UPDATE OF NHTSA'S 2007 ANALYSIS OF ESC EFFECTIVENESS

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ABSTRACT

Objective - The primary goals of this analysis are to expand on and clarify the findings of the 2007 NHTSA analysis by using a greater variety of vehicles and several additional years of crash data. This analysis will also evaluate electronic stability control (ESC) effectiveness in all police-reported crashes.

The principal evaluation questions are:

- What is the effect of ESC on all police-reported crashes?
- What is the effect of ESC on fatal crashes?
- What are the effects of ESC on specific types of crashes?
- How does the effectiveness of ESC differ across passenger cars and light trucks/vans (LTVs)?
- What is the effect, if any, of ESC on collisions with pedestrians, bicyclists or animals?

Methods - Percent effectiveness of ESC was estimated by comparing the types of crashes that vehicle models experienced immediately before and immediately after the introduction of ESC. Because optional ESC generally cannot be identified from the VIN, only models that transitioned from no ESC system to a standard ESC system were included in this analysis. Effectiveness estimates were computed for different crash types relative to a control group of low-speed and similar crashes that are unlikely to be affected by ESC. The estimates should be interpreted as the reduction in the likelihood of a vehicle being involved in a specific type of crash as a result of ESC being added to that vehicle.

Results - When a vehicle is equipped with ESC, it has a smaller likelihood of being involved in a crash than a similar vehicle without ESC. Overall, ESC was associated with a six percent decrease in the likelihood that a vehicle would be involved in any police reported crash and an 18 percent reduction in the probability that a vehicle would be involved in a fatal crash. For passenger cars, the reductions are 5 percent and 23 percent, respectively; for LTVs, 7 percent and 20 percent. Each of these reductions is statistically significant except for the 5 percent overall effect in cars. More specific crash types were also analyzed and these results are presented in the body of the paper.

Discussion –Estimates of effectiveness were especially large for crash types involving loss of vehicle control. Passenger cars and LTV's do not show large differences in effectiveness and show more similar results here than in previous analyses. The effect of ESC on collisions with pedestrians, bicyclists and animals, if any, is still unclear and will be monitored as more data becomes available.

INTRODUCTION

About ESC - Electronic stability control (ESC) is a computerized system that continuously monitors speed, steering wheel position, brake force at each wheel, yaw rate and lateral acceleration. This input allows the system to detect loss of directional stability at the rear wheels (spin out) or directional control at the front wheels (plow out). When loss of control is detected, the system acts by applying braking force to one or several wheels or by reducing engine torque output in order to slow the vehicle or correct its path. For example, if clockwise yaw due to oversteer is detected the system may apply brake force to the front left wheel in order to counteract the vehicle's rotation. This action takes place so quickly

that the system is essentially predictive, preventing loss of control before it occurs.
Through model year 2005, ESC was installed on less than 20 percent of the vehicles sold in the U.S. Due to mounting evidence of the effectiveness of ESC and ensuing legislation, from 2006 on there was a sharp rise in the number of vehicles sold with ESC installed. Although ESC is mandated on all new vehicles of model year 2012 or later, it will take several years for ESC equipped vehicles to saturate the on-road fleet.

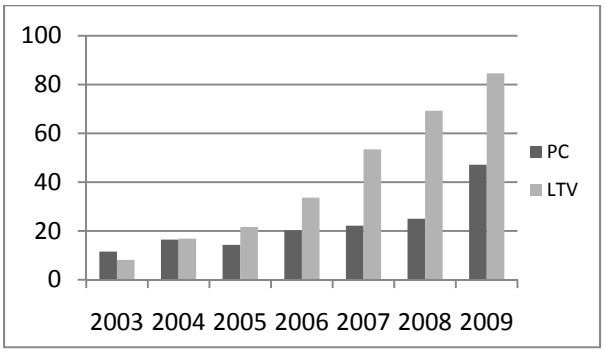

Figure 1. Percent of new vehicles sold in the US with standard ESC.

In 2008, the National Highway Traffic Safety Administration (NHTSA) issued Federal Motor Vehicle Safety Standard (FMVSS) No. 126 which required that passenger cars, multipurpose passenger vehicles (MPVs), trucks and buses with a gross vehicle weight rating (GVWR) of 10,000 pounds or less be equipped with an ESC system that meets the definition and performance requirements of the standard. The standard specified the following phase-in schedule:

Table 1.
Mandatory phase-in schedule for ESC

Model Year	Production Beginning Date	Requirement
2009	September 1, 2008	55% with carryover credit
2010	September 1, 2009	75% with carryover credit
2011	September 1, 2010	95% with carryover credit
2012	September 1, 2011	Fully effective

Past Research -There have been several analyses of the effectiveness of ESC conducted by NHTSA, IIHS, and others in the past, all of which have found statistically significant reductions in crashes attributable to ESC. In 2007, NHTSA published its most comprehensive effectiveness analysis to date.[1] It expanded on previous NHTSA evaluations with additional years of FARS (1997-2004) and State data (1997-2003). This analysis was able to investigate specific types of crashes, and found, among other large reductions, a 70 percent reduction in fatal rollover crashes in passenger cars and an 88 percent reduction in fatal rollover crashes in LTVs. In general, LTVs showed larger crash reductions due to ESC than passenger cars, with a 28 percent overall reduction in fatalities for LTVs and a 14 percent overall reduction in fatalities for passenger cars. A small non-significant increase in collisions with pedestrians, bicyclists or animals was found. This analysis also compared two and four-channel ESC systems, and found a significantly larger reduction in police-reported crashes for the four-channel systems.

Goals of the Evaluation - The primary goals of this analysis are to expand on and clarify the findings of the 2007 NHTSA analysis by using a greater variety of vehicles and several additional years of crash data. Previous research suggests that ESC has a large effect on fatality reduction and overall crash prevention. It is important to understand as clearly as possible the changes to the crash environment that will occur as a larger portion of the passenger vehicle fleet is equipped with ESC. This analysis will be better able to generalize the benefits of ESC due to the use of the National Automotive Sampling System – General Estimates System (NASS GES) to estimate the effects of ESC on all fatal and non-fatal crashes. This data is a nationally representative stratified sample of all police-reported crashes in the U.S. The use of FARS data, a complete census of fatal crashes in the U.S., will allow an in-depth analysis of the effects on all fatal crashes in the U.S.

The principal evaluation questions are:

- What is the effect of ESC on all police-reported crashes?
- What is the effect of ESC on fatal crashes?
- What are the effects of ESC on specific types of crashes?
- How does the effectiveness of ESC differ across passenger cars and LTVs?
- What is the effect, if any, of ESC on collisions with pedestrians, bicyclists or animals?

METHODS

Risk Ratio - The methodology for this evaluation is similar to that of the 2007 NHTSA evaluation. By examining the types of crashes that vehicle models are involved in immediately prior to and subsequent to the introduction of ESC, one can estimate the effectiveness of ESC by using contingency tables to compute associated risk ratios.[2]

For example, if ESC has no effect on rollovers, then the ratio of vehicle rollovers to control-group collisions unlikely to be affected by ESC (such as being struck in the rear while parked) should remain the same before and after the introduction of ESC.

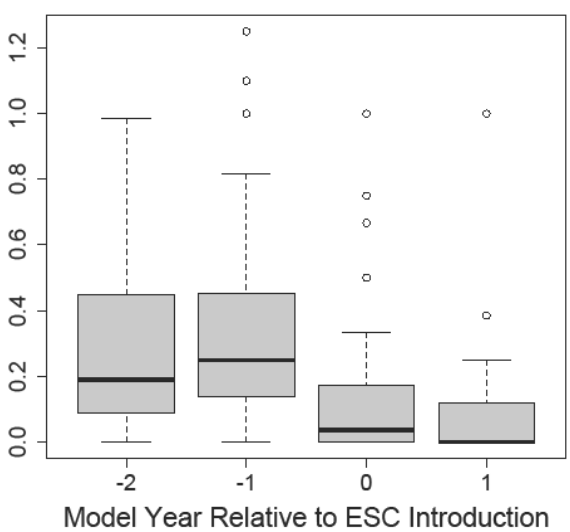

Figure 2. Ratio of rollover crashes to control crashes.

In Figure 2 each vehicle model in the analysis contributes four data points, one each for two years before, one year before, the year of and the year after ESC introduction on that model. The large drop observed in the ratio of rollovers to control crashes between the years before (-2,-1) and the years after (0,1) ESC introduction is evidence of ESC's effectiveness in reducing rollover crashes in relation to control crashes.

This report uses this concept to quantify ESC effectiveness in preventing different types of crashes. As an example, consider the Jeep Liberty, which received standard ESC in 2006. Simply comparing the number of rollovers in the two years before and two years after the introduction of ESC will not account for possible changes in the volume of sales, vehicle miles travelled, etc. That is why control group crashes are needed to give a baseline for comparison.

The following equation estimates ESC effectiveness on fatal rollover prevention in the Jeep Liberty by using data from the two model years before and after introduction of ESC (2004-2005 for the before ESC crashes and 2006-2007 for the after ESC crashes) from the Fatal Accident Reporting System (FARS) database. Any crashes taking place from 2004-2009 involving Cherokee model years 2004-2007 were eligible for inclusion. If ESC has no effect on the incidence of rollover crashes, then the ratio of rollover to control crashes should be similar in the time period before ESC and the time period after ESC, resulting in a risk ratio close to 1.000.

$$\left(\frac{\#\ rollovers\ after\ ESC}{\#\ control\ crashes\ after\ ESC}\right)\Big/\left(\frac{\#\ rollovers\ before\ ESC}{\#\ control\ crashes\ before\ ESC}\right)$$

$$= \left(\frac{5}{38}\right)\Big/\left(\frac{19}{87}\right)$$

$$\text{risk ratio} = 0.602$$

$$\text{percent effectiveness} = (1 - 0.602) * 100 = 40\%$$

The resulting risk ratio measures the effectiveness of ESC at reducing rollover fatalities. A risk ratio less than one implies a reduction in fatalities following introduction of ESC. When the risk ratio is subtracted from one, the result is the percent

effectiveness of ESC. In this example, the effectiveness of ESC is estimated to be 40 percent. In other words, adding ESC to a Jeep Liberty without ESC is estimated to result in a 40 percent reduction in the probability that that vehicle will be involved in a fatal rollover crash.

Control and Treatment Crash Groups - The method of analysis described above requires that vehicles are classified as belonging to either the control or a treatment group based on the type of crash involvement. An ideal control group vehicle would be a stationary vehicle that is struck by another motorist since the presence or absence of ESC in this vehicle would have no effect on the probability of crash involvement (this is not true for the striking vehicle, which is why this determination is made at the vehicle level rather than the crash level). However, there are not enough 'ideal' control vehicle cases to compose an adequate control group, so vehicles are assigned to the control group if their accident involvement is deemed unlikely to have been affected by the presence of ESC. The following list describes the circumstances under which a vehicle is assigned to the control group:

- Hit while parked/stopped
- Backing/parking/low-speed (1-10 MPH)
- Struck in rear
- Non-culpable involvement in a multi-vehicle crash on a dry road

Non-culpable involvements on dry roads make up a large portion of the control group, and this category relies heavily on the accuracy and completeness of the accident description included in the data files. To test if this group of crashes is introducing any bias, the NASS GES estimates were recomputed without the non-culpable involvements on dry roads in the control group. Reassuringly, the resulting weighted estimates were almost identical to those computed when they were included.

All vehicles that are not classified as control group vehicles are eligible to be included in a treatment crash group. The treatment groups are defined using available data gathered from sources such as the police accident report (PAR), which specifies the circumstances of the crash and the role of each vehicle involved.

The treatment groups include:

All non-control group vehicles: This group includes all of the vehicles in the data files that do not meet the criteria for the control group. There will be a large variety of crashes in this group, and it is not expected to show as large of an effect of ESC as some of the other treatment groups that are specifically chosen because they are likely to be affected by vehicle control and stability.

All single-vehicle crashes (except collisions with pedestrians/bicyclists/animals): This group includes all single vehicle crashes in the data files, except for those involving pedestrians, bicyclists or animals, which are analyzed separately. Past research has shown that ESC is particularly effective in preventing single-vehicle types of crashes, which are very likely to be the result of loss of vehicle control.

First-event rollovers: This group is a subset of the single-vehicle crashes and is defined by examining the first harmful event in the crash sequence recorded in the data files. Subsequent-event rollovers, such as vehicles that strike a fixed object and roll as a result, are not included in this group.

All impacts with fixed objects: This group is a subset of single-vehicle crashes and includes all single-vehicle run-off-road crashes except first-event rollovers, collisions with pedestrians, bicyclists, animals or other movable objects such as trains, and non-collisions such as immersion in water or falling off a moving vehicle.

Side impacts with fixed objects: This group is a subset of all impacts with fixed objects. These vehicles are analyzed separately because side impacts are particularly characteristic of loss of vehicle control.

Culpable vehicles in multi-vehicle crashes: This group consists of vehicles that have been identified as the culpable party in a multi-vehicle crash. This group may contain vehicles that experienced loss of

control, but may also contain vehicles that were involved in crashes that would not have been affected by ESC. In past analyses these vehicles have shown a smaller benefit from ESC than those involved in single-vehicle crashes.

Collisions with pedestrians/bicyclists/animals: This group is singled out for analysis because the 2007 NHTSA analysis showed a small non-significant increase in crash risk for vehicles with ESC. One way ESC functions is by attenuating driver steering and/or braking input that may result in loss of control, and it is possible that this could contribute to a reduction in the ability to make emergency evasive maneuvers.

All Crashes: This estimate is derived using results from the all non-control group crashes (it must be derived because the control group includes members of this crash group). Because an assumption of the analysis is that ESC will have no effect on the control group crashes we can estimate effectiveness in all crashes with the following formula:

$$effectiveness = \theta_t * x_t/(x_t + y_c)$$

Where:

θ_t = the estimated effectiveness for non-control group crashes

x_t = the number of non-control group crashes before ESC

y_c = the number of control group crashes before ESC

Because all crashes in the data are either contained in the control or non-control group, this will give an estimate of effectiveness in all crashes. The confidence interval for this estimate can be derived by replacing θ_t with the upper and lower bound estimates for the 95 percent confidence interval of the estimated effectiveness for all non-control group crashes.

All Multi-Vehicle Crashes: This estimate can be derived from the results of the culpable vehicles in multi-vehicle crashes group using the same logic and formula as the 'All Crashes' group above, with

x_t = the number of culpable vehicles in multi-vehicle crashes

θ_t = the estimated effectiveness for culpable vehicles in multi-vehicle crashes

Because all of the control group crashes are multi-vehicle crashes, and because all multi-vehicle crashes in the data files are contained in either the control group or in the culpable vehicles in multi-vehicle crashes group, this will give an estimate of effectiveness in all multi-vehicle crashes.

Included Vehicles - ESC is often offered as an optional feature whose presence is impossible to determine from the vehicle identification number (VIN). Accordingly, only vehicle models that transitioned from no ESC to standard ESC could be included in the analysis. Eligible vehicles were identified using previous NHTSA analyses, www.safercar.gov, and information provided by vehicle manufacturers. The two model years before and the two model years after the introduction of ESC were included when possible. In cases where a major vehicle redesign took place during this period, the included model years were truncated to ensure that only similar vehicles were compared. In some of the more recent models, rollover sensors were introduced and present a potential confound for analyses of rollover crashes. For these vehicles, model years were truncated in analyses including rollover crashes so that the presence of rollover sensors was consistent across all included model years. Some vehicle models are included that had a period of time that ESC was offered as an option; these optional model years are removed.

RESULTS

All Police-Reported Crashes - NASS GES data files from 1997-2009 were used to estimate the effectiveness of preventing vehicle involvement in treatment group crashes of any severity. This data is compiled annually from a nationally representative probability sample of every police reported crash in the U.S. Although many crashes are not reported to police, unreported crashes are unlikely to involve significant personal injury or major property damage.

There are 8040 total NASS GES cases included in this analysis taken from thirteenyears of crash data files. NASS GES data is available at three different levels, the crash level, the vehicle level, and the occupant level. Crash types were assigned to each vehicle case in the vehicle level data using variables at the crash and vehicle levels. Analysis was conducted using SAS PROC SURVEYLOGISTIC to properly specify the survey design.

The results for each analyzed crash category are given in Table 2 below. The reported statistics are: unweighted and weighted risk ratios (see section 2.1 for an explanation of how risk ratios are computed from the crash data), 95 percent confidence intervals for the weighted risk ratios, and percent effectiveness derived from the weighted risk ratio [(1 – risk ratio) * 100]. Any estimate with a 95 percent confidence interval whose upper and lower bounds are both less than 1.000 is statistically significant at the $p < .05$ level and is marked with an asterisk.

Table 2.
ESC Effectiveness in All Police-Reported Crashes (NASS GES)
All Vehicles

Crash Type	Risk Ratio (Unweighted)	Risk Ratio (Weighted)	95% CI (Wald)	Weighted % Effectiveness
All crashes				
All non-co				
All single v ped/bikes				
1st event rollovers	.295	**.332**	**(.223, .494)**	**67%***
All impacts w/ fixed obj.	.513	**.424**	**(.342, .525)**	**58%***
Side impacts w/ fixed obj.	.372	**.29**	**(.187, .449)**	**71%***
All multi-vehicle †	.979	**1.003**	**(.974, 1.035)**	**0%**
Culpable multi-vehicle	.924	**1.011**	**(.901, 1.134)**	**-1%**
Peds/Bikes/Animals	1.057	**.955**	**(.681, 1.340)**	**4%**
* = statistically significant at p < .05				
† = derived estimate, see METHODS, All Crashes				

The unweighted risk ratio estimates are not nationally representative, but are reported because they can lend insight into the reliability of the weighted estimates. Large differences between estimates based on the unweighted and weighted data are often a symptom of insufficient sample size. This does not appear to be a problem with this data, as weighted and unweighted estimates do not differ substantially.

All of the single-vehicle crash categories showed large significant decreases in crash risk for ESC equipped vehicles. These decreases were particularly large for the crash types hypothesized to be affected most by vehicle control and stability: first- event rollovers (67% reduction) and side impacts with fixed objects (71% reduction). The results for multi-vehicle crashes and for collisions with pedestrians, bicyclists or animals are less clear. These estimates are close to zero effect and have large confidence intervals.

All Police-Reported Crashes (Passenger Cars) - When passenger cars were analyzed separately, there were too few cases to obtain significant estimates for most of the crash types. The only significant results were a 60 percent reduction in side impacts with fixed objects and a 72 percent reduction in first-event rollovers. Because small sample sizes lead to large confidence intervals, only very large estimates will be statistically significant. The point estimates for other crash types, while not significant, are similar to the combined results.

Table 3.
ESC Effectiveness in All Police-Reported C
Passenger Cars Only

Crash Type (PC Only)	Risk Ratio (Unweighted)	Risk Ratio (Weighted)	95% CI (Wald)	Weighted % Effectiveness
All crashes †	.92	**.952**	**(.865, 1.067)**	**5%**
All non-control group	.825	**.881**	**(.666, 1.166)**	**12%**
All single vehicle (except ped/bikes/animals)	.652	**.677**	**(.452, 1.013)**	**32%**
1st event rollovers	.347	**.278**	**(.090, .857)**	**72%***
All impacts w/ fixed obj.	.683	**.696**	**(.451, 1.074)**	**30%**
Side impacts w/ fixed obj.	.467	**.397**	**(.192, .818)**	**60%***
All multi-vehicle †	.966	**1.008**	**(.936, 1.104)**	**-1%**
Culpable multi-vehicle	.884	**1.028**	**(.750, 1.407)**	**-3%**
Peds/Bikes/Animals	.990	**.767**	**(.456, 1.291)**	**23%**
* = statistically significant at p < .05				
† = derived estimate, see section 2.2				

All Police-Reported Crashes (LTVs) - LTVs have a larger sample size and when analyzed separately from passenger cars the estimated reductions in loss-of-control crashes were all large and significant. The only non-significant crash types were collisions with pedestrians, bicyclists or animals and multi-vehicle crashes.

Table 4.
ESC Effectiveness in All Police-Reported Crashes (NASS GES)
Light Trucks and Vans Only

Crash Type (LTV Only)	Risk Ratio (Unweighted)	Risk Ratio (Weighted)	95% CI (Wald)	Weighted % Effectiveness

All crashes †	.912	**.933**	**(.898, .972)**	**7%***
All non-control group	.800	**.836**	**(.750, .932)**	**16%***
All single vehicle (except ped/bikes/animals)	.455	**.432**	**(.364, .512)**	**57%***
1st event rollovers	.309	**.359**	**(.239, .541)**	**64%***
All impacts w/ fixed obj.	.436	**.332**	**(.263, .418)**	**67%***
Side impacts w/ fixed obj.	.332	**.268**	**(.162, .445)**	**73%***
All multi-vehicle †	.979	**1.003**	**(.972, 1.037)**	**0%**
Culpable multi-vehicle	.923	**1.011**	**(.894, 1.143)**	**-1%**
Peds/Bikes/Animals	1.075	**1.013**	**(.709, 1.013)**	**-1%**
* = statistically significant at p < .05				
† = derived estimate, see section 2.2				

There are a couple of interesting observations to be made about the results for PCs and LTVs. In the 2007 NHTSA analysis, LTV's showed much larger effectiveness estimates than passenger cars. In this analysis the results seem much more similar across vehicle type. There could be a variety of reasons for this, such as improved stability in later models of

LTV's, inclusion of more compact utility vehicles (CUV's) in the LTV group, inclusion of more non-luxury models of passenger cars, and others. More detailed analysis did not reveal any one specific cause for the increased similarity of effectiveness across cars and LTV's.

Fatal Crashes - The effect of ESC on fatal crashes was estimated using data in 1997-2009 Fatal Analysis Reporting System (FARS). The same vehicle models that were used in the NASS GES analysis were used here as well. This analysis included 6,172 vehicle cases from the FARS database.

Table 5.
ESC Effectiveness in All Fatal Crashes
All Vehicles

Table 5 presents the counts of vehicle cases, risk ratios, 95 percent confidence intervals for the risk ratios, and percent effectiveness estimates for each crash category. The confidence intervals were computed with SAS PROC FREQ, which uses the Cochran-Mantel-Haenszel (CMH) method of interval construction.

Crash Type	Vehicles w/o ESC	Vehicles w/ ESC	Risk Ratio	95% CI (CMH)	% Effectiveness
Count of control crashes	1477	787			
All crashes †	4296	1876	**.82**	**(.77, .875)**	**18%***
All non-control group	2819	1089	**.725**	**(.649, .81)**	**27%***
All single vehicle (except ped/bikes/animal)	1294	348	**.505**	**(.436, .584)**	**49%***
1st event rollovers	502	76	**.284**	**(.22, .367)**	**72%***
All impacts w/ fixed obj.	648	212	**.614**	**(.514, .733)**	**39%***
Side impacts w/ fixed obj.	152	34	**.42**	**(.287, .615)**	**58%***
All multi-vehicle †	2384	1192	**.939**	**(.895, .988)**	**6%***
Culpable multi-vehicle	907	405	**.84**	**(.725, .969)**	**16%***
Peds/Bikes/Animals	415	242	**1.094**	**(.914, 1.311)**	**-9%**
* = statistically significant at p < .05					
† = derived estimate, see section 2.2					

Estimates of ESC effectiveness at preventing fatal single-vehicle crashes (excluding collisions with animals, bicycles, or pedestrians) are very similar to the results of the analysis of all police-reported crashes. This is not a surprising result, since single-vehicle crashes are likely to be loss-of-control crashes that occur at high speeds, regardless of whether they are fatal or not. In other words, one would expect fatal single-vehicle crashes to be fairly representative of single-vehicle crashes in general.

For the single-vehicle crashes the results are clear; ESC is highly effective at preventing fatalities from these types of crashes. These estimates also show narrow confidence intervals, indicating small variance and low volatility. The reduction for all non-control crashes (27%) is also impressively large considering the variety of crashes included in this category.

These results are very similar to the effectiveness estimates for the same crash types reported in the 2007 NHTSA evaluation using FARS data from 1997-2004, however a detailed comparison will not be given because statistical concerns make direct contrasts inappropriate.

Although there are some noticeable differences in the NASS GES and FARS estimates of the effects on collisions with pedestrians, bicyclists or animals and the culpable involvements in multi-vehicle crashes, these estimates are not statistically significant regardless of data source and interpretation of ESC effectiveness in these types of crashes will be deferred until sufficient data is available.

Fatal Crashes (Passenger Cars) - The results for passenger cars are very similar to the overall results. Although the reduction in culpable vehicles in multi vehicle accidents is slightly larger, the sample size is smaller and the reduction is still non-significant. Despite the reduced sample size, the single vehicle crash categories and group give statistica reduction.

Table 6.
ESC Effectiveness in All Fatal Crashes
Passenger Cars Only

Crash Type (PCs)	Vehicles w/o ESC	Vehicles w/ ESC	Risk Ratio	95% CI (CMH)	% Effectiveness
Count of control crashes	177	174			
All crashes †	656	495	**.768**	**(.657, .911)**	**23%***
All non-control group	479	321	**.682**	**(.53, .878)**	**32%***
All single vehicle (except ped/bikes/animal)	253	125	**.503**	**(.373, .678)**	**50%***

1st event rollovers	49	21	**.436**	**(.251, .757)**	**56%***
All impacts w/ fixed obj.	170	89	**.533**	**(.387, .742)**	**47%***
Side impacts w/ fixed obj.	49	17	**.353**	**(.196, .637)**	**65%***
All multi-vehicle †	333	299	**.916**	**(.81, 1.055)**	**8%**
Culpable multi-vehicle	156	125	**.815**	**(.595, 1.117)**	**18%**
Peds/Bikes/Animals	45	48	**1.085**	**(.687, 1.714)**	**-9%**
Total number of cases	656	495			
* = statistically significant at $p < .05$					
† = derived estimate, see section 2.2					

The analysis of passenger car involvements by crash type shows large reductions across crash types, consistent with previous effectiveness analyses. The 23 percent effectiveness estimate for all crashes suggests that nearly a quarter of all fatal crashes in passenger cars may be prevented by adding ESC.

Fatal Crashes (LTV's) - LTV's also show large significant reductions in fatalities. This is the only analysis that showed a significant reduction in culpable multi-vehicle crashes. The only crash category that did not show a significant reduction was collisions with pedestrians, bicyclists or animals, which showed an 11 percent non-significant increase.

Crash Type (LTVs)	Vehicles w/o ESC	Vehicles w/ ESC	Risk Ratio	95% CI (CMH)	% Effectiveness
Count of control crashes	1300	613			
All crashes †	3640	1381	**.805**	**(.752, .865)**	**20%***

Table 7.
ESC Effectiveness in All Fatal Crashes (FARS)
Light Trucks and Vans Only

All non-control group	2340	768	**.696**	**(.614, .79)**	**30%***
All single vehicle (except ped/bikes/animal)	1041	223	**.454**	**(.382, .54)**	**55%***
1st event rollovers	453	55	**.258**	**(.192, .346)**	**74%***
All impacts w/ fixed obj.	478	123	**.546**	**(.438, .68)**	**45%***
Side impacts w/ fixed obj.	103	17	**.35**	**(.208, .59)**	**65%***
All multi-vehicle †	2051	893	**.923**	**(.888, .976)**	**8%***
Culpable multi-vehicle	751	280	**.791**	**(.669, .935)**	**21%***
Peds/Bikes/Animals	370	194	**1.112**	**(.912, 1.356)**	**-11%**
Total number of cases	3640	1381			
* = statistically significant at $p < .05$					
† = derived estimate, see section 2.2					

FARS data is the most comprehensive and accurate fatal-crash data available, and this evaluation and others have shown that this data supports the assertion that ESC has a major impact on vehicle safety. The estimates derived from this data suggest that the inclusion of ESC on all new vehicles in the United States by MY 2012 will save thousands of lives every year due to prevention of fatal loss of control crashes.

In general the results for fatal crashes do not seem to differ greatly from the results for all police-reported crashes. Because ESC is designed to prevent high-speed loss-of-control crashes, which are likely to be fatal, this is not a surprising result.

DISCUSSION

In many ways, ESC is an ideal crash avoidance technology. Because it acts so quickly and without driver input it can prevent a crash without the driver of the vehicle being aware that the system has intervened. Most importantly, it has been shown by this analysis and several others, using a variety of methods, to be highly effective at preventing loss-of-control crashes.

By using NASS GES data this evaluation was able to compute nationally representative estimates of ESC effectiveness on crash involvements. This will be a valuable tool in attempts to predict the broad economic and safety related effects that ESC will have in the future.

Although the results of this analysis and others are very encouraging, it is important to consider any possible disbenefits associated with ESC. There have been no statistically significant increases in any crash type associated with the introduction of ESC. However, small, non-significant increases in the incidence of collisions with pedestrians, bicyclists and animals were observed in this study (FARS only, not GES) and in the 2007 NHTSA evaluation. Because these effects seem to be very small, if they do indeed exist, there is not yet enough data for statistically meaningful results. While this report draws no conclusions about pedestrian crashes, NHTSA plans to keep this category on the "watch" list and repeat the analyses when more data are available. It may also be useful to examine individual cases more closely in order to explore the effects, if any, of ESC on these types of crashes.

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