Analysis of existing data from the Ohio Trauma Registry : a look at the impact of restraint status on injury severity and patient outcome for drivers involved in motor vehicle crashes from 2003 through 2005

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Dedication

With God, all things are possible. I am living proof.

To my dearest husband, Dale, thank you for your love, kindness, and never-ending support. I am married to my best friend and truly the greatest husband a woman could have. Thanks for "bach-ing" it for twenty-four months. I know it was tough at times but we did it together. We would not be realizing this dream were it not for you. You are my rock.

To my beautiful daughters, Kara and Emily. I am the most blessed momma in the world to have two kids that are as kind, gracious, and selfless as you. I thank you from my soul for encouraging me to achieve my dream. You both have been the greatest role models. You are my heroes. I Love You!!!

Carpe Diem!!

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Chapter 1: Introduction

Trauma from motor vehicle crashes (MVC's) has an enormous health care and financial impact on society and is a major public health issue. MVC's are the leading cause of accidental deaths, the leading cause of deaths in children and adolescents and are the 5th leading cause of deaths nationwide (Hoyert DL, 2006). Between 1999 and 2005, 44,368 drivers and passengers suffered serious traumatic injuries in motor vehicle crashes in the State of Ohio and 30,416 (68.5%) were not wearing seat belts, according to the Ohio Emergency Medical Services (EMS) Office of Research and Analysis.

Trauma resulting from motor vehicle crashes can be described as the unintentional transfer of mechanical energy from blunt force causing serious and body-altering physical injury. There are three types of collisions that are involved in each MVC: the motor vehicle colliding with another object, the body colliding with an object inside the car, and the internal organs colliding with the interior of the body cavity.

Traumatic injuries can result from the body making contact with the interior of the vehicle from not wearing a seat belt or absence of airbag, the body making contact with the seat belt and/or airbag, intrusion of auto parts or other objects into the passenger compartment, or from shearing forces due to rapid deceleration.

Many studies have been done proving a reduction in morbidity and mortality through seat belt use with or without airbags. This study offers a novel perspective looking at a larger patient population in Ohio over a three year span, 2003 through 2005, that investigates the impact of restraint status on both injury severity and patient outcome (alive or dead).

Chapter 2: Literature Review

Restraint Status and injury severity

Several studies have been conducted that have explored the relationship between restraint status and injury severity from many perspectives. Some studies have explored the relationship between seat belt use alone and injury severity while others have explored the factors in an MVC that effect injury severity. The impact of air bag alone on injury severity has also been investigated. Researchers have looked at the injury severity of MVC occupants that were fully restrained (wearing a seat belt and air bag was deployed). Other studies have compared restraint status and patient outcomes. A common thread made clear by the literature is that occupants involved in MVC's who are unrestrained have increased injury severity and worse outcomes.

Seat belt alone and injury severity

A study conducted in Japan by Hitosugi, et al. (2000) did a retrospective analysis of 50 forensic autopsies of patients who died in MVC's to determine the effects of seat belt use on injury severity. Their data was collected from accident and autopsy reports and included: cause of death, survival time, mechanism of injury, estimation of injury severity and statistical analysis. The authors found that "injuries were least severe in drivers wearing a three-point belt," which "confirms the protective effect of seat belts." The authors also found that the three-point belt was proven to "significantly decrease fatality rates." Their conclusion was that "injury severity is related to seat belt use" (Hitosugi, 2000)

The authors of the paper "*The Effect of Seat Belt Usage on Hospitalization and Injury Severity of Motor Vehicle Crash Victims*" from the Ohio EMS Office of Research and Analysis found that there was an increase in injury severity by 30% in victims who did not wear seat belts. (Ohio Trauma Acute Care Registry, 2005).

Abdelwahab, et al (2002) determined that "wearing a seat belt decreases the chance of having severe injuries" in MVC's using fuzzy adaptive resonance theory MAP (fuzzy ARTMAP). These neural networks having analytical and predictive capabilities, were used to analyze data from Florida's traffic accident database. This information was then used for simulation experiments to determine the factors that influence a driver's injury severity in MVC in Florida (Abdelwahab & Abdel-Aty, 2002).

According to a study by Farmer et al (1997), in side impact MVC's where the vehicle is struck on the side away from the occupant, termed "far-side occupants" by the author, seat belts prevent serious injury. This is because the belt prevents contact with the objects in the vehicle which cause the most injury such as the roof, instrument panel and steering column. They go on to state that injuries sustained by belted near-side occupants are more serious because of the proximity of the "adjacent side structure" (Farmer, Braver, & Mitter, 1997).

Patients admitted to a Level 1 trauma center who were either ejected, non-ejected unrestrained or non-ejected restrained were compared in a study done by Gongora et al (2001). The results showed that unrestrained ejected patients had significantly increased injury severity as compared to non-ejected patients. Conversely, the non-ejected restrained population had the lowest injury severity.

The purpose of the paper written by Kim et al (1995) was to look at the relationship between driver characteristics and injury severity in Hawaii during 1990. They found that injury severity increased with drivers that engaged in alcohol and/or drug use and did not wear a seat belt. The result of the study showed that there was a significant increase in the odds of severe injury when a seat belt was not used. The odds nearly tripled for an incapacitating

injury to occur and increased five-fold for a fatal injury to occur if a seat belt is not worn (Kim, Nitz, Richardson, & Li, 1995)

Air bag alone and injury severity

Stewart, et al (2003) explored the impact of air bag use on injury severity. He found that the odds of a driver suffering a head injury were not significantly lowered due to the deployment of an airbag but did find that the severity of head injury was significantly lowered (Stewart, Girotti, Nikore, & Williamson, 2003).

Lund and Ferguson (1995) reported from their research that moderate and severe injuries suffered by drivers in airbag equipped vehicles were reduced (Lund & Ferguson, 1995).

Fully restrained (seat belt and air bag) and injury severity

In an article titled "*Effect of Restraint Systems on Maxillofacial Injury in Frontal Motor Vehicle Collisions*," the authors analyzed data on front seat occupants involved in frontal MVC's looking specifically at facial injury and restraint use. Their results showed that facial injuries were significantly reduced in victims who wore a seat belt only or wore a seat belt and had an air bag (Cox et al., 2004).

In a 1995 article, Lund & Ferguson state that with an increase in the use of seat belts, which they state is more effective than airbags, there is a decline in the overall effect of airbags. The authors still believe, however, that airbags are very effective in reducing serious injuries to the face and head when used in combination with seat belts (Lund & Ferguson, 1995).

Restraint status and Patient Outcome

Seat belt alone and patient outcome

The Ohio EMS Office of Research and Analysis' paper entitled "*The Effect of Seat Belt Usage on Hospitalization and Injury Severity of Motor Vehicle Crash Victims*" stated that

wearing seat belts reduces hospital lengths of stay, decreases admissions to the ICU and reduces lengths of stay in the ICU (Ohio Trauma Acute Care Registry, 2005).

Only 36% of fatally injured teens were seat belted according to Fantus, et al in the Bulletin of the American College of Surgeons, quoting a statistic from the National Safety Council's paper from 2002 regarding teenagers wearing seat belts. Also, this article cites data obtained from the National Trauma Databank *Annual Report* 2004 which showed that 79% of teenage driver fatalities had no seat belt while 21% of teenage driver fatalities wore a seat belt (Fantus, 2005).

Gongora et al (2001) discovered that ejected patients, when compared to nonejected unrestrained and nonejected restrained patients, had higher in-hospital mortality, longer intensive care unit (ICU) lengths of stay (LOS) and longer hospital LOS. They cite another study by Malliaris et al, which states that seat belts prevent contact with interior components of the vehicle and are very effective at preventing ejection of the occupant from the vehicle (Gongora et al., 2001).

Air bag alone and patient outcome

In their study, Lund & Ferguson (1995) investigated how effective airbags were with respect to driver fatalities by comparing MVC's with frontal impact damage to non-frontal impact damage. Their results showed that airbags offered a 24% reduction in fatalities in frontal impact damage MVC's and a 16% reduction in fatalities of all crashes (Lund & Ferguson, 1995).

In a National Trauma Databank article written by Fantus, et al (2000), the authors explored the relationship between airbag use and patient mortality. They found that the fatality

rate among drivers with no airbag was 4.38% as opposed to 2.54% for those drivers whose airbag deployed (Fantus, 2005).

These studies are very valid and thorough and have made major contributions to our understanding of the relationships between restraint status and injury severity and restraint status and patient outcome.

Chapter 3: Methods

A retrospective review of existing data from the Ohio Department of Public Safety's (ODPS) Trauma Acute Care Registry Database was studied of MVC drivers from January of 2003 through December of 2005. This data was sent from hospitals throughout Ohio on all trauma patients after the patient is discharged from the hospital. The criteria for gathering this data is very specific and selective (see Appendix B). Over 180 data fields per patient are gathered beginning with the patient's pre-hospital data and ending with their discharge information. It should be noted that not all patients require all of the data fields available in the registry.

A limitation of this study is that the quality of data gathered is dependent on EMS providers, or the personnel in the emergency room, hospital medical records, trauma registry, or state trauma registry, who may or may not have complete or accurate information such as the restraint status of the driver or the speed of the vehicle. Also, injury severity coding done by hospital medical records, hospital trauma registries, and state trauma registry personnel, although held to high standards, is still left to the subjectivity of the coder.

The following data fields for this study were requested and received from the Ohio Trauma Acute Care Registry in Excel Spreadsheet format: motor vehicle crashes via E-codes 810-819 (codes which classify environmental events, circumstances, and other conditions as the

cause of injury and other adverse effects); drivers; January 2003- December 2005; month of MVC; age ≥ 16; gender; safety equipment (seat belt, airbag); injury severity score (ISS); International Classification of Disease-9 (ICD-9) codes 800-959; ICU LOS; ventilator days; discharge status; discharge disposition; and operating room visit. These data fields allow me to look at all of the patients that were 1) admitted to Ohio hospitals for greater than 48 hours, and 2) were drivers involved in motor vehicle crashes in the time period from 1/2003 through 12/2005. This time frame is further broken down by month so seasonal trends may be observed. Age and gender are added to observe trends among age groups and between males and females. Safety equipment was requested to determine restraint status, whether a seat belt and/or airbag were used. Injury severity score (ISS) was obtained which stratifies injury severity for multiple injuries. ICD-9 codes 800-959 were requested to compare restraint status and injury severity. Discharge (DC) status (alive or dead) and disposition (place patient discharged to) give a clear picture of the outcome for the patient after discharge.

Initially it was the intention of this study to look at the impact of restraint status on injury severity by body region, which is why ICD-9 codes were requested. Also, disposition was originally another piece of data to be examined. However, the enormity of these tasks was time and resource-prohibitive and was eliminated from the study. Patient records were excluded from the study whose information was either partially known or unknown, such as restraint status (ie. Seat belt was worn but unknown if air bag deployed) or sex (male or female) was not documented.

ISS is a score given to stratify injury severity for multiple injuries. The score is calculated from the sum of the squares of the three highest abbreviated injury score (AIS) codes in the three most severely injured regions of the body. The range is from one to 75 with one

being minor and 75 being severe. Higher scores have higher risk of death. According to the National Trauma Data Bank (NTDB), ISS is categorized as minor if the score is from 1-9, moderate is from 10-15, severe is from 16-24 and very severe is an ISS greater than 24.

Because this study reviewed existing data obtained from a state database, Institutional Review Board approval was not required.

Chapter 4: Results

The initial population of this study was 12,182 patients. Records for patients whose data was incomplete were eliminated. Also excluded were the records for the patients in 2006, which totaled 1,113, because, as of this writing, only the first half of 2006's data was available from the Ohio Trauma Acute Care Registry. Seat belt was unknown for 630 records, airbag was unknown for 1289 records and gender was unknown for 6 patients, all were eliminated from the final count. The number of patients ultimately included in this study was 9,144 patients, 75.06% of the original population.

The gender breakdown of the patients in this population was 41.10% females and 58.72 % were males. The breakdown of gender by year was consistent with the overall population (table 1).

Table 1: Gender distribution.

	2003-2005 (%)	2003 (%)	2004 (%)	2005 (%)
Female	41.10	41.41	41.52	40.92
Male	58.72	58.59	58.49	59.09

Restraint Status

Restraint status was broken down into no restraint (no seat belt or air bag), seat belt alone, air bag alone, or fully restrained (seat belt and air bag). Table 2 shows overall restraint status by gender from 2003 - 2005 and Table 3 is the data for 2003, 2004 and 2005.

When looking at restraint status by gender, more males than females were unrestrained. This rate increased from 2003 to 2005 with males more than doubling the rate of not using a restraint for 2004 and 2005. More males used seat belt alone or air bag alone than females across the board. Females, moreso than males, were fully restrained for the overall time period 2003-2005 and the years 2003 and 2004 but not for the year 2005, when males were fully restrained the higher percentage (tables 2 and 3).

Table 2: Restraint status by gender.

2003-2005	No Restraint	Seat Belt Only	Air Bag Only	Fully Restrained
Female	16.13%	13.33%	4.84%	6.98%
Male	31.42%	15.17%	5.79%	6.34%

Table 3: Gender and restraint status by year.

	No Restraint (%)			Seat Belt Only (%)			Air Bag Only (%)			Fully Restrained (%)		
	2003	**2004**	**2005**	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**
Female	19.3	14.7	14.1	13.0	13.6	13.22	3.99	5.1	5.42	5.01	7.89	8.14
Male	34.5	30.2	29.2	14.4	16.22	14.88	4.95	6.09	6.37	4.69	5.92	8.54

For the period 2003 through 2005, the majority of drivers had no restraint at 47.55% while 28.50 % had seat belt only, 10.63% had only an airbag deploy and 13.32% were fully restrained (table 4).

Table 4: Restraint status rates.

2003-2005	No Restraint (%)	Seat Belt Only (%)	Air Bag Only (%)	Fully Restrained (%)
	47.55	28.50	10.63	13.32

When comparing 2003, 2004 and 2005 individually, the no restraint group had the highest percentage. More drivers wore their seat belt than having an airbag alone or were fully restrained. Air bag only had the lowest percentages. This data is consistent with the 2003-2005 data (table 5).

Table 5: Restraint status rates by year.

	No Restraint (%)	Seat Belt Only (%)	Air Bag Only (%)	Fully Restrained (%)
2003	53.84	27.52%	8.94	9.70
2004	45.03	29.90	11.25	13.82
2005	43.42	28.10	11.80	16.68

Comparing no seat belt and seat belt, the percentage for no seat belt was higher than for seat belt for the whole study period, 2003-2005, and each year individually. Likewise, the percentage for no air bags was higher than for air bags (table 6 & 7).

Table 6: Seat belt vs. no seat belt rates.

	No Seat Belt (%)	Seat Belt (%)
2003-2005	58.18	41.82
2003	62.78	37.22
2004	56.28	43.72
2005	55.22	44.78

Table 7: Air bag vs. no air bag rates.

	No Air Bag (%)	Air Bag (%)
2003-2005	76.05	23.95
2003	81.36	18.64
2004	74.93	25.07
2005	71.53	28.47

For the time period 2003 to 2005, the 25-34 age range had the highest no restraint percentage (8.60%), 45-54 age range had the highest seat belt only percentage (4.86%), 25-34 age range had the highest air bag only (2.06%), and 45-54 had the highest fully restrained percentage (2.46%) for their individual categories. For all of the age groups collectively, the no restraint group had the highest rates over all. The seat belt only group had a higher rate than the air bag only or fully restrained groups (table 8a).

Table 8a: Age and Restraint status for 2003-2005.

2003-2005	No Restraint (%)	Seat Belt Only (%)	Air Bag Only (%)	Fully Restrained (%)
16-19	6.24	3.36	1.08	1.36
20-24	7.43	3.01	1.29	1.14
25-34	8.60	3.94	2.06	2.06
35-44	8.32	4.78	1.86	1.78
45-54	6.87	4.86	1.54	2.46
55-64	4.51	3.15	0.90	1.80
65-74	2.42	2.48	0.90	1.18
75-84	2.60	2.37	0.80	1.21
85-94	0.56	0.56	0.21	0.31
95-104	0.01	0.00	0.00	0.02

For no restraint, there was a decrease in the highest age range, 25 to 34, from 9.35% in 2003 to 7.63% in 2005. There was a decrease in the no restraint rate for all of the age ranges but the greatest decrease can be seen in the 20 to 24 age range. The seat belt only group had the most significant decrease in the age range 35 to 44, from 5.29% to 3.86%. For remaining age ranges, there was minimal change, if at all. The air bag only group showed the greatest increase in the 16 to 19 age range going from 0.82% to 1.46%. There was very little change from 2003 to 2005 in the other age ranges. Finally, the drivers in the fully restrained group that were in the 45 to 54 age range showed the greatest increase from 1.46% to 3.05%. Most of the other age ranges showed an increase from 2003 to 2005 (table 8b).

Table 8b: Age and restraint status by year.

	No Restraint (%)			Seat Belt Only (%)			Air Bag Only (%)			Fully Restrained (%)		
	2003	**2004**	**2005**	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**
16-19	7.01	5.86	5.83	3.49	3.13	3.46	0.82	0.99	1.46	1.08	1.28	1.73
20-24	9.04	6.71	6.44	2.60	3.22	3.22	1.11	1.41	1.36	0.95	1.32	1.15
25-34	9.35	8.75	7.63	3.99	3.88	3.93	1.65	2.40	2.14	1.71	1.97	2.51
35-44	9.07	7.73	8.14	5.29	5.13	3.86	1.59	2.07	1.93	1.14	2.07	2.17
45-54	7.86	6.51	6.17	4.28	5.36	4.95	1.59	1.58	1.46	1.46	2.93	3.05
55-64	4.91	4.31	4.27	3.33	3.36	2.75	0.70	0.76	1.25	1.27	1.88	2.31
65-74	2.89	2.07	2.27	2.19	2.50	2.78	0.82	0.86	1.02	0.95	1.05	1.56
75-84	3.04	2.53	2.20	1.90	2.80	2.44	0.54	0.82	1.08	0.82	1.12	1.73
85-94	0.67	0.53	0.47	0.44	0.53	0.71	0.13	0.36	0.10	0.25	0.20	0.47
95-104	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00

OUTCOMES

Mortality Rate

The mortality rate for the population in this study was 4.53%. January had the highest overall mortality rate at 6.24% and October had the lowest overall mortality rate at 2.89%. Individually, for 2003, March had the highest mortality at 6.12% and February was the lowest at 2.30%. For 2004, April had the highest at 7.42% and October was the lowest at 1.76%. For 2005, April is the highest at 6.57% and the lowest is 2.14% in November (table 9).

Table 9: Mortality rate by month.

Mortality Rate	2003-2005 (%)	2003 (%)	2004 (%)	2005 (%)
January	6.24	5.47	7.39	5.91
February	4.44	2.30	5.20	5.56
March	5.01	6.12	4.75	4.45
April	5.95	3.95	7.42	6.57
May	4.11	4.60	2.65	5.22
June	4.43	5.70	3.18	4.21
July	3.74	4.30	2.59	4.35
August	3.94	4.83	3.33	3.65
September	4.08	3.00	3.53	5.91
October	2.89	3.54	1.76	3.15
November	4.53	5.53	6.09	2.14
December	4.94	5.81	5.22	3.00

There were more no restraint drivers that had a higher ISS than the seat belt only, air bag only, and fully restrained drivers. Also, there is an inverse relationship between no restraint and restrained (seat belt only, air bag only, and fully restrained) drivers. The lower the ISS, the higher the percentages were for the restrained categories. For no restraint drivers, there was an across-the-board decrease in percentage as the ISS ranges increased (table 10).

Table 10: ISS and restraint status by year.

	No Restraint (%)			Seat Belt Only (%)			Air Bag Only (%)			Fully Restrained (%)		
	2003	**2004**	**2005**	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**
ISS 1-9	44.70	41.62	44.54	56.05	55.67	55.07	55.05	54.04	52.09	57.52	56.90	56.10
ISS 10-15	22.67	21.36	20.75	22.42	22.86	21.81	21.55	23.75	23.90	22.88	27.38	24.59
ISS 16-24	18.55	19.31	17.86	12.63	13.22	13.99	13.47	15.28	14.27	11.76	11.90	13.41
ISS 25-75	14.08	17.71	16.85	8.89	8.25	9.13	9.93	6.93	9.74	7.84	3.81	5.89

Mortality & Restraint Status

The highest mortality for all three years was in the no restraint category and the lowest was in fully restrained (table 11).

Table 11: Mortality rate and restraint status.

	No Restraint (%)	Seat Belt Only (%)	Air Bag Only (%)	Fully Restrained (%)
2003	60.48	10.79	20.73	5.00
2004	60.65	10.36	20.41	8.58
2005	60.25	10.80	20.45	8.50

Over a three year period, the highest mortality, across the board, was in the 25 to 75 ISS while the lowest was in the 16 to 24 ISS. Seat belt only and fully restrained had lower overall mortality than did air bag only (table 12).

Table 12: Mortality rate, ISS and restraint status.

	No Restraint (%)			Seat Belt Only (%)			Air Bag Only (%)			Fully Restrained (%)		
	2003	**2004**	**2005**	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**
ISS 1-9	0.53	2.63	1.93	0.16	0.40	0.44	0.00	0.49	0.46	0.00	0.42	0.72
ISS 10-15	2.34	1.71	1.88	0.73	1.68	1.76	0.79	2.32	0.05	0.00	0.87	1.91
ISS 16-24	0.06	0.04	0.03	0.01	0.04	0.05	0.09	0.18	0.05	0.67	0.06	0.05
ISS 25-75	32.22	25.10	26.39	14.55	15.32	15.91	23.73	15.79	23.17	16.67	12.50	20.69

Chapter 5: Discussion

The purpose of this retrospective study was to determine the impact restraint status had on injury severity and patient outcomes in drivers in the state of Ohio from 2003 through 2005. While there have been many other studies investigating this relationship, none had examined a demographic of this size and in Ohio. The results demonstrate what the other studies collectively had concluded, that being restrained both decreases injury severity and improves patient outcome.

Drivers that are restrained (seat belt only, air bag only or fully restrained) have lower injury severity scores than those drivers who are unrestrained and that have higher ISS scores. The seat belt group is larger than the air bag only group, according to the data, however, the ISS scores stayed relatively similar showing there is no difference in the mode of restraint with respect to injury severity.

Mortality for non-restrained drivers was much higher than for either partially or fully restrained drivers. This echoes the same conclusion many other studies has found. In addition, of the restrained categories, air bag only had the highest mortality and fully restrained had the

lowest mortality. This seems to suggest that just an air bag deploying was not as protective as having both an air bag deploy in the vehicle and the driver wearing a seat belt, which has an additive protective effect. In addition, the air bag only group had a higher mortality than the seat belt only group. These pieces are important and have not been examined in other papers. A partial explanation for these results may be that not all vehicles have air bags, whereas most, if not all, vehicles have seat belts. Also, there is some speculation that drivers who do not wear their seat belt are lulled into a false sense of security with the presence of an air bag in their vehicle. The important message is that drivers, in order to decrease their risk of death in an MVC, should have both a seat belt and an airbag.

Exploring the data helps to determine the target areas in public education for injury prevention. Male drivers in the age range of 25-34 had the highest incidence of being unrestrained. It has been shown in other studies that teenagers and people in their early twenties are at highest risk for injuries and deaths secondary to auto accidents. The trend may be shifting to another demographic due to restraint compliance in people in their teens and early twenties. Mortality rate increased through the winter months from January to April which could be due to inclement weather and the beginning of spring.

Compliance by drivers in using seat belts coupled with operating vehicles equipped with air bags would greatly decrease injury severity and mortality. Enforcing the Ohio seat belt law and education are the two key areas that law enforcement, the general public and educators must continue to focus on. The *Click it or Ticket* program, across the nation, is a program that has shown to be effective in increasing compliance.

This study has shown that being restrained decreases injury severity and improves patient outcome. More work has to be done though. Taking the direction of the original full intent of

this study, many good pieces of important information could have been gleaned to help in our understanding of the impact of restraint status on different body regions, for example, but more time and resources are needed.

Chapter 6: Conclusion

Injury severity and patient mortality were directly impacted by the restraint status of drivers involved in MVC's. For unrestrained drivers, their injury severity scores were higher and the incidence of the MVC being fatal was greater. Conversely, the restrained drivers sustained lower injury severity and were associated with lower mortality in MVC's. Wearing a seat belt with an airbag proved to be safer and more protective over not having an air bag. If an airbag is the only protective device used in a vehicle, this is more protective than no restraint at all. Persistent public education of these facts needs to be a priority of people in healthcare, education, and lawmaking.

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List of Tables

Appendices

APPENDIX A – Definitions

(AIS-90) Abbreviated Injury Score – is a grading scale, revised in 1990, for injuries in which injuries are graded from 1, which is minor, to 6, which is maximum possible injury.

DC disposition - was the patient alive or dead upon discharge from the hospital?

DC status - where the patient was discharged to from the hospital.

E-codes (810-819) - codes which classify environmental events, circumstances, and other conditions as the cause of injury and other adverse effects.

ICD-9 CM – International Classification of Diseases, 9th Revision, Clinical Modifications **–** the official system of assigning codes to diagnoses and procedures associated with hospital utilization in the United States. It consists of a tabular list containing a numerical list of the disease code numbers in tabular form; an alphabetical index to the disease entries; and a classification system for surgical, diagnostic and therapeutic procedures.

ICU LOS – Intensive Care Unit Length of Stay, used as an indicator of injury severity.

(ISS) Injury Severity Score – a score given to stratify injury severity for multiple injuries. The score is calculated from the sum of the squares of the three highest AIS codes in the three most severely injured regions of the body. The range is from one to 75 with one being minor and 75 being severe. Higher scores have higher risk of death. According to the National Trauma Data Bank (NTDB), ISS is categorized as minor if the score is from 1-9, moderate is from 10-15, severe is from 16-24 and very severe is an ISS greater than 24.

MVC – Motor Vehicle Crash.

(NTDB) National Trauma Data Bank – a trauma registry data bank administered by the American College of Surgeons that contains over 1million records from 405 trauma centers in the U.S.

OR visit - whether or not the patient went to the operating room, used as an indicator of injury severity.

Serious trauma - injuries serious enough to cause a person to be admitted to a hospital for at least 48 hours, or causes death at any point during their hospital stay.

Trauma – serious and body-altering physical injury resulting caused from motor vehicle crashes due to the unintentional transfer of mechanical energy from blunt force.

Vent Days - number of days on a ventilator, used as an indicator of injury severity.

APPENDIX B

(OTR) Ohio Trauma Registry patient inclusion criteria

1. Patient's first or initial admission for at least 48 hours, and who meet one of the following inclusion criteria; ****OR****
2. Patients who transfer into or out of any hospital, regardless of their length of stay, and who meet one of the following inclusion criteria; ****OR****
3. Patients that arrive dead on arrival (DOA) and who meet one of the following inclusion criteria; ****OR****
4. Patients that die after receiving any evaluation or treatment while on hospital premises, and who meet one of the following inclusion criteria:

Inclusion Criteria

ICD-9-CM Diagnosis Codes on discharge from acute care hospital	
ICD-9-CM Diagnosis Codes	**ICD-9-CM Diagnoses Descriptions**
800.00 - 819.1	Fractures
821.00 – 904.9	Fractures, dislocations / sprains, intracranial injury, internal injury of thorax, abdomen, and pelvis, open wounds, injury to blood vessels
911.0, 911.1, 912.0, 912.1	Abrasions / friction burns to trunk, shoulder and upper arm
916.0, 916.1, 919.0, 919.1	Abrasions / friction burns to hip, thigh, leg, ankle, other or multiple sites
920 – 929.9	Contusions and crush injury
940.0 – 959.9	Burns, injury to nerves and spinal cord, traumatic complications and unspecified injury
987.9	Smoke inhalation
991.0 – 991.6	Frostbite, hypothermia, and external effects of cold
994.0, 994.1, 994.7, 994.8	Asphyxiation, strangulation, drowning, and electrocution
995.50 – 995.59	Child maltreatment and abuse

*****OR*****			
ICD-9-CM Diagnoses			**E-Code**
384.4	Uncal herniation	**ANY WITH ANY OF THE FOLLOWING External Cause Codes (E-Codes)**	
348.5	Cerebral edema		E800 - E848.8 E878 – E905.0 E906.0- E928.8 E950.0 – E999
348.8	Pneumocephalus		
372.72	Subconjunctival hemorrhage		
518.5	Traumatic ARDS		
784.7	Epistaxis		

Codes separated by a hyphen indicate arrange of codes including both codes AND all codes in between. Example: 800.0 – 801.5 Codes separated by a comma indicate a single code. Example: 901.1, 901.2, 901.8

ICD-9-CM Diagnoses Codes EXCLUDED	
820.0 – 820.9	Isolated hip fracture
905 – 909	Late effects of injury
910.0 – 910.9, 911.2 – 911.7, 912.0 – 918.9, 919.2 – 919.7	Superficial Abrasions, blisters, insect bites
930 - 939	Foreign bodies
EXTERNAL Cause of Codes EXCLUDED	
E849 – E849.9	Place of occurrence
E850 – E869.9	Poisonings
E870 – E876	Misadventures during surgical and medical care
E905 – E905.9	Venomous animals and plants (except snakes)
E929 – E929.9	Late effects of Accidental injury
E930 – 949	Drugs, medicinal and biological substances causing adverse effects in therapeutic use

Abstract

Objective: This study determined the impact of restraint status on injury severity and patient outcome on drivers in Ohio between 2003 and 2005.

Methods: A retrospective review of existing data from the Ohio Department of Public Safety's Trauma Acute Care Registry Database and the following data fields were requested: MVC's via E-codes 810-819; drivers; January, 2003- December, 2005; month of MVC; age ≥ 16; gender; safety equipment; ISS; (ICD-9) codes 800-959; ICU LOS; ventilator days; discharge status; discharge disposition; and OR visit.

Results: Restrained drivers have lower ISS's than unrestrained drivers. Mortality for non-restrained drivers was higher than for restrained drivers.

Conclusion: Injury severity and patient mortality were directly impacted by the restraint status of drivers involved in MVC's. Public education concerning restraint use is key in reducing injury severity and mortality associated with MVC's.

Keywords: Seat belt trauma; ISS + seat belt, air bag; Driver + ICD-9; Injury severity.