ANALYSIS OF FATAL RUN OFF THE ROAD CRASHES INVOLVING OVERCORRECTION

Corresponding author: Lisa K. Spainhour, Ph.D., Associate Professor
spainhou@eng.fsu.edu, 850-410-6123 (phone)

Abhishek Mishra, Research Assistant
amo04h@garnet.fsu.edu, 850-410-6123 (phone)

Both at: FAMU-FSU College of Engineering
2525 Pottsdamer Road
Tallahassee, FL 32310
850-410-6142 (FAX)

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ABSTRACT

In an attempt to identify characteristics that have a strong positive association with overcorrection, data on 579 fatal ROR crashes on state roadways in Florida were analyzed using logistic regression techniques. To overcome shortcomings of traditional analysis methods relying primarily on crash reports, this study relied upon case reviews using a broad variety of resources from various disciplines. The data set used in this study represents a significant enhancement in accuracy and completeness over that in the initial crash reports; overcorrection was identified using Traffic Homicide Investigation reports.

A full model involving 23 explanatory variables was developed, and backward stepwise regression was conducted to identify the most predictive variables. Overcorrection cases were strongly associated with alcohol, inattention, high speed and fatigue/asleep. Outcomes ranged from roadway departure in the opposite direction, to vehicle impact upon returning to the roadway. The study indicated that females were approximately forty percent more likely to overcorrect in a fatal ROR crash than males, with the greatest disparity occurring among middle-aged drivers. Further, while fewer than 20 percent of fatal ROR crashes occurred where rumble strips were present, drivers were more than fifty percent more likely to overcorrect than when they were not present. On high speed (70 mph) roadways with rumble strips, there was almost an 80 percent higher risk of overcorrection in the crash. Thus, while it appears that rumble strips are effective in preventing many run-off-the-road crashes, the contribution of rumble strips' auditory and vibratory sensations to panic oversteering should also be investigated.

INTRODUCTION

A detailed study of fatal crashes in the state of Florida primarily in the year 2000 showed that about one-third of the crashes involved running off the road as the first event, and over twenty-five percent of the run-off-the-road (ROR) crashes involved overcorrection (1). For the purpose of this research, ROR crashes are defined as those involving vehicles that leave the travel lane and encroach onto the shoulder and beyond and either overcorrect, overturn, hit one or more of any number of fixed or non-fixed objects, or otherwise result in a harmful event to the vehicle occupants or other persons. In other words, in this study, ROR crashes include those in which the vehicle leaves the outermost travel lane but overcorrects back into a travel lane before the first harmful event occurs. Because of the high incidence of overcorrection among ROR crashes identified in this study, further analysis was conducted. Overcorrection crashes have long been underreported on traditional crash reports. Because the oversteering maneuver may be the beginning of a whole sequence of events, the initial reporting officer may be unaware of the roadway departure or neglect to mention it on the crash report. To overcome this shortcoming, this study relied upon case reviews using a broad variety of resources from various disciplines to identify crash events and causative factors. The primary resource used in the study was the Traffic Homicide Investigation (THI) report. Additional data sources included video log images, roadway characteristics inventory data, and other information from state databases; site visits were conducted where necessary.

The purpose of this study was to examine human, roadway, vehicle, and environmental factors associated with overcorrection as opposed to traditional ROR crashes. Logistic regression analysis was used to investigate potential associations between a number of predictor variables and a single response variable—whether overcorrection occurred in the crash. Specifically, this research tests a binary response (overcorrection, no overcorrection) for overcorrection crashes and investigates which explanatory variables best account for the occurrence of overcorrection. Note that the occurrence of a crash following the vehicle's return to the travel lanes suggests that an oversteer (improper steering input) has occurred; however, the term overcorrection is used rather than oversteering in identifying these crashes because it is impossible to identify the exact steering input that was applied prior to the crash; therefore, it is impossible to conclusively state that a steering input beyond that needed to correct an off road excursion occurred. In other words, one can conclusively state that a crash occurred following the roadway departure and return; however, one cannot conclusively state that the driver oversteered to cause the crash.

BACKGROUND

ROR crashes have always been a concern in the United States, as they account for a large number of fatal crashes each year. As used in this study, the set of ROR crashes includes those in which the vehicle overcorrects back into a travel lane before the first harmful event occurs. In any ROR crash, including those involving overcorrection, the severity of the crash depends to a large degree on the roadside features and roadway characteristics. Roadside features such as presence of fixed objects, roadway curvature, rumble strips, shoulder type, etc. play an important role in the severity of the crash.

Literature Review

A number of studies have used regression techniques to examine potential contributing factors in traffic crashes (2, 3, 4, 5, 6). However, literature dealing with the contribution of driver oversteer and overcorrection to crashes is more limited. One of the most potentially hazardous situations that a driver can face is the loss of directional control. Whether due to a driver error, an environmental factor, a roadway characteristic, a vehicle problem, or a combination of factors, once control is lost, it is difficult for the driver to regain control of a vehicle that has lost lateral stability. A leading cause of this directional loss of control is the phenomenon known as overcorrection. Overcorrection occurs when a vehicle begins drifting off the road one way and the driver oversteers in the opposite direction, leading the vehicle to cross over into oncoming lanes of traffic, sideswipe an adjacent vehicle, or travel off the road into a hazard. The situation often occurs when a driver is faced with a piece of unexpected or unusual information, which leads the operator to input a large steering angle. The combination of this driver input and speed causes the vehicle to begin a rapid rotation, and often leads to an outright spin. Melcher discussed the driver oversteering mechanism based on fundamental physics and dynamics principles (7). This study presents the underlying theory of how oversteer leads to loss of directional control, which arises at the contact patch between tire and pavement.

Roadside characteristics, especially the presence of rumble strips and edge drop-offs, can also affect the occurrence of overcorrection in ROR crashes. Shoulder-mounted rumble strips, crosswise grooves milled or pressed into the paved shoulder, are frequently introduced as a warning device to prevent vehicles leaving the paved roadway. Vehicles passing over shoulder rumble strips produce a sudden rumbling sound and cause the vehicle to vibrate, thereby alarming inattentive, drowsy, or sleeping drivers of encroachment on the shoulder and possibly on the roadside. Rumble strips have been shown to be effective in the incidence of reducing ROR crashes (8, 9). However, there is some concern that this safety feature might lead to overcorrection crashes. The sudden noise and vibration that occurs when the vehicle drives over it may cause a sudden fright or panic, causing the driver to immediately jerk the wheel too hard in the opposite direction, causing overcorrection.

According to Morena, rolled in rumble strips and concrete intermittent rumble strips reduce the number of run-off-the-road crashes on a given roadway by 20%. The milled design reduced crash frequency by 39% (10). Miles and Finley (11) investigate the effect of length, width, spacing, depth and type of rumble strip on the overall and differential volume of ambient sound caused by vehicle traversal. They conclude that each dimension plays a specific role in generating sound when traversed by vehicle tires, and that current standard rumble strip design (milled strips that are 7 inches long, 16 inches wide, 0.5 inches deep, and spaced at 12 inches) is the only one proven to provide adequate increases in sound to alert all drivers, including commercial motor vehicle (CMV) drivers. However, they point out that passenger vehicles require less aggressive rumble strip designs to provide adequate increases in sound to alert the drivers than commercial vehicles. The current standard design (in a skip or intermittent pattern) is the standard in Florida. Roβmeier et al use a driving simulator to study the interaction of auditory and visual input on the actions of drowsy drivers when they traverse shoulder-mounted rumble strips, but do not directly investigate potential oversteer following the auditory stimulation or compare the effect of different rumble strip designs (12). The study found that drowsy drivers responded to both auditory (simulated rumble strip noise and/or bell tone) and visual clues of a roadside departure and responded by turning the steering wheel, but they did not examine the relationship between the volume of the auditory signal and the angle of steering input (i.e. correct response versus oversteer).

Several studies have found a correlation between the depth of the drop-off or the profile at the pavement edge and crash frequency (13, 14, 15). An improper combination of speed and steering angle when returning the vehicle to the pavement after an edge drop-off can result in an overcorrection type crash. Hallmark et al studied the contribution of pavement edge drop-off to crash frequency and severity on rural two-lane paved roadways with unpaved shoulders (13). In this study, crashes that were “probably” or “possibly” related to edge drop-off comprised less than 3% of rural crashes. However, these crashes were much more likely than other crashes on similar roadways to result in a fatality or serious injury.

Logistic Regression

Regression methods have become an integral component of any data analysis concerned with the relationship between a response variable and one or more explanatory variables. The dependent variable in logistic regression is usually dichotomous, that is, the dependent variable can take the value 1 with a probability of success *p*, or the value 0 with probability of failure 1- *p*. This type of variable is called a Boolean (or binary) variable. If the independent variables are categorical, or a mix of continuous and categorical, logistic regression is preferred. Regression coefficients have a useful interpretation, showing the increase or decrease in the predicted probability of having a characteristic or experiencing an event due to a one-unit change in the independent variables.

The advantage of using the logistic regression model rather than a linear or any other type of model is that the independent or predictor variables in logistic regression can take any form. That is, logistic regression makes no assumption about the distribution of the independent variables. They do not have to be normally distributed, linearly related or of equal variance within each group. The relationship between the predictor and response variables is not a linear function in logistic regression; instead, the logistic regression function is used. The phenomenon of overcorrection is discrete or qualitative in nature, i.e. either overcorrection occurs in the crash or it does not; therefore, binary logistic regression is applicable. The structure of the model is as follows:

$$p(x) = \frac{e^{(\beta_0+\beta_1 X_1+\beta_2 X_2+\cdots+\beta_n X_n)}}{1+e^{(\beta_0+\beta_1 X_1+\beta_2 X_2+\cdots+\beta_n X_n)}}$$

$$\text{logit[p(x)]} = \ln\left(\frac{p(x)}{1-p(x)}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n$$

where p = probability of success
β_0 = constant term
β_i = i^{th} coefficient (logit)
X_i = value of i^{th} independent predictor variable

The goal of logistic regression is to correctly predict the outcome for individual cases using the most parsimonious model. To accomplish this goal, a model is created that includes all predictor variables that are useful in predicting the response variable. Several different options are available during model creation. Variables can be included or removed from the regression model by the testing the significance. This is known as stepwise regression, and is useful for developing a model that includes only those variables that are both significant and have high predictive values.

METHODOLOGY

The primary approach in this project was a case study analysis of the crashes, followed by a more detailed logistic regression analysis. This research is a part of more descriptive study done to evaluate the causes and effects of traffic crash fatalities occurring on state-maintained roads in Florida in the year 2000; additional results are available in Spainhour et al (1). For this purpose, a comprehensive database was developed to encompass different crash characteristics related to the driver, vehicle, environment and roadway at the time of the crash. This database contains the data input from Florida Traffic Crash Report (FTCR); site location and other site information queried from the Roadway Characteristics Information (RCI) mainframe database. Extracts from Florida Department of Transportation (FDOT) Crash Analysis Reporting system (CAR) database and other additional sources were used to complete the missing/incomplete data.

The data set analyzed in this study involved 579 run-off-the-road crashes of the 1683 crashes that occurred in the year 2000, including traditional run-off-the-road (ROR) crashes and those in which the vehicle was overcorrected back onto the roadway. Twenty-nine crashes in which the vehicle impacted a guardrail, attenuator, or other longitudinal barrier at or near the edge of the travel lane were excluded from the study because the crashes could not be clearly classified as overcorrection/oversteering or redirection. The data set originally consisted of 2080 fatal crashes that occurred on state roadways of Florida, primarily in the year 2000. The original study included a supplemental set of CMV crashes from the years 1998 and 1999; however, these were excluded from the sub-study described herein.

A systematic approach was adopted to analyze the factors affecting overcorrection crashes. The primary resource used in the study was the Traffic Homicide Investigation (THI) report. Completed for all fatal crashes in the state of Florida, the THI report contains the results of a detailed crash investigation conducted by a specially trained officer. The THI report contains any available background information on the drivers prior to the crash, plus the detailed information of roadway features, environmental characteristics, vehicle condition etc. associated with the crash. Analysis of skid marks; crash reconstructions; and interviews with driver, passengers, and witnesses as available, make these reports much more comprehensive and accurate than standard crash reports, especially concerning vehicle trajectory and overcorrection. Additional data sources used in this study included video log images, roadway characteristics inventory data, and other information from state databases. Where necessary, site visits by an interdisciplinary team of engineers, crash reconstruction experts, and safety specialists were conducted. Crash reconstructions involved traditional techniques based on linear momentum and energy absorption/crush damage. Depending on the case, site visits involved measuring and photographing various site features, including approach features, pavement markings, and sight distances, and investigating sun glare, traffic volumes, and other time-dependent aspects. Because of the time delay between when the crashes occurred and when the data was collected, information on the depth of the drop-off at the edge of the pavement was not collected during the site visits.

The data set used in this study contains a great deal of information from comprehensive case study reviews and represents a significant enhancement in data quality, particularly in accuracy and completeness, over that in the initial crash reports. For instance, roadway features (presence of rumble strips, shoulder type, etc.) were documented in the direction of the vehicle departure using Roadway Characteristics Information (RCI) data and videologs from Florida Department of Transportation (FDOT) sources, as well as site visits where necessary. As another example, the vehicle type variable on the original crash reports does not include SUV as a separate vehicle type, nor does it include vehicle model. Analysis showed that officers coded SUV's as either passenger cars or light trucks using no systematic classification schemes. As part of the case study review, vehicle model was identified from the VIN number and SUV's were uniformly grouped into a class with passenger vans and light trucks.

Finally, Figure 1 illustrates how the more detailed Traffic Homicide Investigation (THI) can provide more accurate information about a crash when compared to the initial Florida Traffic Crash Report (FTCR). Note that the diagram in Figure 1a is intentionally shown upside down so that North is facing in the same direction in both diagrams for ease of comparison. In the FTCR (Fig. 1a), the vehicle is shown traveling (from the top of the page) in the outermost lane, departing the roadway to the right, according to the FTCR, for an unknown reason. Examining the reconstruction diagram accompanying the THI report (Fig. 1b), further investigation has shown that the vehicle was actually traveling in the inside lane when it departed the roadway to the left and overcorrected back across the roadway before a second departure to the right.

The set of promising variables fell into four categories: driver, vehicle, roadway, and environmental factors. Coding and preparing data for statistical analysis were required to transform contributing factors into useful qualitative variables for logistic regression modeling. Careful consideration and multiple iterations were needed in the development of classification schemes for certain variables. A fundamental data consideration was whether the variable selected and the coding schemes effectively captured essential features of the data source. Final coding and data manipulation techniques yielded a combination of continuous and categorical variables. Many variables were partitioned from the range of values taken by continuous variables into sub-ranges which were then treated as discrete categories. Frequently, only the Boolean outcome (factor present or not present) was coded because this technique was found to be highly indicative. However, where multiple categorical values were required, the discrete categories required a logical ordering that was important to consider when interpreting results. It was important to code categorical variable with the most benign case as 1, because the coding affects the odds ratio and slope estimates. The first category, the one of lowest value, is designated as the reference category. The dependant variable *overcorrect* has the value of 0 if no overcorrection took place and 1 if it did. The various independent variables and their meanings and final codings are illustrated in Table 1.

The STATA statistical software program was used to perform logistic regressions. STATA handles missing data by ignoring all the data rows that have missing entries. Therefore measures were taken to fill the missing data. For example, in the few cases where ADT data was missing, the average ADT for all the crashes in the study was assigned.

RESULTS AND DISCUSSION

Outcomes following overcorrection involved either leaving the roadway again following inappropriate steering input, or impacting another vehicle on the roadway. The latter crashes would not be considered ROR crashes using traditional categorization techniques. Approximately 36 percent of the vehicles crossed the entire roadway and departed on the opposite side from the initial roadway departure. Approximately 33 percent of the overcorrecting vehicles returned to a travel lane but subsequently exited the roadway in the same direction as the initial ROR event. These vehicles potentially suffered no worse an outcome, since they left the roadway again in the same direction; however, the abrupt steering input typically induced a rotation about the yaw axis, resulting in tripping and possibly overturning, which might not have happened otherwise. Approximately 29 percent of the overcorrecting vehicles returned to the roadway prior to hitting another vehicle on the roadway. Of those, 63 percent impacted (e.g. sideswipe, rear-end) a vehicle traveling in the same direction, while 37 percent crossed either a centerline or a grass median and impacted a vehicle traveling in the opposite direction.

Table 2 looks at the initial cause of and primary contributing factor to the ROR event that resulted in the overcorrection. Of crashes where the primary contributing factor could be identified, alcohol is the most common contributing factor, followed by speed, inattention, and fatigue/asleep. With the exception of speed, the contributing factors paint a picture of a driver that drifts off the road at a gentle angle, then abruptly oversteers back onto the road surface, resulting in the crash. The speeding drivers, as well as the aggressive drivers tend to be attempting to maneuver around other vehicles when they get too close to the edge of the pavement, leave the roadway, and overcorrect.

As stated previously, logistic regression analysis was used to study human, roadway, vehicle, and environmental factors associated with overcorrection as opposed to traditional ROR crashes. To analyze the factors affecting overcorrection crashes, twenty-three explanatory variables were selected, as described above. A binary logistic regression of each individual variable was performed to investigate the effect of each independent variable on overcorrection. Table 3 summarizes these explanatory variables along with their coefficients, odds ratios and p-values. In Table 3, the variables are sorted according to p-value. That is to say, the variables at the top of the table have the most significance in the model, and those at the bottom of the table have the least significance. Odds in logistic regression express the likelihood of an occurrence relative to the likelihood of a nonoccurrence. Accordingly, an odds ratio greater than one indicates that an overcorrection is more likely as the code value increases. The higher the ratio is, the stronger the correlation is. The logistic regression coefficients show the change in the predicted logged odds of experiencing an event or having a characteristic for a one-unit change in the independent variables; negative coefficients are associated with decreased odds ratios and positive coefficients are associated with increased odds ratios.

To further explain the meaning of the data, an example is presented. The variable gender has a p-value of 0.011, the lowest in the study, meaning that the result is statistically significant to almost a 99 percent level. Driver gender has odds ratio of 0.540, showing that females are more likely to overcorrect than males. This can be explained in the following way. The odds ratio is less than one, meaning that a male (Male =01) is less likely to overcorrect than a female (Female=00). Specifically, the co-efficient value of -0.617 means that a male is $e^{-0.617}$ or 0.540 times the odds of overcorrect as a female. Conversely, a female has 1/0.540 or 1.85 greater odds of overcorrecting in a fatal ROR crash than a male.

The results in Table 3 show that overcorrection has a strong positive association with the presence of rumble strips, inclement weather, rural locations, incapacitated drivers, and running off the road to the left or straight. However, only the presence of rumble strips is a significant explanatory variable, with almost a 95 percent confidence level. Overcorrection has a strong negative association with male drivers, speeding, paved or curbed shoulders, wet or slippery roads, and larger vehicles, but the last two variables are not significant, assuming an 85 percent confidence level.

To remove variables that were not significant and did not have a high predictive value in the model, backward stepwise regression was performed. Stepwise regression removed all of the original variables except for five, namely, gender, presence of rumble strips, speeding, second shoulder type and vehicle movement. Table 4 summarizes the results of the stepwise regression with a p-value cutoff of 0.2. The results are generally consistent with those in the full model, except that road condition no longer meets the minimum established level of significance. Minor adjustments in the odds ratios and p-values occur for the remaining variables as well. With a log likelihood of -266.932, the likelihood ratio chi-squared statistic for the model (22.80) yields a p-value of 0.0009. A well-fitting model is significant at the 0.05 level or better; therefore, we can reject the null hypothesis and conclude that the variables have an associated relationship that is explained well by the model.

The most significant two variables in Tables 3 and 4 are discussed in more detail here; others have less certainty or a weaker association with overcorrection. As detailed previously, females have higher odds than males of overcorrecting after running off the road. Table 5 elaborates on this result by looking at the overcorrection rate of males and females in various age groups. Ages are grouped according to the categories defined in Table 1. Regardless of age, females were at about a forty percent higher risk of overcorrecting in a fatal ROR crash than males. The greatest disparity occurred among middle-aged drivers. However, the trend was reversed for older drivers, where males were about one-third more likely to overcorrect after departing from the roadway. Note that the risk is only significant at 95% confidence when the interval includes 1.0.

Tables 3 and 4 also showed a strong correlation between overcorrection and presence of rumble strips. Table 6 elaborates on this data, looking at both rumble strip presence and posted speed. Posted speed limits are grouped according to the categories defined in Table 1. The first item to note is that only about 16 percent of the ROR crashes in the data set occurred roads with rumble strips. Identification of rumble strips is based on RCI data plus an analysis of both THI reports and video log photos; as stated previously, rumble strip presence is verified in the direction of the roadway departure. While not the focus of this study, this fact indicates that run-off-the-road crashes are not strongly associated with the presence of rumble strips.

When rumble strips are present, however, vehicles are more than fifty percent more likely to overcorrect than when they are not present. This effect varies greatly depending on the speed limit of the roadway. On high speed (70 mph) roadways, there is almost an 80 percent higher risk of overcorrection when rumble strips are present; however, on medium speed roadways (55-65 mph), the risk of overcorrection is actually reduced when rumble strips are present. Only one low speed (under 55 mph) roadway in the study had rumble strips, reducing the ability to examine the effect of rumble strips on overcorrect in low speed roadways. Note, however, that overcorrection is much less common on low speed roadways compared to higher speed roadways.

CONCLUSIONS AND RECOMMENDATIONS

A detailed study of fatal crashes in the state of Florida primarily in the year 2000 showed that about one-third of the fatal crashes involved running off the road as the first event, and over twenty-five percent of the fatal run-off-the-road (ROR) crashes involved overcorrection (1). Because of the high incidence of overcorrection among fatal ROR crashes, further study was undertaken. To overcome shortcomings of traditional methods relying primarily on crash reports, this study relied upon case reviews using a broad variety of resources from various disciplines to identify crash events and causative factors. Chief among those resources were traffic homicide investigations (THI) and roadway characteristics inventory (RCI) data. Where necessary, site visits were conducted by a multidisciplinary team of engineers, crash reconstruction specialists, and safety experts.

In an attempt to identify characteristics that have a strong positive association with overcorrection, data on 579 fatal ROR crashes on state roadways in Florida were analyzed using logistic regression techniques. The data set used in this study represents a significant enhancement in data quality, particularly in accuracy and completeness, over that in the initial crash reports. One of the principle improvements in quality was the ability to identify overcorrection because of the THI reports. Overcorrection cases were strongly associated with alcohol, inattention, and fatigue/asleep, all factors that might cause the driver to drift off the roadway, and high speed, which tends to be associated with the vehicle's tires encroaching on the shoulder during aggressive passing maneuvers. Outcomes ranged from roadway departure in the opposite direction, to a vehicle impact upon returning to the roadway.

Since the outcome of these models is discrete in nature, logistic regression was identified as the most suitable approach. To analyze the factors affecting overcorrection in the fatal ROR crashes, twenty-three explanatory variables were selected. Backward stepwise regression with a significance level of 0.2 removed all of the original variables except for five, namely, gender, presence of rumble strips, speeding, second shoulder type and vehicle movement. The two most significant variables in both models were gender and presence of rumble strips. The study indicated that females were at about a forty percent higher risk of overcorrecting in a fatal ROR crash than males. The greatest disparity occurred among middle-aged drivers. Further, while fewer than 20 percent of fatal ROR crashes occurred where rumble strips were present, drivers are more than fifty percent more likely to overcorrect than when they are not present. On high speed (70 mph) roadways with rumble strips, there is almost an 80 percent higher risk of overcorrection in the fatal ROR crash.

One limitation of the study was that shoulder drop was not collected at the ROR sites and therefore could not be included as a dependent variable. Drop-off depth was not typically collected during the traffic homicide investigation and could not be verified by a subsequent examination of the photographic data. Because of the time delay between when the crashes occurred and when the site visits were conducted, information on the depth of the drop-off at the edge of the pavement was deemed to be unreliable and thus was not collected. However, a large number of overcorrecting vehicles (114 out of 156) left the edge of the paved roadway prior to overcorrecting. Because of the literature associating deep edge drop-offs with oversteering (13, 14, 15), the effect of edge drop-off on crash type and frequency should be investigated more thoroughly.

It is important to note is that only about 16 percent of the ROR crashes in the data set occurred roads with rumble strips. This indicates that rumble strips are effective in preventing many run-off-the-road crashes. However, the contribution of rumble strips' auditory and vibratory sensations to panic oversteering should also be investigated. Additional research should be undertaken into the effects of varying the position, depth, and type of rumble strips on the tactile warning sensations resulting from driving over the rumble strips.

Many overcorrection crashes in the study appear to involve a panic reaction following an unintended roadway departure. At highway speeds, overcorrecting or excessive steering can cause the driver to lose control, which can force the vehicle to slide sideways and roll over or lose control. While the effect of educational programs on driver behavior can be debated, one can argue that drivers could benefit from additional training regarding how to properly respond to emergency driving situations. In the event of a roadway departure, the driver should gradually reduce the vehicle speed and ease the vehicle back on to the roadway when it is safe to do so.

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Table 1 Description of Variables Affecting Overcorrection Crashes

Variable Name	Variable Definition	Data Type	Variable Values
GENDER	Driver gender	Binary	00- Female; 01- Male
DRIVER_AGE	Driver age	Categorical	01- Younger Driver (<25yrs); 02- Middle Aged (25-64); 03- Older Driver (≥65 years)
VEH_MOVE	Movement of vehicle before overcorrection	Categorical	01- Straight; 02- Slowing/Turning; 03- Passing/Changing; 04- Others
VEH_TYPE	Type of vehicle involved	Categorical	01- Passenger car; 02- SUV/Van/Light truck; 03- Single Trailer & above
ROADTYPE	Type of road facility	Categorical	01- Limited Access; 02- Divided; 03- Undivided
INCAP	At-fault driver under influence of alcohol (BAC >0.08)	Binary	00- No; 01- Yes
POSTED_SPEED	Posted speed on roadway	Categorical	01- <55 mph; 02- 55-65 mph; 03- 70 mph
VEH_SPEED	Recorded speed of the vehicle just before crash	Categorical	01- <55 mph; 02- 55-69 mph; 03- ≥70 mph
SPEEDING	Whether driver was driving at speed higher than the posted limit	Binary	00- No; 01-Yes
OCCUPANTS	Number of occupants inside the vehicle	Categorical	01- One occupant; 02- Two or more occupant
ROR_DIR	Direction of the vehicle at the time of ROR crash	Categorical	01- Right; 02- Left; 03- Straight
RUMBLE_STRIP	Presence of rumble strips in ROR direction	Binary	00- No ; 01-Yes
NUM_OF_LANES	Number of lanes	Categorical	01- One-Three; 02- Four or more
ADT	Average daily traffic for the site.	Categorical	00- <10k; 01- 10k-20k; 02- 20k-30k; 03- 30k-40k; 04- >40k
ROAD_COND	Condition of roadway at the time of crash	Categorical	01- Dry; 02- Wet/ Slippery
SLD_TYPE1	First shoulder type in the direction of the ROR	Categorical	01- Unpaved; 02- Paved; 03-Curb
PAVE_SLDWIDT	Width of paved/unpaved shoulder in the direction of the ROR	Categorical	01- <5; 02- 5-10; 03- 10-15; 04- >15
SLD_TYPE2	Second shoulder type in the direction of the ROR	Categorical	01- Unpaved; 02- Paved; 03- Curb
RURAL	Geographical location of roadway	Binary	00- No; 01-Yes
MEDIAN_WIDTH	Width of median	Categorical	01- <=20; 02- 21-54; 03- >54
AVG_T_FACTOR	Average truck factor of roadway	Categorical	01- <6.66; 02- 6.67-13.64; 03- >13.64
DAYLIGHT	Lighting condition at the time of crash	Binary	00- No; 01-Yes
BADWEATHER	Weather condition at the time of crash	Binary	00- No; 01-Yes

Table 2 Initial Contributing Factor in ROR Overcorrection

Contributing Factor	**Number**	**Percent**
Alcohol	46	29.5%
Speed	20	12.8%
Unknown	18	11.5%
Inattention	17	10.9%
Fatigue/Asleep	15	9.6%
Drugs	10	6.4%
Alcohol and Drugs	9	5.8%
Tires	6	3.8%
Aggression	3	1.9%
Distraction	3	1.9%
Medical	2	1.2%
Access Point	1	0.6%
Congestion	1	0.6%
Curvature	1	0.6%
Fog	1	0.6%
Inexperience	1	0.6%
Obstructed View	1	0.6%
Obstruction	1	0.6%
Total	156	100.0%

Table 3 Logistic Regression Results—Full Model

Variable Name	Code Values and Definition	Coefficients	Odds Ratio	p > |z|
GENDER	00- Female; 01-Male	-0.617	0.540	0.011
RUMBLE_STRIP	00- No; 01-Yes	0.587	1.798	0.056
SPEEDING	00- No; 01-Yes	-0.479	0.620	0.120
SLD_TYPE2	01- Unpaved; 02- Paved; 03- Curb	-1.528	0.217	0.145
ROAD_COND	01- Dry 02- Wet/ Slippery	-0.658	0.518	0.162
VEH_MOVE	01- Straight; 02- Slowing/Turning; 03- Passing/Changing; 04- Others	0.163	1.177	0.185
VEH_TYPE	01- Passenger Car; 02- SUV/Van/Light truck; 03- Single Trailer & above	-0.226	0.798	0.235
AVG_T_FACTOR	01- <6.66; 02- 6.67-13.64; 03- >13.64	-0.203	0.816	0.243
RURAL	00- No; 01-Yes	0.324	1.383	0.272
BADWEATHER	00- No; 01-Yes	0.529	1.698	0.319
INCAP	00- No; 01- Yes.	0.233	1.262	0.334
ROR_DIR	01- Right; 02- Left; 03- Straight	0.201	1.223	0.361
ADT	00- <10k; 01- 10k-20k; 02- 20k-30k; 03- 30k-40k; 04- >40k	0.068	1.070	0.472
VEH_SPEED	01- <55 mph; 02- 55-69 mph; 03- ≥70 mph	-0.198	0.820	0.526
DRIVER_AGE	01- Younger Driver (< 25yrs); 02- Middle Aged (25-64); 03- Older Driver (≥65 years)	0.115	1.122	0.564
ROADTYPE	01- Limited Access; 02- Divided; 03- Undivided	0.101	1.107	0.607
MEDIAN_WIDTH	01- <=20; 02- 21-54; 03- >54	0.113	1.120	0.611
PAVE_SLDWIDT	01- <5; 02- 5-10; 03- 10-15; 04- >15	0.073	1.076	0.638
SLD_TYPE1	01- Unpaved; 02- Paved; 03-Curb	0.093	1.098	0.644
DAYLIGHT	00- No; 01-Yes	-0.104	0.901	0.657
POSTED_SPEED	01- <55 mph; 02- 55-65 mph; 03- 70 mph	0.150	1.162	0.667
OCCUPANTS	01- One occupant; 02- Two or more occupants	-0.057	0.945	0.852
NUM_OF_LANES	01- One-Three; 02- Four or more	-0.060	0.942	0.852

Table 4 Variables Remaining after Stepwise Logistic Regression

Variable	**Coef.**	**Odds Ratio**	**p > |z|**
GENDER	-0.676	0.509	0.003
RUMBLE_STRIP	0.550	1.733	0.053
SPEEDING	-0.373	0.689	0.093
SLD_TYPE2	-1.428	0.240	0.165
VEH_MOVE	0.167	1.182	0.152

Table 5 Overcorrection Based on Age and Driver Sex

	Young Males	**Young Females**	**Mid-Age Males**	**Mid-Age Females**	**Older Males**	**Older Females**	**All Males**	**All Females**
Overcorrection	29	18	58	31	8	5	95	54
No Overcorrection	83	34	208	64	10	10	301	108
Total	112	52	266	95	18	15	396	162
% Overcorrection	25.89	34.62	21.80	32.63	44.44	33.33	23.99	33.33
Relative Risk (Min & Max, 95% CI)	0.82	2.18	1.04	2.16	0.31	1.81	1.05	1.84

Table 6 Overcorrection Based on Posted Speed and Rumble Strip Presence

	Low Speed-No Rumble Strips	**Low Speed-Rumble Strips**	**Medium Speed-No Rumble Strips**	**Medium Speed-Rumble Strips**	**High Speed-No Rumble Strips**	**High Speed-Rumble Strips**	**Total-No Rumble Strips**	**Total-Rumble Strips**
Overcorrection	15	1	81	8	25	26	121	35
No Overcorrection	141	0	142	20	83	37	366	57
Total	156	1	223	28	108	63	487	92
% Overcorrection	9.62	100.00	36.32	28.57	23.15	41.27	24.85	38.04
Relative Risk (Min & Max, 95% CI)	6.43	16.83	0.43	1.45	1.13	2.80	1.13	2.07

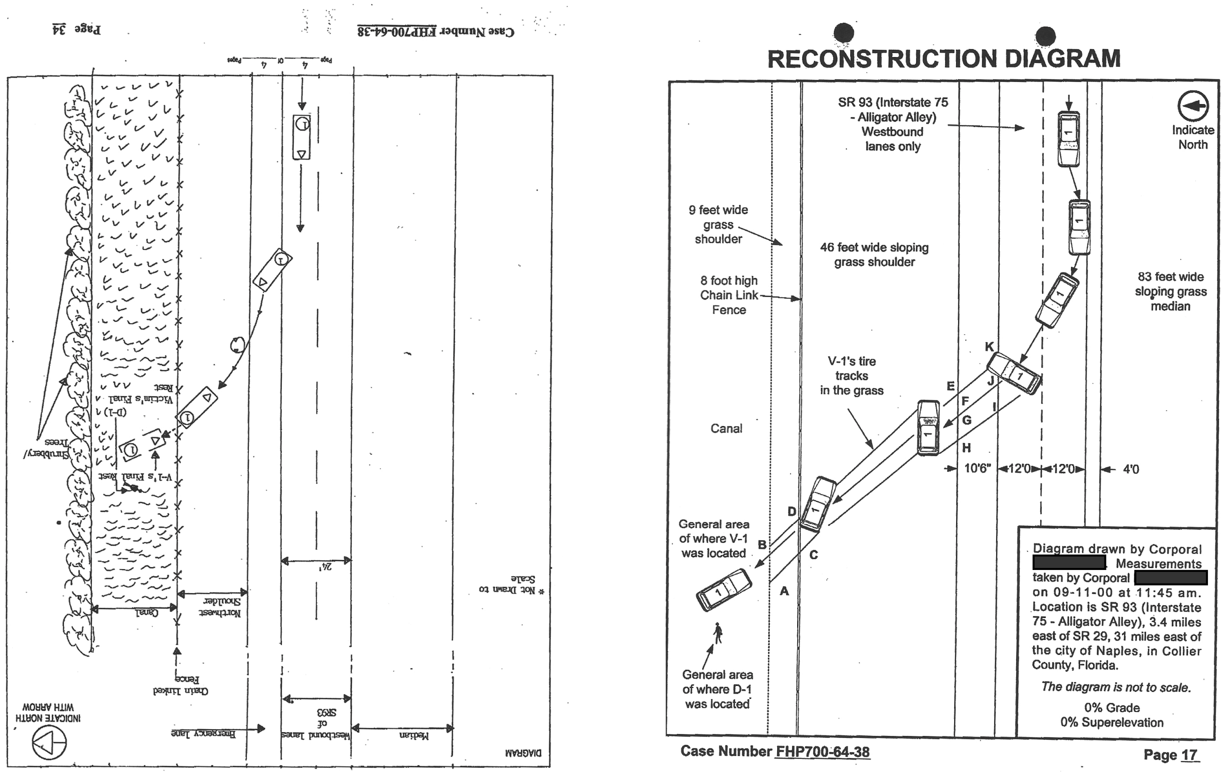

Diagram drawn by Corporal [redacted]. Measurements taken by Corporal [redacted] on 09-11-00 at 11:45 am. Location is SR 93 (Interstate 75 - Alligator Alley), 3.4 miles east of SR 29, 31 miles east of the city of Naples, in Collier County, Florida.

The diagram is not to scale.

0% Grade
0% Superelevation

a) **b)**

Figure 1 Example Crash Diagram from a FTCR.