The Effects of Alcohol on In-Hospital Mortality in Drivers Admitted after Motor Vehicle Accidents

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Abstract

Background: The effects of alcohol on morbidity and mortality following motor vehicle accidents (MVAs) are controversial. This study was performed to address the effect of alcohol on in-hospital mortality for drivers in MVAs admitted to a trauma center before and after controlling for injury severity, safety device use, and patient demographics. Methods: A retrospective study was performed using data from the National Trauma Data Bank®, version 4.3. The cohort consisted of drivers in an MVA who were 15 years of age or older, had been admitted to the hospital on the same day as the accident, were screened for alcohol, and had no documentation of drugs in their system. Analyses were performed to explore the relationships between patient age, gender, race, presence of head injury, comorbidity status, injury severity score (ISS), and presence of alcohol and in-hospital mortality. Results: The cohort consisted of 67,021 patients, 38.3% of whom were drivers involved in an MVA and, following screening, were found to have alcohol present in their system. Drivers who had alcohol present were more likely to be younger, male, White, not using a safety device, and to have sustained a head injury, than drivers who had no alcohol present in their system (alcohol absent drivers) at hospital presentation. After controlling for potential confounding variables, risk factors for in-hospital mortality included male sex, older age, and higher injury severity, while protective factors included the presence of alcohol and use of safety devices. The single strongest predictor of mortality was ISS. Sensitivity analyses to reflect the impact of inflation in true ISS scores in the subgroup of patients who had alcohol present as well as a head injury revealed that the protective effect of alcohol diminished and became nonsignificant when the ISS was reduced by 9% and became a significant risk factor for in-patient mortality when the false elevation in ISS was estimated at 21%. Conclusions: These results suggest the importance of carefully considering the consequences that falsely inflated ISS scores might have for patients with alcohol present. Future work should evaluate the possible inflation of ISS and attempt to reconcile different interpretations of the effects that the presence of alcohol may have on MVA mortality based by jointly considering crash site and in-hospital data.

Drinking and driving is a tremendous public health concern. Alcohol consumption has been implicated as a factor in over half of fatal motor vehicle accidents (MVAs), with associations found between alcohol consumption and the severity of the car crash. Although it is well established that alcohol consumption is a risk factor for MVAs, the effects of alcohol on morbidity and mortality following an MVA are more controversial. There are studies that report: 1. significantly lower mortality for hospitalized trauma patients in the presence of elevated blood alcohol levels compared to a sober group matched for similar injury severity, consistent with the belief that “drunks don’t get hurt when they fall, because they are so relaxed”3; 2. no significant differences in outcome between intoxicated and non-intoxicated drivers4,5; and 3. findings that drivers with higher blood alcohol levels are at a significantly increased risk of serious or fatal injury when controlling for potential confounding variables such as injury severity.6

One of the hypotheses explaining the apparent protective effect of alcohol on morbidity and mortality in hospitalized patients is misclassification of injury severity.6 Due to alcohol intoxication, a patient may appear to have sustained a closed head injury and, therefore, be classified with higher
injury severity. When matched with sober patients who sustained similar injury severity, these intoxicated patients may appear to recover quicker or more fully than those patients whose injury severity was not falsely elevated by the depressant effects of alcohol.

The purpose of this study was to address the effect of alcohol on in-hospital mortality for drivers in MVAs admitted to a trauma center before and after controlling for injury severity, safety device use, and patient demographics. The null hypothesis was that survival for drivers involved in MVAs was not related to alcohol presence. Additionally, we evaluated the notion that patients with alcohol involvement may have had falsely inflated injury severity scores (ISSs), because the effects of alcohol, such as incoherence and reduced motor function, may have been attributed to head injury.

Methods
Data Source
The data in this study were obtained from the National Trauma Data Bank® (NTDB), version 4.3, which includes over 1.21 million trauma cases from 377 institutions that were gathered from 1988 through 2004.7 The data bank is managed through the American College of Surgeons (ACS) and collects data from 55% of all Level I trauma centers, 35% of Level II trauma centers, and many Level III trauma centers throughout the United States. Data entry is voluntary at participating hospitals and, therefore, may not reflect the actual number of trauma patients seen at an institution. Further, the NTDB provides no weighting information that would allow the user to estimate national incidence rates.

Target Population
Drivers who were 15 years of age or older and involved in a moving MVA were identified as the target population of interest.

Inclusion Criteria
Patients presenting at a trauma center who were initially considered for the study were coded as being: 1. the driver in a moving MVA (i.e., Ecodes: 810.0, 811.0, 812-812.9, 813.0, 814.0, 815-815.9, 816.0-816.9, 819.0, 822.0, 823, 823.0); 2. 15 years of age or older; 3. admitted to the hospital on the same day as the accident; 4. screened for alcohol; and 5. had no documentation of drugs in their system. Patients who were passengers (not drivers) in an MVA and those sustaining injuries resulting from a nonmoving MVA were not included. Patients who had a documented presence of drugs in their system were not included, since the drugs might confound the affects that alcohol played on mortality.

Exclusion Criteria
Drivers presenting at a trauma center due to a MVA were excluded if they lacked 1. gender data, 2. ISS data, or 3. mortality outcome. The results from these inclusion and exclusion criteria are summarized in Figure 1.

Variable Selection and Definition
Injury severity data was judged from the ISS, which can range from 0, indicating virtually no injury in any body region, to 75, which would indicate severe injury in three different body regions or an extremely severe injury in any one body region. Safety devices were coded as either: 1. seat belt (SB) used; 2. air bag (AB) deployed; 3. seat belt used and air bag deployed (SB + AB); or 4. no safety devices (None) used. If no safety device information was provided, these patients were retained and labeled as “Not Coded.” Patients’ comorbidity status was inferred based on coded ICD-9 values in accordance to the scheme proposed by Deyo and colleagues.8,9 The Deyo-Charlson comorbidity index (DC_CI) was coded as either 0 (no comorbidities coded) or 1 (one or more comorbidities coded). Race was coded as either: 1. White, 2. Black; 3. Hispanic, or
4. Other, which collapsed Asian, American Indians, and Other. If no race data was provided, patients were retained and labeled as Not Coded. Patients were coded as having a head injury if the abbreviated injury scores (AIS) coded for the patient indicated the head as an affected area with a score greater than 0; the coding of AIS scores were given the same meaning as the ISS scores.

Statistical Analysis

Initial analyses summarized descriptive statistics for the patient cohort and explored the relationships between age, gender, race, head injury, comorbidity status, injury severity (using ISS), and mortality with alcohol presence, using chi-square for categorical and analysis of variance (ANOVA) for continuous variables.

Preliminary logistic regression models were used to model mortality for each predictor separately (alcohol presence, age, gender, race, presence of head injury, DC_CI, use of safety devices, and ISS). For categorical predictors (all but ISS and age), contrasts were developed to compare each categorical level with a reference. For age and ISS, odds ratios were evaluated for both 1 and 10 units of change, since a single unit of change (e.g., age 15 to 16 years) is not typically considered meaningful when forming odds ratios based on continuous variables. In addition, model odds ratios, based on model coefficients, model fit statistics, and prediction parameters, were summarized. Model fit statistics included prior mortality rates, the model cut score for classification, maximum rescaled R², and overall percent correct prediction. The traditional Hosmer-Lemshow statistic for goodness-of-fit was not included because of the known positive bias in large samples. Prediction parameters included sensitivity, specificity, positive and negative predictive value, and metrics to evaluate gain in prediction, including absolute gain (AG), relative gain (RG), and percent of possible gain (PPG). The effects of the presence of alcohol and selected covariates were evaluated by considering all variables simultaneously. The characteristics of the final model were summarized in the same fashion as for the preliminary logistic regressions.

Finally, to evaluate the hypothesis that injury severity may be falsely elevated in patients with alcohol in their system, sensitivity analyses were conducted to evaluate the influence that falsely elevated ISS scores would have on risks associated with alcohol. This was done by evaluating ISS scores by alcohol presence and head injury status using ANOVA and determining the percent of ISS overestimation necessary in patients with alcohol and head injury to change the observed odds ratios for alcohol presence from a significant protective to a significant risk factor. For example, what was the effect on the odds ratios associated with alcohol presence in a logistic model when the ISS for patients with alcohol in their system and a head injury was reduced by "X"% to adjust for the presumed false elevation in injury severity?

Results

Cohort Description

As summarized in Figure 1, of the 1.21 million trauma cases in the NTDB, 70,039 patients (5.7%) met the study inclusion criteria. Of these, 67,021, or 95.7%, were retained after applying the exclusion criteria. In this sample, 38.3% of these drivers involved in an MVA were screened and found to have alcohol present in their system.

Summaries of patient characteristics for the cohort are displayed in Tables 1 and 2. Patients with alcohol present were, on average, about 6 years younger than those with alcohol absent (34.2 vs. 40.3 years old, p < 0.0001). Males made-up 64.8% (p < 0.001) of the cohort and were much more likely to have alcohol present than females (77.9% vs. 22.1%, p < 0.0001). The majority of patients (68.7%) were White. Very few patients in the sample (94.1%) had comorbidities, with a higher percentage of patients in the alcohol absent group having some comorbidities (6.4% vs. 5.1%, respectively; p < 0.0001). Approximately 35% of the patients were coded as having a head injury, with a higher percentage in the alcohol present group compared to the alcohol absent group (37.3% vs. 33.0%, respectively; p < 0.0001).

Safety device use was of particular interest for several reasons. First, the largest single group of patients (33.1%) was coded as having used no safety devices, with 23% not coded at all. The second highest classification was seat belts only (31.75%). Air bag deployment alone was the least coded category (4.3%), with seat belt and air bag deployment coded 7.8% of the time. Second, with alcohol present, the percentage of patients who did not use any safety devices was substantially higher than for patients who had alcohol absent (42.7% vs. 27.2%, respectively; p < 0.0001). For injury severity based on ISS, although those with alcohol present had a slightly lower ISS than those with alcohol absent (11.8 vs. 12.2, p < 0.0001), this statistically significant difference was not considered clinically relevant. Overall, hospital mortality was 4.68%. For patients with alcohol present, the mortality was significantly lower than for patients with alcohol absent in their system (3.8% vs. 5.2%, p < 0.0001).

Factors Affecting Mortality

Logistic regression techniques were used to model mortality relative to the presence of alcohol in conjunction with patient age, gender, race, presence of head injury, comorbidity status, use of safety devices, and injury severity. Table 3 summarizes the logistic regression results for each model, including fit and quality of prediction, and the odds ratio associated with model classification of mortality for each patient relative to actual mortality. When considering alcohol presence alone, the model correctly classified a patient as having lived or died 60% of the time. Diagnostic confidence, also called the positive predictive value (PV+), reflects the probability of patient mortality given the model-predicted mortality, was .038, which is lower than the .0467 rate in the population.
The odds ratio for the model was .728, which indicated that the presence of alcohol in the system of a driver hospitalized because of an MVA was protective for mortality. The single best predictor of mortality was ISS. In this model, PV+ was .189, which represents an improvement over the sample mortality rate of 14.3%, with this gain representing approximately 15% of the total gain possible. The odds ratio for ISS was 19.5, indicating that those patients predicted to die by the logistic regression model were 19.5 times more likely to have died than those patients predicted to survive.

Positive predictive value for the full, or final, model (which included all prognostic factors) was .192, which represents a 14.6% improvement over the sample mortality rate, with this gain representing 15.3% of the total gain possible. The odds ratio for the final model was 23.4, indicating that those patients predicted to die by the logistic regression model were 23.4 times more likely to have died than those patients predicted to survive.

Table 4 summarizes the unadjusted and adjusted odds ratios based on the logistic regression models. Considering the unadjusted odds ratios: 1. Alcohol presence had an odds ratio of .73 (95% CI 0.67 – 0.79), which indicated that for drivers involved in an MVA whose injuries were sufficient to need hospitalization, alcohol was protective of mortality; 2. males were more likely to die than females (odds ratio, 1.17); 3. all non-White race categories were less likely to die than Whites; 4. patients who sustained a head injury were more likely to die than those who did not sustain a head injury (odds ratio, 2.08); 5. patients who had one or more Deyo-Charlson comorbidities were more than twice as likely to die than patients who had no comorbidities (odds ratio, 1.17); 3. all non-White race categories were less likely to die than Whites; 4. patients who sustained a head injury were more likely to die than those who did not sustain a head injury (odds ratio, 2.08); 5. patients who had one or more Deyo-Charlson comorbidities were more than twice as likely to die than patients who had no comorbidities (odds ratio, 2.08); 6. safety devices, when coded, were significantly protective of mortality compared to when no safety devices were used; 7. mortality was more likely in older patients, with a 27% greater risk for mortality with each 10-year gain in age; and 8. mortality was more likely with greater ISSs, with a 175% greater risk for mortality for each 10-point gain in ISS.

The pattern of adjusted odds ratios from the final model
that considered all prognostic factors was generally similar to that of the unadjusted results: 1. alcohol presence, although a slightly weaker effect, was still a significant protective effect for mortality (odds ratio, 0.80); 2. males had a higher risk for mortality (odds ratio, 1.24); 3. race categories referenced to Whites were no longer significant factors; 4. head injury was no longer a significant factor (odds ratio, 1.08); 5. the DC_CI was no longer a significant factor (odds ratio, 1.00); 6. safety devices were still protective of mortality, but these effects were slightly lower; 7. mortality continued to be more likely for each 10-year gain in age; and 8. mortality continued to be more likely with greater injury severity, represented by ISS, with a 181% greater risk of mortality for each 10-point gain in ISS.

**Sensitivity to Inflated ISS**

Assuming that there was a false elevation of reported injury severity (by ISS evaluation) for patients who had alcohol in their system and were coded as having a head injury, two questions remained: 1. what was the relationship between the ISS, the presence of alcohol, and diagnosis of a head injury; and 2. what effect would a false inflation in the ISS have in influencing the apparent effect of alcohol presence as a prognostic factor for mortality.

Differences in ISS scores based on alcohol presence (Yes/No) and head injury diagnosis (Yes/No) were evaluated using a 2 x 2 ANOVA. Both the alcohol and head injury factors demonstrated significant main effects and the alcohol presence by head injury interaction was significant.
The alcohol by head injury interaction effects, summarized here as differences in the ISS [mean (standard deviation)] for those without and with head injuries in the alcohol present and not present groups, respectively, were: 9.68 (10.09) vs. 15.43 (12.76) in the alcohol present group and 10.03 (10.23) vs. 16.56 (12.92) for the no alcohol present group, respectively; p < 0.0001. However, the 5.32 ISS difference between head injury and no head injury (15.43-9.68, or 59% increase) in the alcohol group was not considered clinically meaningful, compared to the 6.53 ISS difference (16.56-10.03, or 65%) in the no alcohol group, because of the relatively small magnitude of the difference, and the direction of the change was opposite of what would be expected if the presence of alcohol was artificially inflating the ISSs due to the over diagnosis of head injury.

Table 5 summarizes the adjusted odds ratios based on the full logistic model, where the ISSs were adjusted to reflect differing amounts of false elevation. Only those values that reflected changes in interpretation of the odds ratios for alcohol presence are reported. From this table, one can observe the protective effect of alcohol diminished and became nonsignificant when the ISS for this patient subgroup was reduced by 9%. Alcohol presence remained nonsignificant until the level of false elevation was estimated at 21%, at which level the presence of alcohol was a significant risk factor for in-hospital mortality. Therefore, the prognostic value of alcohol presence on in-hospital mortality is related to one’s belief about the potential for false elevation in ISS coding for patients with alcohol in their system, in this case limited to situations in which patients were coded as having a head injury.

**Discussion**

In this study, 38% of the drivers involved in an MVA and screened were found to have alcohol present in their system. This percentage or number may reflect bias due to differing criteria for alcohol screening; it might appear high if all drivers involved in an MVA were screened, and low if only those suspected of having alcohol in their system were screened. From Figure 1, almost 100,000 patients otherwise eligible for inclusion in this study, were not included because they were not screened for alcohol, and of the 235,392 drivers involved in MVAs, 54.6% (128,598) were not screened. Data entry in the NTDB is voluntary at participating hospitals and, therefore, may not include all trauma patients seen at

**Table 4** Summary of Unadjusted and Adjusted Odds Ratios Associated with Mortality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Contrast</th>
<th>Unadjusted Odds Ratio</th>
<th>95% CI</th>
<th>Adjusted* Odds Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>Yes Ref No</td>
<td>0.728</td>
<td>0.674 – 0.787</td>
<td>0.8013</td>
<td>0.729 – 0.881</td>
</tr>
<tr>
<td>Sex</td>
<td>M Ref F</td>
<td>1.167</td>
<td>1.080 – 1.261</td>
<td>1.238</td>
<td>1.130 – 1.357</td>
</tr>
<tr>
<td>Race</td>
<td>White Ref White</td>
<td>1.000</td>
<td></td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Black B Ref W</td>
<td>0.710</td>
<td>0.633 – 0.797</td>
<td>1.066</td>
<td>0.933 – 1.217</td>
</tr>
<tr>
<td></td>
<td>Hispanic H Ref W</td>
<td>0.584</td>
<td>0.495 – 0.689</td>
<td>1.024</td>
<td>0.847 – 1.238</td>
</tr>
<tr>
<td></td>
<td>Other A Ref W</td>
<td>0.590</td>
<td>0.464 – 0.789</td>
<td>0.826</td>
<td>0.628 – 1.086</td>
</tr>
<tr>
<td></td>
<td>Not Coded O Ref W</td>
<td>0.734</td>
<td>0.625 – 0.861</td>
<td>1.007</td>
<td>0.833 – 1.215</td>
</tr>
<tr>
<td>Head Injury</td>
<td>Yes Ref No</td>
<td>2.079</td>
<td>1.934 – 2.234</td>
<td>1.084</td>
<td>0.993 – 1.182</td>
</tr>
<tr>
<td>DC_CI</td>
<td>Yes Ref No</td>
<td>2.077</td>
<td>1.849 – 2.334</td>
<td>1.004</td>
<td>0.872 – 1.157</td>
</tr>
<tr>
<td>Safety</td>
<td>SB+AB SB+AB Ref None</td>
<td>0.408</td>
<td>0.340 – 0.490</td>
<td>0.579</td>
<td>0.472 – 0.711</td>
</tr>
<tr>
<td></td>
<td>SB SB Ref None</td>
<td>0.532</td>
<td>0.484 – 0.584</td>
<td>0.724</td>
<td>0.648 – 0.808</td>
</tr>
<tr>
<td></td>
<td>AB AB Ref None</td>
<td>0.558</td>
<td>0.452 – 0.688</td>
<td>0.633</td>
<td>0.496 – 0.807</td>
</tr>
<tr>
<td></td>
<td>None Ref None</td>
<td>1.000</td>
<td></td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not Coded Not coded Ref None</td>
<td>0.951</td>
<td>0.871 – 1.039</td>
<td>1.204</td>
<td>1.084 – 1.338</td>
</tr>
<tr>
<td>Age†</td>
<td>10-Year Gain</td>
<td>1.267</td>
<td>1.244 – 1.290</td>
<td>1.336</td>
<td>1.307 – 1.365</td>
</tr>
<tr>
<td>ISS†</td>
<td>10-Point Gain</td>
<td>2.752</td>
<td>2.679 – 2.827</td>
<td>2.806</td>
<td>2.725 – 2.890</td>
</tr>
</tbody>
</table>

*Adjustments for final model, which included Alcohol, Sex, Safety Devices, Age, and ISS. †Note that for both Age and ISS, 1-year or 1-point gains were also statistically significant.

**Table 5** Sensitivity Analysis for Logistic Regression Models, Adjusting for Possible Inflation of ISS Scores for Patients with Alcohol in Their System Who Were Coded as Having a Head Injury

<table>
<thead>
<tr>
<th>ISS Adjustment* (%)</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>Interpretation for In-hospital Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (multiply by 1)</td>
<td>.80</td>
<td>0.72 – 0.89</td>
<td>Alcohol a significant protective effect</td>
</tr>
<tr>
<td>8% (multiply by .92)</td>
<td>.91</td>
<td>0.82 – 0.99</td>
<td>Alcohol a significant protective effect</td>
</tr>
<tr>
<td>9% (multiply by .91)</td>
<td>.92</td>
<td>0.84 – 1.01</td>
<td>Alcohol not a significant protective effect</td>
</tr>
<tr>
<td>20% (multiply by .80)</td>
<td>1.09</td>
<td>0.99 – 1.20</td>
<td>Alcohol not a significant risk factor</td>
</tr>
<tr>
<td>21% (multiply by .79)</td>
<td>1.11</td>
<td>1.01 – 1.22</td>
<td>Alcohol a significant risk factor</td>
</tr>
</tbody>
</table>

*ISS values reduced by the given percentage in patients with alcohol and head injury.
an institution. Furthermore, since alcohol screening was not reported for every driver involved in an MVA, alcohol screening may have been based on a high level of suspicion by the treating physician.

Drivers who had alcohol present were more likely to be younger, male, White, and not using a safety device, compared to those drivers who were “alcohol absent” at hospital presentation. These results are similar to other investigators’ findings. In a series of MVAs reported in Oklahoma, Baker and coworkers demonstrated that alcohol consumption was a significant predictor of not using seat belts. Richter and associates reported an association between elevated blood alcohol levels and male gender in a series of fatal MVAs.

Drivers who had alcohol present were also more likely to have been diagnosed with a head injury. This finding supports the hypothesis that closed head injury may be overdiagnosed in patients with alcohol present because of the effects of alcohol intoxication. However, injury severity based on ISS was actually significantly lower in patients with alcohol present (11.8 vs. 12.2) and, therefore, an inconsistency exists relative to the assertion that patients with alcohol involvement may have falsely inflated ISSs.

Logistic regression analyses revealed that in-hospital mortality was significantly associated with the presence of alcohol, gender, safety device use, age, and injury severity, based on ISS. Further, the full logistic model demonstrated good fit and a significant improvement in prediction over change, as summarized in Table 3. Risk factors for in-hospital mortality included male sex, older age, and higher injury severity, while protective factors included the presence of alcohol and use of safety devices. These associations between mortality and gender, safety device use, age, and injury severity are similar to those reported by others.

The finding that the presence of alcohol was protective of in-hospital mortality was, however, somewhat surprising but consistent with the general impression voiced by some when they say anecdotally that “It’s the drunk driver who walks away.” Ironically, those with alcohol present had lower mortality rates even though they were also less likely to use safety devices. This pattern of results is consistent with the notion that drunk drivers who are hospitalized due to an MVA had lower mortality rates, even though they were less likely to be wearing seat belts, because their accidents were less serious or involved lower energy. Unfortunately, the NTDB provides no information regarding the nature of the MVAs and, therefore, this hypothesis cannot be evaluated with these data.

Our results are different than those reported by Waller and colleagues who reported a detailed analysis of data from more than one million drivers involved in an MVA in North Carolina. They found strong relationships between blood alcohol level and injury severity, including death. Covariates included car accident characteristics (e.g., crash speed and type of impact), driver demographics, and seat belt use; fatalities included those that occurred at the scene of the crash as well as during hospitalization. These investigators concluded that drivers with alcohol present are more likely to sustain a serious injury or death compared to those with an absence of alcohol. Although this study used car crash characteristics as potential confounding variables, it did not use important clinical markers, such as the ISS, to account for potential differences in patient outcome. The findings of Waller and coworkers were supported by House and associates, who reported that when the effects of other factors associated with driver injury are taken into account, drivers with higher blood alcohol levels were more likely to be seriously or fatally injured.

However, our findings are similar to those reported by Ward and colleagues who compared outcomes in hospitalized trauma patients with an average blood alcohol level of 0.149% to a sober control group with similar injury severity. They found that in-hospital mortality was significantly lower in patients who had alcohol present. Limitations of the study by Ward and coworkers include the fact that the investigators pooled patients who sustained different mechanisms of injury, such as penetrating trauma, which differs with respect to the ease of resuscitation and stabilization, compared to an MVA.

One of the hypotheses explaining the apparent protective effect of alcohol on morbidity and mortality in hospitalized patients is misclassification of injury severity. Because of alcohol intoxication, a patient may appear to have sustained a closed head injury and, therefore, be classified with higher injury severity. Patients in this study with alcohol present were more likely to be classified as having a head injury; however, ISS scores for those with and without head injuries were not significantly different for those with and without alcohol present in their system.

Lack of information about the severity of the accident would explain this result if those with alcohol present happened, on average, to be involved in lower energy accidents. Similar ISSs in this situation would still reflect inflation in true ISSs. Therefore, we adjusted the ISSs to reflect possible false inflation of injury severity in the subgroup of patients who had alcohol present as well as a head injury. In this subgroup, we found that the protective effect of alcohol diminished and became nonsignificant when the ISS was reduced by 9% and became a significant risk factor for inpatient mortality when the false elevation in ISS was estimated at 21%. Therefore, the prognostic value of alcohol presence on in-hospital mortality is related to one’s belief about the potential for false elevation in ISS coding for patients with alcohol in their system, in this case limited to situations in which patients were coded as having a head injury. If one believes this false inflation is slight, defined as less than 9% inflation in ISS, then alcohol presence would be considered a protective effect for in-hospital mortality. In contrast, if one considers this inflation moderate, defined here as between 9% and 20%, then alcohol presence may not have any prognostic value. However, if one believes this inflation is relatively large, defined here as greater than 20%,
then alcohol presence would be considered a risk factor for in-hospital mortality.

Limitations include the fact that this was a retrospective database study with all of the problems inherent with this methodology. Similar to most database projects, users cannot independently verify the accuracy of the data, its standardization, or its input. Retrospective studies often do not capture some important data elements specific to the research question. For example, the “presence” or “absence” of alcohol is recorded, but not the alcohol level of the patient. Ideally, one would like to be able to trace a dose-related relationship between blood alcohol content (BAC) and the effects or consequences associated with the presence of alcohol described above. Information bias was another problem. There was no information on the crash characteristics, such as speed, direction of impact, and type of vehicles involved that could have helped to determine the energy level of the accident; furthermore, there was no way to determine on-scene mortality, which is critical to calculate absolute mortality after an MVA. Few fields are required in the NTDB, and we lost a large portion of our initial sample due to incomplete data fields. Additional biases are related to whether or not a patient was tested for alcohol in the NTDB. It is well recognized that alcohol testing biases exist, based on age, gender, and circumstances of admission.6

Finally, there was the lack of information regarding when during hospitalization the information was recorded into the NTDB. For example, to test the hypothesis that a closed head injury is over diagnosed in patients with alcohol present because of the effects of alcohol intoxication, the coding of the head injury would need to have been recorded at the time of presentation and not discharge. By the time of discharge, it may become clear that the patient did not actually sustain a closed head injury.

In conclusion, we found that drivers who had alcohol present were more likely to be younger, male, White, not using a safety device, and coded as having sustained a head injury than drivers who had alcohol absent at hospital presentation. After controlling for potential confounding variables, risk factors for in-hospital mortality included male sex, older age, and higher injury severity, while protective factors included the presence of alcohol and use of safety devices. The single strongest predictor of mortality was the ISS. This suggests the importance of carefully considering the consequences that falsely inflated ISS scores might have for patients with alcohol present. This study clearly demonstrated that alcohol, as a protective effect against mortality, can become a risk factor if alcohol presence causes an over estimation of the ISS. Future work should evaluate the possible inflation of ISS and attempt to reconcile different interpretations of the effects that the presence of alcohol may have on MVA mortality that is based by jointly considering crash site and in-hospital data.

Disclosure Statement

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

References