Comparison of Crashes Involving Ambulances with Those of Similar-Sized Vehicles

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ABSTRACT

Objective. To describe the characteristics and associated occupant injuries of motor vehicle collisions (MVCs) involving ambulances as compared with MVCs involving similar-sized vehicles. **Methods.** Motor vehicle crash data in Pennsylvania from 1997–2001 were analyzed to compare the characteristics of crashes involving ambulances with those involving vehicles of a similar size. Crash demographics (e.g., location of crash, roadway conditions, intersection type) and associated injuries were examined and compared using chi-square tests and Fisher's exact test. **Results.** 2,038 ambulance MVCs and 23,155 crashes involving similar-sized vehicles were identified. Weather and road surface conditions were similar, but ambulance MVCs occurred with increased frequency on evenings and weekends. Ambulances were more likely to be involved in four-way intersection crashes (43% vs. 23%, p = 0.001), angled collisions (45% vs. 29%, p = 0.001), and collisions at traffic signals (37% vs. 18%, p = 0.001). More people were involved in ambulance MVCs (p = 0.001), with 84% of ambulance MVCs involving three or more people and 33% involving five or more people. Injuries were reported in more ambulance MVCs (76% vs. 61%, p = 0.001). Pedestrian involvement was rare (<5% in both groups). **Conclusion.** Ambulance crashes occur more frequently at intersections and traffic signals and involve more people and more injuries than those of similar-sized vehicles. **Key words:** ambulances; motor vehicle collisions; emergency medical services.

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It has long been recognized that morbidity and mortality from motor vehicle collisions (MVCs) is significant.[1] Unfortunately, ambulances and other emergency vehicles are also involved in MVCs. According to the National Highway Traffic Safety Administration, a total of 302,969 emergency vehicles were involved in MVCs from 1991 to 2000, with 1,565 involving fatalities.[2] It could be surmised that the injuries sustained in ambulance MVCs are a factor of the vehicle size. No direct comparison has been done between ambulances and other similar-sized vehicles (such as delivery or postal trucks) to see whether differences exist. The purpose of this study was to better describe the characteristics and associated occupant injuries of MVCs involving ambulances as compared with MVCs involving other similar-sized vehicles.

Methods

We analyzed MVC data collected by the Pennsylvania Department of Transportation from 1997 to 2001 to compare the characteristics of ambulance crashes with those involving similar-sized vehicles. Crashes involving ambulances were identified in the database through a unique identifier. Similar-sized vehicle crashes were identified by matching the "body type" variable in the database to those most similar to that of an ambulance ["van commercial cutaway (ex. box van)," "van-based motorhome," "pickup with slide-in camper," "pickup based motorhome (chassis mounted)," "truck based panel," "utility base body unknown," "unknown light truck (van based or conventional)," or "single unit straight truck"].

We compared EMS and hospital data between groups by using probabilistic linkage of the crash data, Pennsylvania Department of Health EMS patient care report data, and hospital outcome data using CODES 2000 software (Strategic Matching, Inc., Morrisonville, NY). The technique of probabilistic linkage, which has been previously described and validated,[3,4] uses common variables between different databases as a method of combining those databases. Variables for a given record contained within each database (e.g., time, date, and location of crash; age and gender of patient) are compared, the probability that the two records refer to the same event is determined, and items with a high probability are then "linked."

The following factors were analyzed and compared:

- Crash demographics (time of crash, day of crash)
- Environmental considerations (light conditions, weather)
- Roadway considerations (road surface, intersection involvement, traffic signals)
- Number of vehicles and people involved
- Number and severity of injuries on scene
- EMS-reported patient data
- Hospital patient data

Comparisons between groups were made using chi-square tests and Fisher's exact test (in cases

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with expected counts less than 5). P-values ≤0.05 were considered significant. The Geisinger Health Systems Institutional Research Review Board and the Office of Emergency Medical Services of the Pennsylvania Department of Health approved the project.

RESULTS

A total of 2,038 MVCs involving ambulances and 23,155 MVCs involving similar-sized vehicles were identified in Pennsylvania from 1997 to 2001. EMS data were available for 11% of ambulance MVCs and 10% of similar-sized vehicle crashes. Hospital data were available for less than 1% of either type of MVC.

Table 1 indicates that, while both groups of vehicles experienced more crashes during weekday daylight hours, ambulance crashes occurred with increased frequency in the evenings and weekends compared with similar-sized vehicles. No substantial difference was noted in the other environmental or roadway conditions encountered.

Differences were noted in the crash demographics between ambulances and similar-sized vehicles, as Table 2 illustrates. Similar-sized vehicles were more likely to be involved in rear-end collisions, while ambulances were more likely to be involved in angled collisions. Ambulances were more likely to be involved in collisions occurring at four-way intersections and traffic signals. As Table 3 shows, collisions involving ambulances more often involved more people and more injuries, but not more vehicles.

TABLE 1. Environmental Conditions

Condition	Ambulances ($n = 2,038$) (%)	Similar-sized Vehicles ($n = 2,3155$) (%)	p-value
Time of crash			
0001–0600 hours	8	6	0.001
0601–1200 hours	31	41	
1201–1800 hours	43	44	
1801–0000 hours	19	10	
Day of crash			
Sunday	9	4	0.001
Monday	13	17	
Tuesday	16	18	
Wednesday	16	17	
Thursday	15	17	
Friday	17	19	
Saturday	15	8	
Light			
Dawn	2	2	0.001
Daylight	71	83	
Dark–streetlights	17	7	
Dark–no streetlights	8	6	
Dusk	2	1	
Weather			
Not adverse	77	79	0.04
Raining/sleet	16	14	
Snowing	6	6	
Other	1	1	
Road surface			
Dry	71	74	0.001
Wet	20	17	
Snow	3	4	
Ice	3	2	
Other	4	3	

TABLE 2. Crash Demographics

	Ambulances ($n = 2,038$) (%)	Similar-sized Vehicles ($n = 2,3155$) (%)	p-value
Crash description			
Rear-end	22	30	0.001
Head-on	4	6	
Angle	45	29	
Sideswipe	9	9	
Hit fixed object	12	14	
Other	7	11	
Type of intersection			
Non-intersection	41	58	0.001
T-intersection	12	15	
Four-way intersection	43	23	
Other	3	4	
Road type			
Highway	67	72	0.001
Street	31	26	
Ramp	2	2	
Traffic control device			
NA	53	71	0.001
Traffic signal	37	18	
Stop sign	7	9	
Other	2	1	
Unknown	1	1	
Estimated cause			
Environment	6	4	0.001
Operator	89	89	
Roadway	1	1	
Vehicle	3	5	
Number of vehicles			
1	18	20	0.29
2	69	67	
3–4	12	12	
5+	<1	<1	

DISCUSSION

This is the first study that directly compares ambulance crashes with crashes involving similar-sized vehicles. The data analysis shows that several significant differences exist.

Ambulance crashes involved more people and more injuries than those crashes involving similar-sized vehicles. This increase occurred despite the fact that there was not a corresponding increase in the number of vehicles involved. Emergency vehicle driver training programs, such as the Emergency Vehicle Operators Course (offered by Volunteer Firemen's Insurance Services),[5] note that ambulance crashes often produce more injuries than typical MVCs. This study confirms these earlier observations. Ambulance crashes were also more likely to occur at four-way intersections

TABLE 3. Patient Demographics

	Ambulances (n = 2,038) (%)	Similar-sized Vehicles (n = 2,3155) (%)	p-value
Crash severity			
Fatal	1	2	0.001
Major injury	3	4	
Moderate injury	16	13	
Minor injury	47	36	
Unknown injury	9	7	
No injury	23	38	
Person count			
1–2	16	49	0.001
3–4	50	36	
5–6	23	10	
7–10	9	4	
11+	1	1	
Injury count			
0	24	39	0.001
1–2	56	53	
3–4	15	6	
5+	6	1	
Pedestrian count			
0	96	97	0.23
1–2	4	3	
3+	<1	<1	
Gender of patient—male	67	90	0.001

and traffic signals and to occur as angled collisions, associations that have previously been noted by other authors.[6–8]

Consideration was made in trying to adjust for the speed of the collision when comparing the severities of the injuries sustained. Unfortunately, the database did not contain road speed limit data or estimated vehicle speed for many collisions. While estimates were available for some MVCs, the database includes a notation that the estimated vehicle speed "is not a highly reliable field." Because of these factors, it was not possible to adjust the injury severity for the speed of the crashes. The closest correction possible was to compare the roadway types. As noted in Table 2, there were not substantial differences in the roadway types between the groups of crashes. This implies that in many crashes, the vehicles were traveling on similar road types. In Pennsylvania, ambulances are not legally permitted to exceed the speed limit.

If injury rates were simply a function of vehicle size, one would expect the two groups of vehicles to be similar. However, our research shows the number of injuries is increased with ambulance crashes compared with vehicles of similar size, and therefore not solely a function of the vehicle size.

The increased occurrence of ambulance crashes at intersections was noted to occur at those with traffic signals but not stop signs. While other drivers would be expected to stop at a stop sign all the time, they would not stop if they had a green traffic signal. In Pennsylvania, ambulances utilizing lights and sirens are required to come to a complete stop at a red traffic signal and ensure that they will be given the right of way before proceeding through the intersection.

The increased frequency of ambulance crashes at intersections and traffic signals is a factor that could be affected by driver education. Several authors have suggested that limiting the use of lights and sirens during response and transport may reduce these crashes.[9–13] It has been shown that the use of lights and sirens does not significantly decrease ambulance response times[14,15] and is associated with an increased number of injuries and crashes.[6,8,16,17] While emergency vehicle driver training programs have been in existence for some time, and a recent initiative has focused on intersections,[18] this study suggests that there may be further opportunity to reduce ambulance crashes and their injuries by concentrating on additional efforts to reduce the risk of intersection crashes.

Several other differences were noted. Crashes involving similar-sized vehicles were much more likely to occur during the week as opposed to the weekend. While a similar trend was shown with ambulances crashes, its magnitude was much smaller. Also, crashes involving similar-sized vehicles were more likely to occur between 6 AM and 6 PM, and less likely to occur after 6 PM. Presumably, many of the similar-sized vehicles are commercial vehicles, such as delivery trucks, that are used considerably less during the evenings and weekends. Crashes involving similar-sized vehicles involved male patients 90% of the time, while ambulance crashes had a male patient only 67% of the time.

No substantial difference was noted in the weather and road surface conditions. This seems logical given that the basic vehicle characteristics, such as handling and stopping ability, are similar between the two sets of vehicles.

LIMITATIONS

Several limitations exist with the study. Unfortunately, linkage was poor between the police-reported information and the EMS and hospital data. Because of this, the decision was made not to analyze the EMS or hospital data, as it would be difficult to generate any relevant conclusions. The data contained within the database were reported by police and not able to be secondarily validated. The accuracy of police reports has been questioned by some investigators[19]; however, police officers are trained to observe and report accident information and police reports have been noted to be more accurate than ambulance reports or emergency department records.[20]

CONCLUSION

Ambulance MVCs involve more people and more injuries than crashes of similar-sized vehicles. Ambulance MVCs occur more frequently at intersections and traffic signals. Further study is needed to determine whether additional EMS vehicle operator education, reduced operations with lights and sirens, intersection signaling devices, or other interventions are most effective at reducing these crashes at intersections and traffic signals.

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