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The Effectiveness of Center High Mounted Stop Lamps A Preliminary Evaluation

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16. Abstract

This is the National Highway Traffic Safety Administration's initial evaluation of the effectiveness of production Center High Mounted Stop Lamps (CHMSL), which have been standard equipment on passenger cars since September 1985. It is based on a census of police reported accidents that occurred at the 50 National Accident Sampling System (NASS) areas between June 1 and September 5, 1986, a nationally representative data set. The involvement rate in rear impacts for model year 1986 cars (all CHMSL equipped) is compared to 1985 cars (mostly without the lamps). CHMSL reduced the likelihood of being struck in the rear while braking by a statistically significant 22 percent. (In the NASS data, CHMSL reduced rear impacts of all types by 15 percent; since earlier studies indicated that two thirds of all rear impacts involve braking by the struck car, the 15 percent overall reduction is equivalent to a 22 percent reduction of rear impacts while braking.) The data also suggest that CHMSL may be especially useful in preventing chain collisions involving three or more vehicles. All effectiveness estimates have to be considered preliminary and may change in follow-up studies based on larger accident samples.

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INTRODUCTION

Center High Mounted Stop Lamps (CHMSL) have been standard equipment on all passenger cars sold in the United States since September 1, 1985. They are required by an October 1983 amendment [1] of Federal Motor Vehicle Standard 108 [2]. The amendment requires "an additional small red stoplamp mounted on the centerline of the rear of the automobile with specified ranges of vertical locations and brightness. The vertical location is specified with the intent of positioning the lamp higher than conventional stoplamps. The lamp is actuated only by braking. [Until September 1, 1986, it was permitted for CHMSL to be actuated by the hazard warning switch as well as by braking.] Accident reduction, specifically in the group of accidents in which braking by the struck vehicle is a critical factor, is the purpose of the CHMSL [3]." Before the requirement was promulgated, the lamps were shown to reduce the reaction time needed by the driver of a following vehicle.

NHTSA sponsored installation of CHMSL on vehicle fleets comprising over 3000 telephone company cars and taxicabs and accumulating over 40 million miles of highway experience. The CHMSL equipped cars had 53 percent fewer "CHMSL relevant" rear impacts - i.e., where the driver actuated the CHMSL by braking prior to being struck - than control fleets with conventional lamps [3]. The effectiveness observed in these fleet tests is not necessarily comparable to the results of this preliminary evaluation, because the fleet tests included all impacts reported by the drivers of the fleet vehicles, even those not causing any damage, whereas this evaluation is based on police reported accidents, which exceed some minimum damage criterion, usually at least several hundreds of dollars.

Several hypotheses have been advanced to suggest why the lamps might be effective. Since its central location makes the "CHMSL separate and distinct from all other rear lamps and signals, any possible ambiguity of the signal is reduced," especially, the "likelihood that the signal will be interpreted as a directional signal....An additional benefit of the central location of the brake lamp may be that it lies in an area of the forward visual field toward which a following driver most often glances [3]." The CHMSL, in combination with the two lower side mounted lamps, forms a triangle which could be an additional cue to get the driver's attention. Finally, it is possible that the high mounting of the lamp makes it visible through the windows of a following vehicle and enables the driver of the third vehicle in a chain to react to the first car's braking.

The CHMSL amendment is one of the first NHTSA regulations for which a comprehensive evaluation plan [4] was published at the time the rule was promulgated. The plan outlines several statistical analyses of accident data to determine the actual effectiveness of production CHMSL in reducing rear impact crashes, after the rule takes effect, plus studies of the actual cost of production lamps.

The first accident analysis outlined in the plan has been completed and is the subject of this report. It is based on accident data collected around the United States by the agency's 50 National Accident Sampling System (NASS) teams during the summer of 1986. The evaluation plan warns of the possibility that the effectiveness of CHMSL may change in future years as more and more of the fleet will have the lamps. Therefore, the results of the NASS study, although statistically significant

and nationally representative, must be considered preliminary and subject to change as additional data are analyzed.

ANALYSIS TECHNIQUES

The objective of the study is to compare model year 1986 passenger cars, all of which have CHMSL, to 1985 cars, most of which do not. (A small but significant proportion of the 1985 cars do have CHMSL and, as will be shown below, the analysis has to be adapted to account for that fact.) Specifically, the intent is to compare the likelihood of 1985 vs. 1986 cars being involved, while braking, as the struck vehicle in front to rear collisions with other vehicles (a so-called "CHMSL relevant" crash involvement). CHMSL are assumed to have little or no effect on accident risk in crash modes other than rear impacts - i.e., the striking car in a front to rear collision or either car in a head on or front to side collision - or even in rear impacts where the driver did not activate the lamp by braking. These other crash modes act as a control group or measure of exposure for the 1985 and 1986 cars. Let

C_{85} = n of MY 85 cars in CHMSL relevant crashes (struck in the rear while braking)
C_{86} = n of MY 86 cars in CHMSL relevant crashes
I_{85} = n of MY 85 cars involved in other vehicle to vehicle collisions
I_{86} = n of MY 86 cars involved in other vehicle to vehicle collisions

The reduction of CHMSL relevant accident risk in model year 1986, relative to 1985 is

$$E = 1 - [(C_{86}/C_{85}) / (I_{86}/I_{85})]$$

This reduction can be attributed to CHMSL unless there are other factors that cause the 1985 and 86 cars to have significantly different crash mode distributions. For example, the 1985 cars are a year older

than the 86 models at the time the accident data are collected; if older cars have relatively fewer/more rear impacts, it could bias the results. The possibility of biases was explored in a preliminary analysis of the crash mode distributions of 1978-84 model year cars (all pre-CHMSL) in the 1982-84 NASS files. The investigation showed that the proportion of accidents that are rear impacts was insensitive to the age of the car as well as the model year, never varying by more than 1 percent from the overall average (within sampling error) and showing no trends in any direction. It can be concluded that the one year age difference between the 1985 and 86 cars is likewise of negligible importance and that E is in fact due to CHMSL.

The accident reduction from model year 1985 to 86, however, does not fully measure the effectiveness of CHMSL because many 1985 cars already had CHMSL in advance of the federal requirement. Some of the 1985 cars were built with CHMSL while others were retrofitted some time after the original sale. Let p be the proportion of the 1985 fleet which had CHMSL at the time the accident data were collected. The true effectiveness of CHMSL in reducing rear impact accident risk is

$$e = E / (1 - p + Ep)$$

because

$$1 - E = [1 - e] / [(1-p) + (1-e)p]$$

The proportion of the 1985 fleet which had CHMSL is not known exactly but can be approximated with some precision. Fortunately the above formula for effectiveness is rather insensitive to changes of a few percent in p. The only 1985 makes and models which were built with CHMSL as <u>standard</u> equipment were most types of Cadillacs [5] [6] [7] [8]. In

this case, where the CHMSL vehicle is readily identifiable, it is better to exclude all Cadillacs from the 1985 and 1986 accident data than to include them and count their sales toward p. CHMSL were sold as optional equipment on several other 1985 GM models (106,144 cars total) [5] and on 5,002 Ford Motor Co. cars for government fleets [7]. A substantially larger number of vehicles were retrofitted with aftermarket CHMSL. Inquiries to lamp manufacturers [6] and the American Automobile Association [9] (who sold a large number of these CHMSL to their members) suggest that approximately 4,000,000 aftermarket CHMSL were produced during 1982-86. Perhaps about 3,000,000 of them were actually sold at retail and installed on cars. Inquiries to the AAA indicated that most of the lamps were installed on model year 1980-85 cars - i.e., an average of 500,000 cars per model year - but proportionately more on the later model years. Thus, it is possible that close to 1,000,000 model year 1985 cars were retrofitted with CHMSL. When that quantity is added to the 111,146 that were originally sold with CHMSL (excluding Cadillacs), it appears that about 1,100,000 cars, or 10 percent of all model year 85 cars are now CHMSL equipped. Given the extensive uncertainty about the number of retrofits, a range of $p = 5$ percent to $p = 15$ percent, with $p = 10$ percent as the best estimate, will be used in the preceding adjustment formula for CHMSL effectiveness.

DESCRIPTION OF THE DATA

The National Accident Sampling System (NASS) operated during 1986 in 50 geographical areas, selected by probability sampling, which are a representative cross section of the United States [10]. Each of the 50

areas is an entire county, a group of contiguous counties, a large central city, or the portion of a large metropolitan county which is outside the central city. NHTSA has a contract accident investigation team operating in each of the areas. A team regularly visits every police station in its area (or, in the case of the most populous areas, a probability sample of the police stations) and scans all police accident reports submitted to the station. In all, the 50 teams scanned a nationally representative sample of about 5 percent of the police reported accidents in the United States. Ordinarily, the teams pick a subsample of these police reports and perform detailed investigations of their own. The CHMSL data, however, were collected as a NASS Special Study. They potentially included every police report scanned by the teams, not just the detailed investigation subsample. The data for the analysis were transcribed directly from the police report, without the team gathering additional information in the field.

The special study operated as follows: a team visited a police station and reviewed all accident reports that had been submitted since their last visit. An accident was included in the study if:

(a) Two or more vehicles were involved. Single vehicle crashes were excluded.
(b) At least one of the vehicles was a model year 1985 or 1986 passenger car. Accidents involving only pre-1985 vehicles and/or 1985-86 trucks, motorcycles, etc. were excluded.

If a crash met criteria (a) and (b), the team entered the following information about each vehicle involved in the crash onto a special form, based on the police report:

- Date of the accident
- Time of day
- Police report number
- Vehicle number in the accident (as shown on the police report)

- Vehicle model year
- Vehicle role (striking, struck, or both)
- Primary impact site (front, left side, right side, rear, unknown)
- Secondary impact site (if the vehicle had 2 impacts)
- Vehicle eligibility category (eligible vehicles are passenger cars other than Cadillacs; ineligible vehicles are Cadillacs, trucks, motorcycles, etc.)

"Impact sites" were assigned by the teams based on information in the police report, with a rather inclusive definition of what constitutes a "rear impact." Rear corner impacts were included among rear impacts. If the police showed damage location on a diagram of a car, rear impacts included any cars with damage behind the C pillar if the striking car was traveling in the same direction as the struck car. If police used the TAD scale [11], rear impacts included any damage codes starting with "B." Note that "rear impacts" include all crashes where a car was struck in the rear, not just the "CHMSL relevant" ones where the car was braking before impact. This is because police reports do not usually allow an identification of which accidents were CHMSL relevant. "Vehicle eligibility category" is used to identify vehicles that are excluded from the analysis: Cadillacs, because they already had CHMSL in 1985 and, as stated previously; trucks, etc., because they did not have CHMSL even in 1986.

When a crash had a 1985 or 1986 passenger car with rear impact damage, the team submitted a copy of the police report to NHTSA in addition to the special form. When a crash had 1985 or 86 cars, but none of these cars had rear impact damage, the information was encoded on the special form and used in the analysis, but the police report was not submitted. As stated above, crashes not involving 1985 or 86 cars were not selected even for coding on the special form. Together with the NASS team number, the information on the special forms was written to a disk

file. The automated data file, then, contains one record for every vehicle involved in the collisions that met the study criteria (a) and (b). The teams began scanning police reports for the special study on June 1, 1986; however, accidents which occurred before June were excluded even if the police report was scanned after June 1. The data used in the analyses of this preliminary report include all accidents scanned through September 5, 1986. The data file contains 28,886 vehicle records. A follow-up report will include accidents scanned through December 31, 1986, the last day of the special study.

One major difference between the special study and earlier CHMSL analyses based on test fleets is that the latter focused on "CHMSL relevant" crashes - i.e., those in which the driver of the struck vehicle was known to have been braking before the crash, activating the CHMSL and/or conventional stop lamps. The use of police reports in the special study, as stated above, does not usually allow the identification of which accidents are CHMSL relevant; therefore the first step of the analysis is based on all rear impacts, not just the CHMSL relevant ones. An adjustment factor is needed to obtain CHMSL relevant crash reduction. Digges found that approximately two thirds of all rear impacts in the test fleets were CHMSL relevant [3]. In the absence of other information, it is assumed that the same proportion of the NASS rear impacts were CHMSL relevant. In order to make the NASS results comparable to those of the earlier fleet tests, it is necessary to increase the effectiveness in the special study (overall rear impact reduction) by half, as follows. Let

R_{85} = n of MY 85 cars involved as struck vehicle in front to rear impacts
R_{86} = n of MY 86 cars involved as struck vehicle in front to rear impacts
O_{85} = n of MY 85 cars involved in other vehicle to vehicle collisions (striking veh. in front to rear; either veh. in head-on or angle)
O_{86} = n of MY 86 cars involved in other vehicle to vehicle collisions

The reduction of rear impact (all types - not just CHMSL relevant) involvement risk in model year 1986, relative to 1985 is

$$E' = 1 - [(R_{86}/R_{85}) / (O_{86}/O_{85})]$$

This quantity is first adjusted to account for the fact that some proportion p of the 1985 cars have CHMSL.

$$e' = E' / (1 - p + E'p)$$

is the effectiveness of CHMSL in reducing overall (not just CHMSL relevant) rear impact risk. Finally, the reduction of CHMSL relevant accidents is

$$e = e'/.67$$

EFFECTIVENESS OF CHMSL

OVERALL EFFECTIVENESS - Table 1 is the basic analysis of CHMSL effectiveness. The first step in the derivation of the numbers in Table 1 is to exclude the records of all vehicles on the automated file which

- are not model year 1985 or 1986, or
- are Cadillacs, trucks, motorcycles, etc., or
- have unknown impact location(s)

The remaining 1985-86 passenger cars are classified as being "with rear impact damage" if either the primary or the secondary damage location is the rear. (Note that this includes all rear impacts, not just those where the struck car was braking.) Otherwise they have "front or side damage only." In Table 1, damage location (with vs. without rear impact damage) is tabulated by model year (1985 vs. 1986).

Table 1 shows that model year 1985 cars were involved in 1860 rear impacts at the NASS sites during the summer of 1986, while the model year 1986 cars had only 1571 rear impacts. But in the "control group" of

TABLE 1

REAR IMPACT INVOLVEMENTS - MODEL YEAR 1986 VS. 1985

(Tabulation, by impact location, of all 1985 and 1986 passenger cars involved in vehicle to vehicle collisions in the NASS areas, 6/1/86 - 9/5/86)

	Number of Collision Involvements	
Model Year	With Rear Impact Damage	Front or Side Damage Only
1985	1860	5602
1986	1571	5469

Chi-Square = 13.67

Rear Impact Reduction - 1986 vs. 1985:

$$1 - \left(\frac{1571}{1860} \,/\, \frac{5469}{5602}\right) = 13.48 \text{ percent}$$

frontal and side damage involvements, there was little difference between the 1985 cars (5602 involvements) and the 1986 cars (5469 involvements). Based on the formula derived earlier in the report, the reduction of rear impact involvement risk in model year 1986, relative to 1985 is

$$1 - \left(\frac{1571}{1860} \,/\, \frac{5469}{5602}\right) = \textbf{13.48 percent}$$

The reduction is statistically significant (Chi-square = 13.67; alpha = .05; In fact, it would be significant even if alpha = .001).

The 13.48 percent reduction of rear impact crashes for model year 1986 vs. 1985 understates the true effect of CHMSL, because some of the 1985 cars already have CHMSL. It was estimated above that about 10 percent of 1985 cars (even excluding Cadillacs) most likely have CHMSL, but perhaps as few as 5 percent or as many as 15 percent. Based on the formula developed earlier, the overall rear impact reduction of CHMSL is estimated by

$$.1348 \,/\, [1 - .1 + (.1348 \times .1)] = \textbf{14.8 percent}$$

if 10 percent of the 1985 fleet has CHMSL. But this estimate could range from

$$.1348 \,/\, [1 - .05 + (.1348 \times .05)] = 14.1 \text{ percent}$$

if 5 percent of the 85 cars have CHMSL to

$$.1348 \,/\, [1 - .15 + (.1348 \times .15)] = 15.5 \text{ percent}$$

if 15 percent of them have CHMSL. This shows that the estimate is not too sensitive to fairly large variations in the assumption about how many 1985 cars were retrofitted with CHMSL.

Finally, for the reduction of "CHMSL relevant" accidents (i.e., those in which the driver of the struck vehicle was braking), the effectiveness has to be divided by the proportion of rear impacts that are

CHMSL relevant (2/3 of rear impacts, according to the fleet tests [3]). The "best estimate" of the reduction of CHMSL relevant accidents is

$$14.8/.67 = 22.1 \text{ percent}$$

That estimate could range from 14.1/.67 = 21.0 percent if only 5 percent of the 85 cars have CHMSL to 15.5/.67 = 23.1 percent if as many as 15 percent of the 85 cars have CHMSL.

The preceding analysis yielded two effectiveness estimates: a smaller number (14.8 percent) for overall rear impact reduction and a larger one (22.1 percent) for CHMSL relevant crash reduction. It is important to remember that either way, the absolute number of crashes avoided is the same. The 22.1 percent reduction of CHMSL relevant crashes is a "larger slice of a smaller pie" and the 14.8 percent overall rear impact reduction is a "smaller slice of a larger pie."

As stated earlier, these NASS results are not necessarily comparable to earlier field tests because the NASS data are limited to police reported crashes (exceeding some specified minimum damage criterion) while the field tests included all impacts reported by drivers, even those not resulting in damage.

BY LEVEL OF URBANIZATION - NASS includes a representative range of accident locations, from the most built-up cities to the most isolated rural areas. In Table 2, the 50 NASS sites are split into 4 categories, by level of urbanization and separate analyses are performed on the data from each group. The definitions of the 4 categories and the reductions of rear impact involvements (model year 1986 vs. 1985) are:

TABLE 2

REAR IMPACT INVOLVEMENTS - MODEL YEAR 1986 VS. 1985

-BY TYPE OF ACCIDENT LOCATION (URBANIZATION)-

(Tabulation, by impact location, of all 1985 and 1986 passenger cars involved in vehicle to vehicle collisions in the NASS areas, 6/1/86 - 9/5/86)

	Number of Collision Involvements	
Model Year	With Rear Impact Damage	Front or Side Damage Only
IN CENTRAL CITY OF METRO AREA WITH OVER 1,000,000 PERSONS		
1985	452	1563
1986	377	1445
Rear Impact Reduction: $1 - (\frac{377}{452} / \frac{1445}{1563})$ = **9.8 percent**		
SUBURB OF METRO AREA WITH OVER 1,000,000 PERSONS		
1985	791	2213
1986	700	2282
Rear Impact Reduction: $1 - (\frac{700}{791} / \frac{2282}{2213})$ = **14.2 percent**		
METROPOLITAN AREA WITH FEWER THAN 1,000,000 PERSONS		
1985	475	1373
1986	387	1351
Rear Impact Reduction: $1 - (\frac{387}{475} / \frac{1351}{1373})$ = **17.2 percent**		
OUTSIDE METROPOLITAN AREAS		
1985	142	453
1986	107	391
Rear Impact Reduction: $1 - (\frac{107}{142} / \frac{391}{453})$ = **12.7 percent**		

Central cities of metro areas with over 1 million persons:	9.8 percent
Suburbs of metro areas with over 1 million persons:	14.2 percent
Metropolitan areas with fewer than 1 million persons:	17.2 percent
Outside metropolitan areas:	12.7 percent

The differences in the effectiveness are easily within the "noise" level, given the sample sizes for the 4 groups. The effectiveness of CHMSL does not show correlation with the level of urbanization.

BY TYPE OF REAR IMPACT - The NASS special study data are detailed enough to show the number of vehicles involved in a collision and the role of each vehicle (striking, struck, or both). One hypothesis stated earlier is that CHMSL might be especially effective in preventing chain collisions involving three or more vehicles because the high mounting of the lamp makes it visible through the windows of a following vehicle and enables the driver of the third vehicle in a chain to react to the first car's braking.

The eligible 1985-86 cars with rear impact damage were divided into three groups:

(a) Lead [struck] cars in 2 vehicle front to rear collisions
(b) Lead cars in 3 or more vehicle chain collisions. A "chain" collision is an accident involving 3 or more vehicles in which one vehicle has only rear impact damage (i.e., the "lead" vehicle); one vehicle has only frontal damage; and all other vehicles have frontal and rear impact damage (these are the "middle" vehicles).
(c) Middle cars in 3 or more vehicle chain collisions

Cars with rear impact damage that did not fit into those groups were not used in the analysis (e.g., cars in 3 vehicle collisions that were not of the chain type).

Table 3 computes effectiveness of CHMSL in reducing each of the three types of rear impact involvements. Note that in all cases, however,

TABLE 3

REAR IMPACT INVOLVEMENTS - MODEL YEAR 1986 VS. 1985

-BY TYPE OF REAR IMPACT-

(Tabulation, by impact location, of all 1985 and 1986 passenger cars involved in vehicle to vehicle collisions in the NASS areas, 6/1/86 - 9/5/86)

LEAD CAR IN 2 CAR FRONT TO REAR COLLISION

	Number of Collision Involvements	
Model Year	As Lead Car in 2 Car Front to Rear Collision	Front or Side Damage Only (All Crashes)
1985	1261	5602
1986	1083	5469

Rear Impact Reduction: $1 - (\frac{1083}{1261} / \frac{5469}{5602}) =$ **12.0 percent**

LEAD CAR IN CHAIN COLLISION (3 OR MORE VEHICLES)

	Number of Collision Involvements	
Model Year	As Lead Car in Chain Collision (3 or More Veh.)	Front or Side Damage Only (All Crashes)
1985	235	5602
1986	175	5469

Rear Impact Reduction: $1 - (\frac{175}{235} / \frac{5469}{5602}) =$ **23.7 percent**

ONE OF THE MIDDLE CARS IN CHAIN COLLISION (3 OR MORE VEHICLES)

	Number of Collision Involvements	
Model Year	As Middle Car in Chain Collision (3 or More Veh.)	Front or Side Damage Only (All Crashes)
1985	317	5602
1986	260	5469

Rear Impact Reduction: $1 - (\frac{260}{317} / \frac{5469}{5602}) =$ **16.0 percent**

the "control group" of cars with frontal or side damage only is the same; it includes all cars with frontal or side damage only, not just the cars involved in that particular type of collision - i.e., the same control group as was used in Table 1 (overall effectiveness). That is because the control group is meant to be just a generalized measure of "exposure" or "overall accident risk" for 1985 vs. 1986 cars - it assumes that, if it weren't for CHMSL, the 1985 and 1986 cars would have this ratio (5602 to 5469) for any crash mode.

Table 3 indicates that the risk of being the struck car in a 2 vehicle front to rear collision decreased from model year 1985 to 1986 by:

$$1 - (\frac{1083}{1261} / \frac{5469}{5602}) = \textbf{12.0 percent}$$

If 10 percent of 1985 cars had CHMSL, the effectiveness of CHMSL in reducing all types of rear impact involvements in 2 vehicle collisions is:

$$.12 / [1 - .1 + (.12 \times .1)] = \textbf{13.2 percent}$$

If 2/3 of these crashes were CHMSL relevant (involved braking by the struck vehicle), the reduction of "relevant" 2 vehicle crashes would be

$$13.2/.67 = \textbf{19.7 percent}$$

The risk of being the lead car in a 3 or more vehicle chain collision decreased from model year 1985 to 1986 by:

$$1 - (\frac{175}{235} / \frac{5469}{5602}) = \textbf{23.7 percent}$$

Thus, the effectiveness of CHMSL in reducing all types of lead car involvements in 3 or more vehicle chain collisions is:

$$.237 / [1 - .1 + (.237 \times .1)] = \textbf{25.7 percent}$$

If 2/3 of these crashes were CHMSL relevant, the reduction of "relevant" lead car involvements would be

$$25.7/.67 = \textbf{38.4 percent}$$

The risk of being one of the middle cars in a 3 or more vehicle chain collision decreased from model year 1985 to 1986 by:

$$1 - \left(\frac{260}{317} \,/\, \frac{5469}{5602}\right) = \textbf{16.0 percent}$$

Thus, the effectiveness of CHMSL in reducing all types of middle car involvements in 3 or more vehicle chain collisions is:

$$.16 \,/\, [1 - .1 + (.16 \times .1)] = \textbf{17.5 percent}$$

If 2/3 of these crashes are CHMSL relevant, the reduction of "relevant" middle car involvements would be

$$17.5/.67 = \textbf{26.1 percent}$$

The NASS results are consistent with the hypothesis that CHMSL are especially effective in preventing chain collisions. It is too early, however, to state a definitive conclusion that CHMSL are more effective in 3 vehicle than in 2 vehicle collisions: statistical tests do not show a significant difference in effectiveness. Since the analyses in Table 3 all use the same "control group," the appropriate statistical test is a simple Chi-square on the table of model year x type of rear impact involvement. For example, to test if CHMSL are more effective in preventing lead impacts in chain collisions than in preventing rear impacts in 2 car collision, use the table

235	1261
175	1083

The Chi-square is 1.74, which is not statistically significant (alpha = .05 or even .10). Likewise, to test if CHMSL are more effective in preventing lead or middle impacts in chain collisions than in preventing rear impacts in 2 car collision, use the table

552 1261

435 1083

The Chi-square is 1.27, which is not statistically significant (alpha = .05 or even .10).

CONCLUSIONS

1. The NASS Special Study data acquired during the summer of 1986 strongly support a conclusion that CHMSL were effective at that time in reducing a vehicle's risk of being struck in the rear by another vehicle. The specific effectiveness estimate has to be considered preliminary and may change in follow-up studies based on ever larger accident samples.

2. Effectiveness was about the same in the large cities, suburbs and nonmetropolitan areas of the NASS sample.

3. The results are consistent with a hypothesis that CHMSL are especially effective in preventing chain collisions, but do not provide statistically significant support for a conclusion to that effect.

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