced severe injury: 24 occupants who received AIS 3 or greater injuries from the belt itself are believed to have been wearing it correctly. Twenty-six of the lap belted occupants sustained serious to fatal injuries in crashes in which other occupants--either unrestrained or lap/shoulder belted, and often seated in the more vulnerable front seating locations--were less seriously injured or not injured at all. The injuries characteristically induced by the lap belt were among the most dangerous types of injuries: those to the head, spine, 3/ and abdomen. The ages of lap belt injured persons ranged from 4 to 82 years (more than half were younger than 15 years, however) and included both males and females. Finally, the postcrash medical handling of several of the lap belt injury victims demonstrated the need for improved understanding by medical personnel of the possibility and gravity of seat belt induced injuries in motor vehicle crashes.

The Safety Board is aware that the cases investigated in its project are not representative of the range of real-world accidents and, therefore, the findings are not necessarily representative of overall lap belt performance. That is, it may be that if sufficient, accurate data were available on lap belt performance in crashes, it would be shown that lap belts reduce crash losses to a greater extent than they increase them. Unfortunately, the data needed to make such a showing are not available.

As part of this study, the Safety Board examined many studies that have been used in attempts to determine seat belt effectiveness. The types of work done in this area fall into three general categories: observational surveys of restraint use, laboratory tests, and analysis of large databases, most of which are derived from police accident records. Observational surveys, while useful in providing estimates of belt use rates by nonaccident-involved occupants, provide no information on accidents and injuries. Laboratory tests can provide certain kinds of information about belt performance, but the enormous variations in crash possibilities and human responses cannot be approached in the laboratory, thus severely limiting the significance of laboratory tests for estimating real-world belt performance.

Most effectiveness studies are based on analysis of data derived originally from police accident reports. Studies based on one or more States' traffic accident databases are examples of these; the Fatal Accident Reporting System (FARS) of the National Highway Traffic Safety Administration (NHTSA) is another (the FARS database is limited to fatal accidents reported by the police). Other studies are based on analysis of data from the NHTSA's National Accident Sampling System (NASS) or its predecessor, the National Crash Severity Study (NCSS). These two databases consist of a sample of accidents, drawn from among all police-reported accidents, that were reinvestigated for inclusion in the NASS or NCSS database. For a variety of reasons, discussed in detail in the report, none of these databases (singly or in combination) provide wholly suitable information for estimating the real-world performance of seat belts.

2/ There is no officially agreed-upon definition of "correct" lap belt use, but the Safety Board used the term to mean snugly crossing the lower abdomen between the pubis and the umbilicus, with the belt low on the hips below the crest of the ilium. This appears to be the generally accepted meaning.

3/ In this study, lap belt induced head and spine injuries are those brought about by the violent jackknifing motion over the lap belt—injuries that would not have occurred but for the use of the lap belt.

Based on the information collected by the Safety Board in its special crash investigation program and corollary research, summarized in its report, the Board concluded the following:

- In frontal collisions, persons using lap-only belts may not be adequately protected against injury and may sustain additional injuries, induced by the lap belt itself.

- Lap belts may induce injury, ranging in severity from minor to fatal, to the head; spine; abdomen; intra-abdominal viscera, connecting tissue, and blood vessels; and intra-thoracic viscera, connecting tissue, and blood vessels. Such injuries may occur singly or in combination.

- The types of injuries induced by lap belts can be difficult to diagnose, particularly if attending medical personnel are unfamiliar with the symptoms or are unaware that serious injury can be belt induced; in some cases, symptoms of belt induced injury may not become apparent for some time. Inadequate medical treatment may also occur if attending medical personnel have been misinformed about the patient's use or nonuse of a belt system, about the type of belt system used, about whether the patient was ejected during the crash, or about other important facts of the crash.

- The gravity of typical lap belt induced injuries is such that if appropriate treatment is not provided quickly, serious irreversible consequences, including death, may result; some physicians advise that medical personnel attending a motor vehicle crash victim should suspect serious injury has occurred, particularly if lap belt use is known or suspected, and to act quickly to explore this possibiity and begin appropriate treatment.

- Because of a variety of weaknesses in available accident databases, it is not possible to determine the overall effectiveness of lap belts in preventing fatalities and reducing injury; the Safety Board is unable to state with confidence whether passenger vehicle occupants should be advised to use rear seat lap belts or not.

- The relative inadequacy of lap belts to provide crash protection, and their ability to induce serious injury, have been known for many years to researchers, some parts of the medical profession, and to others concerned with occupant crash protection.

- Lap/shoulder belts provide superior crash protection to that of lap belts alone, and present a significantly lesser risk of induced injury; such systems appear to work effectively even for children, and they can be used with child safety seats and booster seats.

The Safety Board believes that many emergency medical personnel, including those operating ambulance service, police or fire rescue personnel, emergency room nurses and physicians, and others called on to treat motor vehicle crash victims remain unaware of the possibility and gravity of seat belt induced injuries. Although the Board found many articles in leading medical journals concerning this problem, it appears that there is still a widespread lack of understanding in this area. In 6 cases reviewed by the Board, out of the 26 in which a lap belted person was involved (nearly 25 percent), there was serious question about the adequacy of the medical handling of the lap belted victim. In some there was little doubt that poor diagnosis and inadequate treatment contributed to the death of a person who might well have survived with prompt, appropriate treatment. As more people begin to use their belt systems, it will be very important for the medical community to educate itself about the type of injuries they may be called on to diagnose and treat, and take action to ensure that this knowledge is rapidly and effectively disseminated to those who will need it.

As a result of this safety study, the National Transportation Safety Board recommends that associations and groups concerned with emergency medicine:

> Through communication with your organization's members and with other medical personnel, disseminate informed guidance to those called on to treat motor vehicle crash victims concerning the nature, severity, and appropriate handling of injuries that can be sustained by those using belt restraint systems. Ensure that emergency medical personnel receive training on the internal, head, and spine injuries that should be suspected in the case of crash victims who were using a lap belt, and the urgency of proper diagnosis and treatment. Encourage those emergency personnel who transport injured crash victims to relate accurate information to hospital emergency room personnel concerning the circumstances of the victim's involvement in the crash (seating location, use or nonuse of seat belt, type of belt used, etc.) (Class II, Priority Action) (H-86-49)

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility ". . . to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any actions taken as a result of its safety recommendations and would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation H-86-49 in your reply.

GOLDMAN, Acting Chairman, BURNETT, LAUBER, and NALL, Members, concurred in this recommendation.

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