

CORRELATING DELTA-V TO OCCUPANT INJURY USING EVENT DATA RECORDERS

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INTRODUCTION

Delta-V, defined as the total change in vehicle velocity, has traditionally been used as a measure of crash severity and predictor for occupant injury for vehicular crashes. Typically, delta-V is estimated using measured vehicle post-crash damage in tandem with computer codes such as WinSmash or Crash3.

Several researchers have previously correlated this delta-V estimate with risk of occupant injury using logistic regression. Winnicki and Eppinger (1998) developed chest injury risk curves for varying injury and delta-V levels in conjunction with a methodology to evaluate benefits associated with depowering airbags. Similarly, Bahouth et al. (2004) generated a statistical predictive model based on delta-V for all occupant restraint types and crash modalities.

Event Data Recorders (EDRs), installed in many late model vehicles, are an alternate means of obtaining delta-V for a real-world collision. EDRs are similar to “black boxes” in airplanes as they record information in the event of a highway collision, including vehicle change in velocity as a function of time. Current research suggests excellent agreement (within 6 percent) between EDR-recorded delta-V and actual delta-V in frontal collisions (Niehoff et al., 2005).

The objective of this research is to correlate EDR delta-V to occupant injury in real-

world collisions and compare to the results using other methods of estimating delta-V.

METHODS

Suitable cases were selected from the National Highway Traffic Safety Administration (NHTSA) EDR database. Currently, the database consists of EDR data for over 1700 cases, all of which are GM vehicles. As these cases were collected in conjunction with NASS/CDS, the corresponding occupant injury information is matched to corresponding EDR data. Suitable cases were limited to frontal collisions with airbag deployment, a single crash event, available EDR data, and known occupant injury. Based on these criteria, there were 191 suitable cases available for analysis; 152 belted and 27 unbelted front seat occupants.

Binary logistic regression models were fit to the entire dataset as well as belted and unbelted data subsets using delta-V as a predictor of serious occupant injury. For this study, serious injury is defined based on the Abbreviated Injury Severity scale (AAAM, 2001).

RESULTS AND DISCUSSION

Figure 1 and Figure 2 show the injury risk curves for overall occupant injury and chest injury, respectively, based on the available data. Note that the chest injury curves only include 179 cases, as injury by body region was not known in 12 instances. For all models, tests of the global null hypothesis

were significant to the 0.0001 level or better. Pearson goodness-of-fit statistics were 0.097 and 0.904 for the belted and unbelted subset data models indicating reasonable fits.

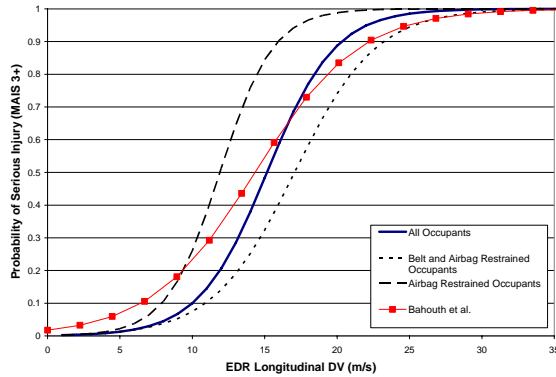


Figure 1: Occupant Maximum Injury as a Function of Longitudinal Delta-V.

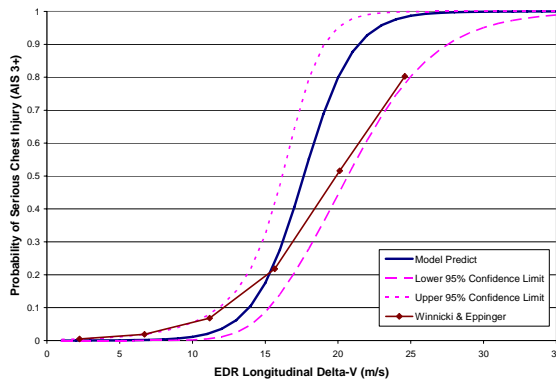


Figure 2: Occupant Chest Injury as a Function of Longitudinal Delta-V.

As expected, for the same delta-V, Figure 1 shows lower injury risk for occupants restrained by both a belt and airbag than for an occupant restrained by an airbag only. For comparison purposes, the Bahouth risk curve is also plotted in Figure 1. There is reasonable agreement for the developed model including all occupants with larger differences evident in the lower delta-V region. This discrepancy is most likely a result of the Bahouth model including all crash modes while the model developed herein is limited to frontal collisions.

For occupant chest injury, Figure 2 shows the developed model with 95% confidence bounds. Since the data set was smaller, no effort was made to split the data by belted and unbelted occupants. Also, the Winnicki and Eppinger risk curve is plotted for comparison purposes. Although there is not exceptional agreement, the risk curve does fall within the confidence bounds of the risk curve developed in this study. Note that the Winnicki and Eppinger risk curve has been based on data collected between 1991 and 1996 while the current study incorporates data from 2000 to 2004.

SUMMARY/CONCLUSIONS

EDRs offer an alternate means of developing occupant injury risk curves based on injury in real-world collisions. Injury risk curves are generated for overall occupant injury and chest injury using EDR delta-V as the predictor. Reasonable agreement was found with previous work that used vehicle-damage methods to estimate delta-V.

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ACKNOWLEDGEMENTS

The authors would like to thank NHTSA for the provision of the EDR data.