ADHS Internship Presentation

Erin Campbell

MPH Candidate- Biostatistics

March 8, 2013

Outline

- Chain of Events in a MVC
  - ALISS and ASTR databases
- Probabilistic linkage
- Data analysis of traumas vs non-traumas
- Type and number of injuries by collision manner
- Future Recommendations

Chain of Events After an MVC

911 call is placed and law enforcement/EMS are dispatched.

ACR is a paper form filled out on scene and manually entered in ALISS.

Any accident occurring on a public road where a police report is completed is entered into ALISS

If EMS is called to the scene, a patient care report (PCR) is completed at the crash scene.

Trauma center emergency departments generate a separate trauma record.

Trauma records are transmitted electronically to the ASTR on a quarterly basis.

ALISS

- Managed by ADOT
- Law enforcement officers complete the Arizona Crash Report (ACR) which is then submitted to ADOT for entry into the ALISS database.
- Unique identifiers such as name or driver's license number are not input into the database.
- ALISS calculates age based on DOB.

ASTR

- Managed by ADHS
- Electronically submitted by the trauma registrar.
- Contains unique identifiers, in addition to information on the nature of injury and treatment received.

Why link ASTR and ALISS?

- ASTR and ALISS refer to singular events.
- By linking the two databases, ADOT and ADHS will be able to study MVCs where injuries or loss of life have occurred.
  - Identify new correlations to prompt better or new preventative measures and treatment modalities to reduce mortality and morbidity.

The Numbers… Part 1

- For 2010 and 2011, a total of…
  - 580,000+ people in 406,789 vehicles were involved in 210,382 crashes as reported to ALISS.
    - 129,761 people were documented as having a possible injury
- ASTR
  - 23,787 records for 2010 and 2011 indicate a MVC as the mechanism of injury

Probabilistic Linkage

What is Probabilistic Linkage?

- Linking of two databases by comparing common variables contained in each database.
- Most successful when variables are unique
  - Eg: Name, date of birth and social security number
- Success is dependent upon the uniqueness of the variables being used and also on the number of errors present within the data.

ALISS + ASTR

- Matched on date, age, gender and hour of injury.
- There is a high percentage of missing variables within the database as detailed below.

	ALISS (N=129,761)	ASTR (N=23,787)
Date	0 (0%)	0 (0%)
Age	13,462 (10.4%)	1 (<0.001%)
Gender	14,005 (10.8%)	0 (0%)
Hour of Injury	33,191 (25.6%)	7,101 (29.9%)

- A +/- 1 hour buffer was allowed as a match for hour of injury.

Probabilistic Matching

- Utilized Link Plus (a program provided by the Centers for Disease Control.)
- Each variable designated as a part of the matching algorithm is given a weighted score that represents the probability that the records belong to the same person
  - Positive and negative scores will be obtained based on agreement and disagreement across two records
- The 'score' is used to determine links and non-links.

[D:\RegPlus\LinkPlus\Configuration\all.cfg] - [Linkage Configuration]

File Manual Review Data Tools Help

Data Type: Delimited — File 1: F:\crash.csv

Delimited — File 2: F:\trauma.csv

Select blocking variables

Data Item (File 1)	Data Item (File 2)	Phonetic System
Age	Age	
gender	Gender	

Select ID variables (File 1)

Select ID variables (File 2)

Select matching variables and methods

Data Item (File 1)	Data Item (File 2)	Matching Method
Age	Age	Exact
gender	Gender	Exact
Date	DateofInjury	Date
Hour	Timehour	Value-specific

Adv

Missing Value (File 1) — Add — Remove

Missing Value (File 2) — Add — Remove

☑ Direct Method

Cutoff Value: 2

Results will be saved to ...

D:\RegPlus\LinkPlus\Report\all.txt

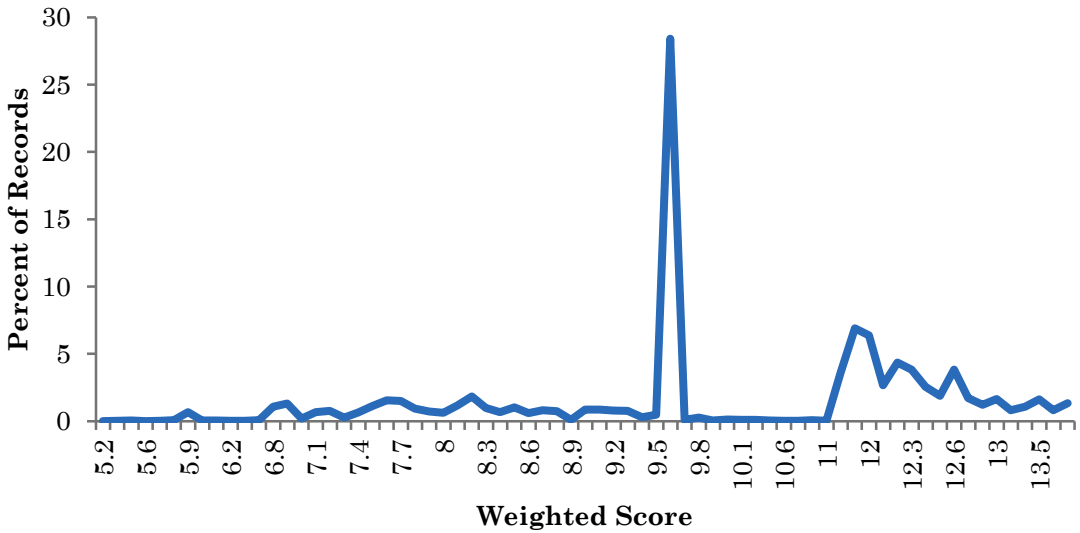
Please configure your linkage, and then click the Run button.

☑ = true matches ☒ = false matches ☐ = uncertain matches

Score	Class	Link ID	File	Record #	dateofinjury;Dat	age;Age	Timehour;Hou	Gender;gende
	1	2909	1	1566	01/27/2010	19	2	F
11.3	1	2909	2	6408	01/27/2010		2	F
	0	2910	1	1239	02/13/2010	29	6	F
11.3	0	2910	2	10742	02/13/2010	29	6	M
	0	2911	1	991	03/16/2010	57	6	M
11.3	0	2911	2	14988	03/16/2010	57	6	F
	0	2912	1	4319	06/26/2010	29	8	F
11.3	0	2912	2	27878	06/22/2010	29	8	F
	0	2913	1	88	03/10/2010	39	13	M
11.3	0	2913	2	11939	03/17/2010	39	13	M
	0	2914	1	3165	05/30/2010	33	13	F
11.3	0	2914	2	28177	06/30/2010	33	13	F
	1	2915	1	600	03/12/2010	20	11	M
11.3	1	2915	2	12378	03/12/2010		11	
	0	2916	1	97	03/14/2010	57	19	M
11.3	0	2916	2	12575	03/13/2010	57	19	M
	1	2917	1	5942	04/17/2010	19		M
11.3	1	2917	2	18572	04/17/2010	19	2	M
	1	2918	1	1659	02/06/2010	28		M
11.3	1	2918	2	9840	02/06/2010	28	14	M
	1	2919	1	1948	03/14/2010	47		M
11.3	1	2919	2	13694	03/14/2010	47	11	M
	1	2920	1	6346	06/04/2010	32		M
11.3	1	2920	2	28441	06/04/2010	32	12	M
	1	2921	1	1512	01/17/2010	20		M
11.3	1	2921	2	5739	01/17/2010	20	1	M

Probabilistic Matching Cont'd

- Distribution of probability weights is normally bimodal.
- First peak reflects incorrect matches while second peak reflects correct matches.
- Space between the peaks is a gray area which require manual review.



Results of the Matching

- 15,220 pairs of records were matched.
  - After de-duplicating the matches, retaining the match with the higher weighted score the final number of matched pairs was **14,412.**
- 60.6% of the trauma records were successfully matched.
- Positive predictive value = 91.6%, negative predictive value is 66%
- Specificity = 90.2% and sensitivity = 69.8%

	Matches	Non Matches
Linked	10,060	922
Unlinked	4,352	8,453
Total	14,412	9,375

Discussion

- Ideally all trauma patients injured in MVCs would be successfully matched to ALISS
- Lack of unique identifiers in crash data makes this an unrealistic goal.
- High specificity and sensitivity represent a successful matching schematic
  - Without unique identifiers, confidence in the accuracy of the matching is not high

Trauma versus Non-Trauma Crashes

Data analysis of probabilistically linked data

Looking At:

- Difference between crashes that result in injuries qualifying as major trauma and crashes that do not.
  - Traumas are defined as those observations that were positively linked.
  - Independently looked at passenger vehicles and motorcycles.
- Type of injuries by manner of collision
- Number of injuries sustained by persons injured in an accident

The Numbers… Part 2

- Persons in Motor Vehicles (566,559 total)
  - 11,185 traumas
  - 555,374 non-traumas
- Persons on Motorcycles (7,045 total)
  - 1,734 traumas
  - 5,211 non-traumas

METHODS: STATISTICAL ANALYSIS

- Exposure variables of interest:
  - Manner of collision
    - Rear-to-rear and rear-to-side were combined into one category
    - Other includes accidents without a collision manner specified
  - Safety Devices
    - Seat belts, car seats, helmets and airbags
  - Estimated speed- measured in MPH
- Potential confounders- age and gender

Methods: Missing Data

- Missing information for age, speed and seatbelt usage was imputed.
- No way to determine missing seat position and gender.
  - Also no way to fill in missing observations for helmet use for motorcycle riders.
- Seat belt usage is often self-reported so there is potential for that information to be higher than reality

Methods: Limitations

- Not all trauma cases were accurately linked.
- Airbag deployment
  - Noted in both ALISS and ASTR but not well populated.
  - Airbag deployment is unknown in over 60% of records for front row passengers.
  - Excluded from study due to poor reporting

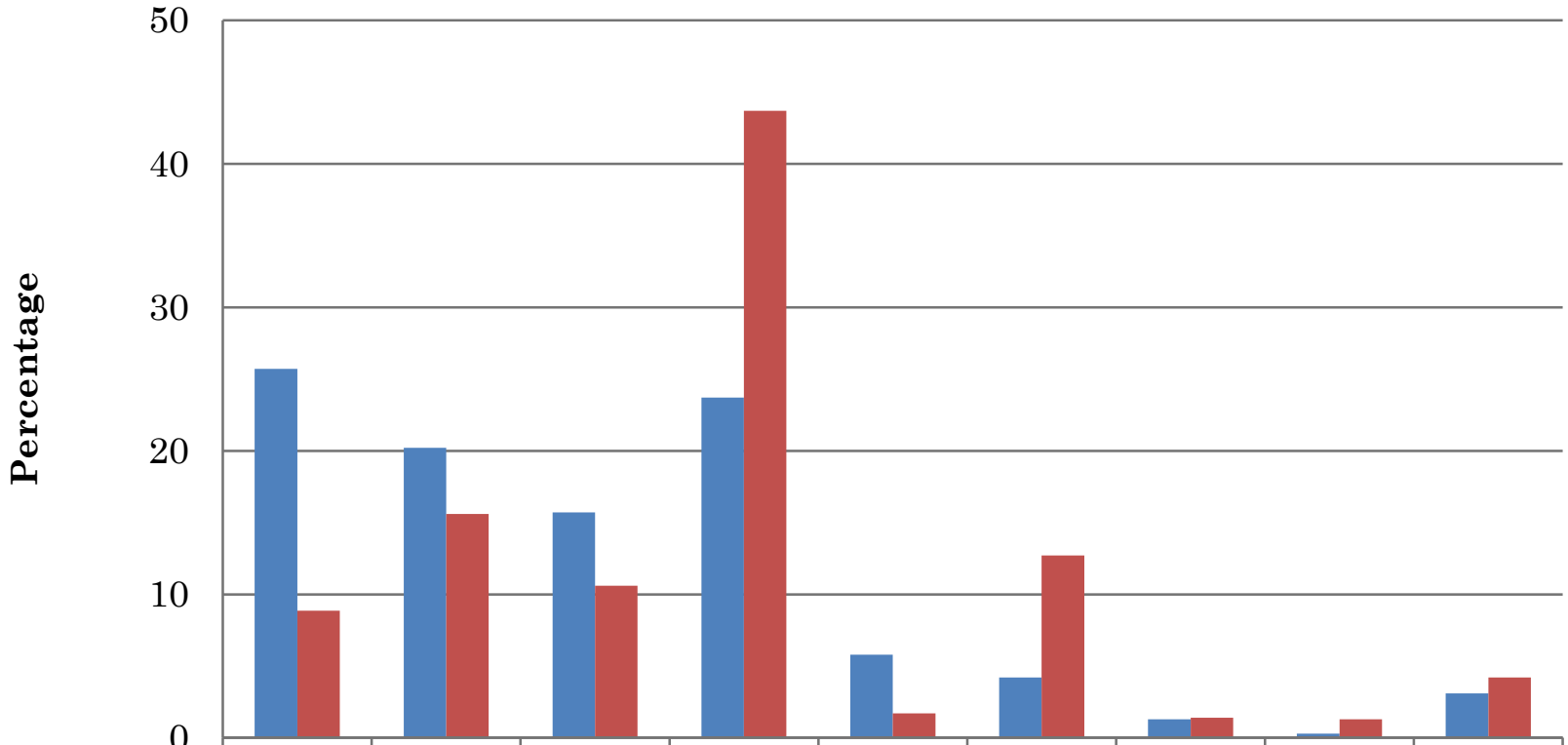
Airbag Deployment for Front Row Passengers (n= 496,059)			
	Total	**Trauma (N=9,963)**	**Non-Trauma (N=486,096)**
Not Applicable	22,252 (4.5%)	319 (3.2%)	21,933 (4.5%)
Not Deployed	101,444 (20.5)	1,072 (10.8)	100,372 (20.7)
Deployed	27,249 (5.5)	2,098 (21.1)	25,151 (5.2)
Unknown	345,114 (69.6)	6,474 (65.0)	338,640 (69.7)

Limitations Continued

- Drug and Alcohol use
  - Not well reported in ALISS and this therefore also excluded

Alcohol and Drug use for drivers (N=9.382)			
Alcohol use		**Drug Use**	
Suspected from ALISS	263 (2.8%)	**Suspected from ALISS**	224 (2.4%)
Confirmed Above Legal Limit from ASTR:	1,354 (14.4)	**From ASTR:** **Confirmed Legal use:** **Confirmed Legal and Illegal use:** **Confirmed Illegal use:**	 164 113 930
		Total	1207(12.9)

Trauma versus Non-Trauma by Collision Manner



	Single Vehicle	Angle	Left Turn	Rear End	Head on	Sideswipe same direction	Sideswipe opposite direction	Rear to Side/ Rear to Rear	Other / Missing
Trauma	25.7	20.2	15.7	23.7	5.8	4.2	1.3	0.3	3.1
Non-Trauma	8.85	15.6	10.6	43.7	1.7	12.7	1.4	1.3	4.2

Results: Passenger Vehicles

- There was a statistically significant difference between the two groups for all variables previously discussed
- Previous research has shown there is an interaction between seatbelt usage and gender; and seatbelt usage and seat position
  - Interaction between seatbelt usage and seat position was not statistically significant and was excluded from the model.

	Odds Ratio	95% Wald Confidence Limits	P-value
Age	1.007	(1.006, 1.008)	<0.0001
Log(Estimated Speed)	1.095	(1.079, 1.110)	<0.0001
Gender			
Male	1.000	Reference	
Female	1.297	(1.239, 1.357)	0.0004
Seat Restraint (Belt or Carseat)			
Yes	1.000	Reference	
No	3.984	(3.703, 4.288)	<0.0001
Seat Position			
Driver	1.000	Reference	
Front Row Other	1.079	(1.025, 1.135)	0.0034
2nd Row	0.911	(0.851, 0.979)	0.0107
3rd Row	1.056	(0.892, 1.259)	0.5093
External	1.281	(0.678, 2.429)	0.4429
Extraction			
No	1.000	Reference	
Yes	8.667	(8.057, 9.327)	<0.0001

Collision Manner			
Rear-End	1.00	Reference	
Single Vehicle	3.631	(3.419, 3.846)	<0.0001
Angle	2.029	(1.913, 2.152)	<0.0001
Left Turn	2.396	(2.251, 2.553)	<0.0001
Head-on	4.705	(4.285, 5.167)	<0.0001
Sideswipe same direction	0.566	(0.512, 0.626)	<0.0001
Sideswipe opposite direction	1.586	(1.339, 1.879)	<0.0001
Rear to Side/ Rear to Rear	0.428	(0.307, 0.596)	<0.0001
Other/Unknown	1.250	(1.113, 1.404)	0.0002
Gender*Seat Restraint	0.886	(0.810, 0.969)	0.0083

Model 1: Passenger Vehicles
Pr(Y=Trauma)

(33,499 omitted for missing gender and/or seat position- 5.9%)

Model 2: Motorcycles Only

	Odds Ratio	95% Wald Confidence Limits	P-value
Age	1.010	(1.007, 1.014)	<0.0001
Log(Estimated Speed)	1.170	(1.122, 1.221)	<0.0001
Helmet			
Yes	1.000	Reference	
No	1.371	(1.204,1.561)	<0.0001
Collision Manner			
Rear End	1.000	Reference	
Single Vehicle	1.350	(1.117, 1.631)	0.0019
Angle	1.780	(1.397, 2.268)	<0.0001
Left Turn	2.623	(2.038, 3.376)	<0.0001
Head on	2.077	(1.335, 3.230)	0.0012
Sideswipe same direction	0.973	(0.722, 1.312)	0.8589
Sideswipe opposite direction	1.021	(0.516, 2.022)	0.9524
Rear to Side/ Rear to Rear	0.377	(0.087, 1.626)	0.1908
Other/Unknown	1.379	(0.968, 1.963)	0.0748

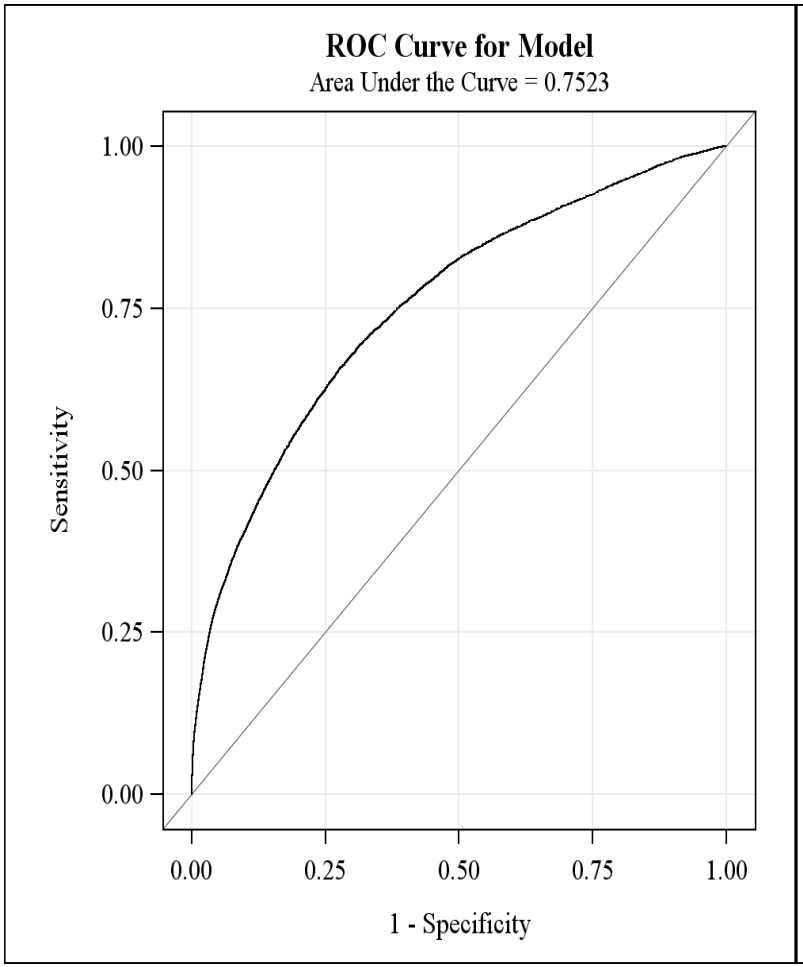
(2,129 omitted because of missing gender and/or helmet usage- 30.2%)

Receiver Operating Characteristic (ROC) curve

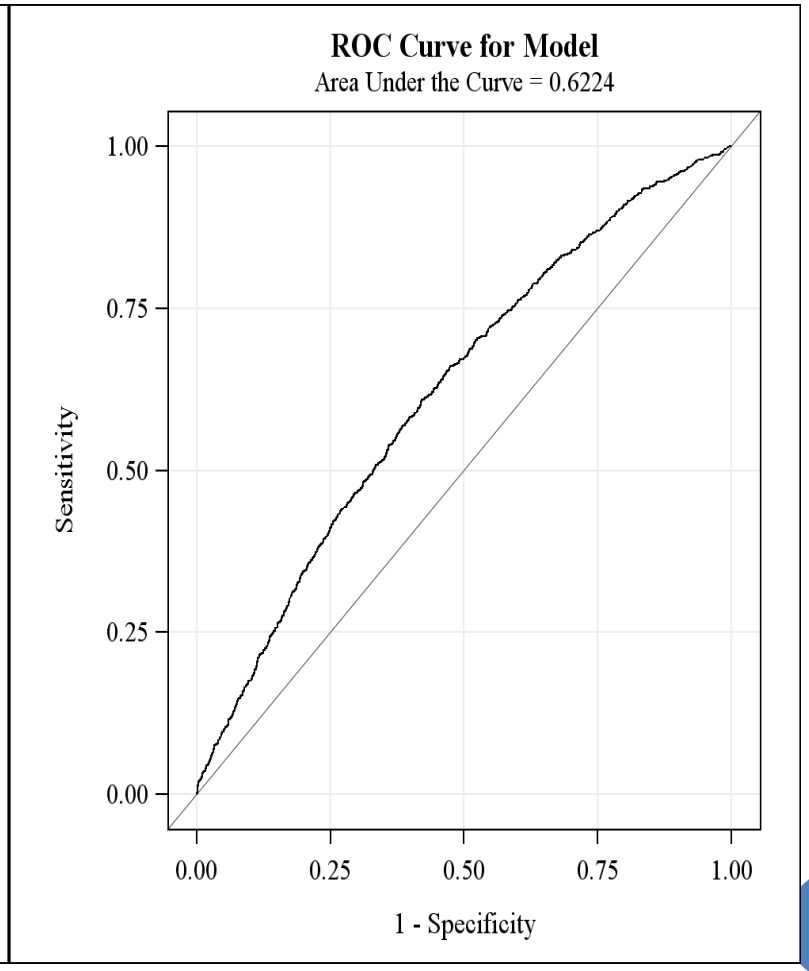
- Accuracy of a test to discriminate persons with injuries from MVC that qualify as a trauma from those that were not traumas.
- Sensitivity= number of true positives/ (true positives+ false negatives)
- Specificity = number of true negatives/(true negatives and false positives)
- Interested in the area under the plot of (1-specificity) versus sensitivity
  - Area= 0.5 indicates random predictions
  - Area > 0.8 is considered a valuable curve in predicting the responses of the individual subjects

ROC Curve

Model 1



Model 2



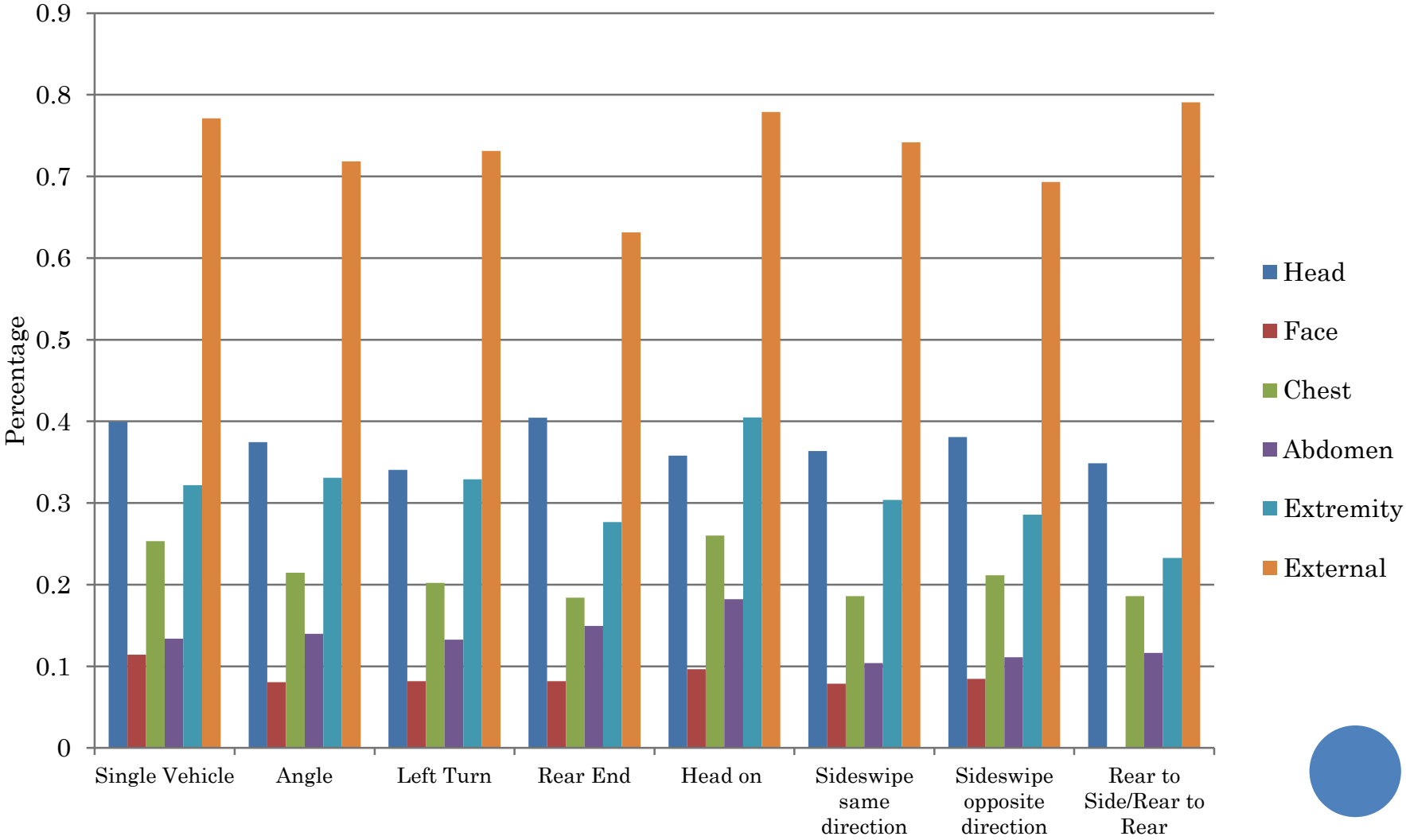
Area Under the ROC Curves

- Neither model reaches the generally accepted value of 0.8 for a good predictive model
  - Model 1- 0.7523
  - Model 2- 0.6224
- More factors could be looked at
  - Airbag usage
  - Alcohol and Drug usage
  - Vehicle type
  - Weather conditions

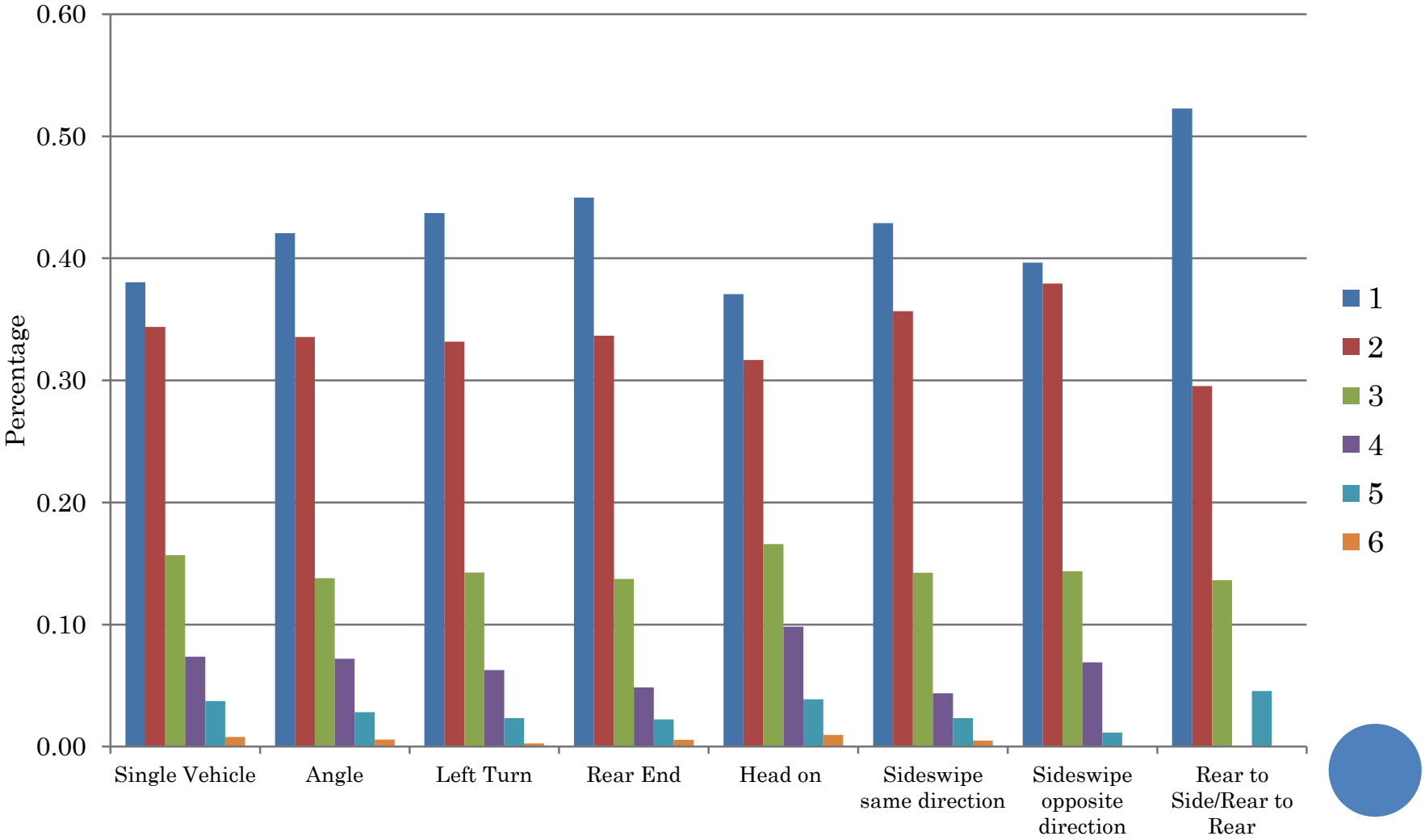
Utilizing only the Matched Records

- Allows us to look at the types of injuries that result based on collision manner
- Allows us to look at the number of body areas injured.

Body Area Injured by Collision Manner



% of people with Multiple Body Part Injuries by Collision Manner



Safety Recommendations

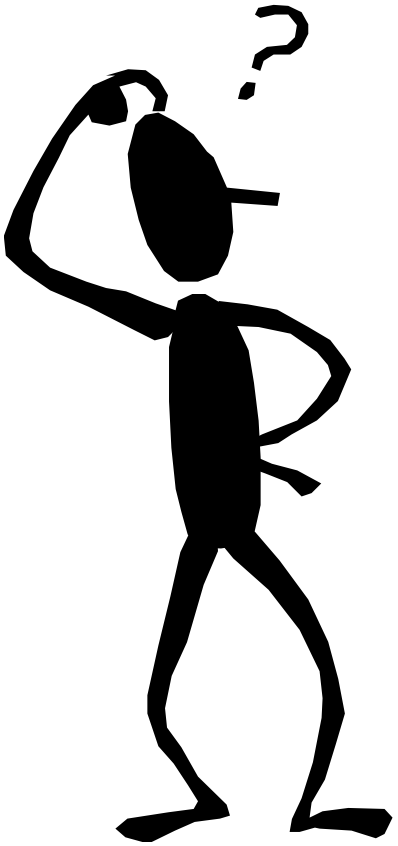
- Seat belt usage is an important factor in preventing traumatic injuries in passenger vehicle collisions.
- Not possible to say what the effect of airbag deployment is as it is not well reported.

Future

- Discussions have already led ADOT to begin investigating setting up a process to electronically submit records to ADHS containing unique identifiers.
- With time, trends can be identified.
  - Allow the state to identify problem areas and weaknesses in the current system.
- EMS database will help fill in the gap between the incident and treatment at a trauma center

In Summary…

- Valuable information can be obtained by establishing a working link between ASTR and ALISS.
- While the overall models do not meet the overall threshold for a valuable predictive curve, there are still significant differences in the outcome based upon collision type, restraint systems, speed, extrication and age.



Questions?