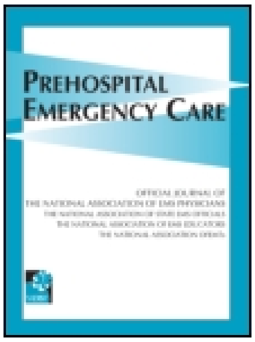

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C HARACTERISTICS OF F ATAL A MBULANCE C RASHES IN THE U NITED S TATES : A N 11- YEAR R ETROSPECTIVE A NALYSIS

Christopher A. Kahn, Ronald G. Pirrallo & Evelyn M. Kuhn

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Characteristics of Fatal Ambulance Crashes in the United States: An 11-year Retrospective Analysis

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ABSTRACT

Background. Ambulance crashes have become an increasing source of public concern. Emergency medical services directors have little data to develop ambulance operation and risk management policies. **Objective.** To describe fatal ambulance crash characteristics, identifying those that differentiate emergency and nonemergency use crashes. **Methods.** This was a retrospective analysis of all fatal ambulance crashes on U.S. public roadways reported to the Fatality Analysis Reporting System (FARS) database from 1987 to 1997. Main outcome measures were 42 variables describing crash demographics, crash configuration, vehicle description, crash severity, and ambulance operator and vehicle occupant attributes. **Results.** Three hundred thirty-nine ambulance crashes caused 405 fatalities and 838 injuries. These crashes occurred more often between noon and 6 PM (39%), on improved (99%), straight (86%), dry roads (69%) during clear weather (77%), while going straight (80%), through an intersection (53%), and striking (81%) another vehicle (80%) at an angle (56%). Most crashes (202/339) and fatalities (233/405) occurred during emergency use. These crashes occurred significantly more often at intersections ($p < 0.001$), at an angle ($p < 0.001$), with another vehicle ($p < 0.001$). Most crashes resulted in one fatality, not in the ambulance. Thirty pedestrians and one bicyclist comprised 9% of all fatalities. In the ambulance, most serious and fatal injuries occurred in the rear (OR 2.7 vs front) and to improperly restrained occupants (OR 2.5 vs restrained). Sixteen percent of ambulance operators were cited; 41% had poor driving records. **Conclusions.** Most crashes and fatalities occurred during emergency use and at intersections. The greater burden of injury fell upon persons not in the ambulance. Rear compartment occupants were more likely to be injured than those in the front. Crash and injury reduction programs should address improved intersection control, screening to identify high-risk drivers, appropriate restraint use, and design modifications to the rear compartment of the ambulance. **Key words:** ambulances; emergency medical services; accidents, traffic; accident prevention; deaths; safety.

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Modern emergency medical services (EMS) systems rely on the ambulance to provide quick and reliable transportation for the ill and injured. However, the benefits of traveling in an ambulance are tempered by driving hazards beyond those of the typical passenger vehicle.[1] This is especially true when lights and sirens are used.[2,3] Due regard for public safety, as an ethical directive and a key component of state emergency vehicle traffic legislation, demands that EMS providers competently deal with these hazards.[4]

An ambulance crash violates the medical profession's first duty—to do no harm. Not surprisingly, crashes are an increasing source of public concern and litigation.[4–6] Nonetheless, EMS directors have little objective data to develop policies governing safe ambulance operations. Pirrallo and Swor raised this issue in a 1994 study of fatal ambulance crashes, and significant changes in policy and practice followed.[7] In 1994, the National Association of EMS Physicians and the National Association of State EMS Directors published a position paper that made recommendations for the appropriate operation of emergency ambulances.[3] In 1995, the National Highway Traffic Safety Administration (NHTSA) published an Emergency Vehicle Operators Course that addressed the unique characteristics of ambulance driving.[8] Simultaneously, the legal system began holding ambulance services increasingly liable for ambulance crashes.[4–6]

Whereas previous authors have analyzed the appropriateness of emergency vs nonemergency use, few have examined the wider range of factors that contribute to ambulance collisions.[2,9–14] To address this deficiency, we analyzed a large series of fatal ambulance crashes that occurred during emergency and nonemergency use. Our primary objective was to describe characteristics of fatal ambulance crashes. We hope this construction of an illustrative model of fatal ambulance crashes will identify potential risk factors that might be modified by educational, design, policymaking, or regulatory efforts.

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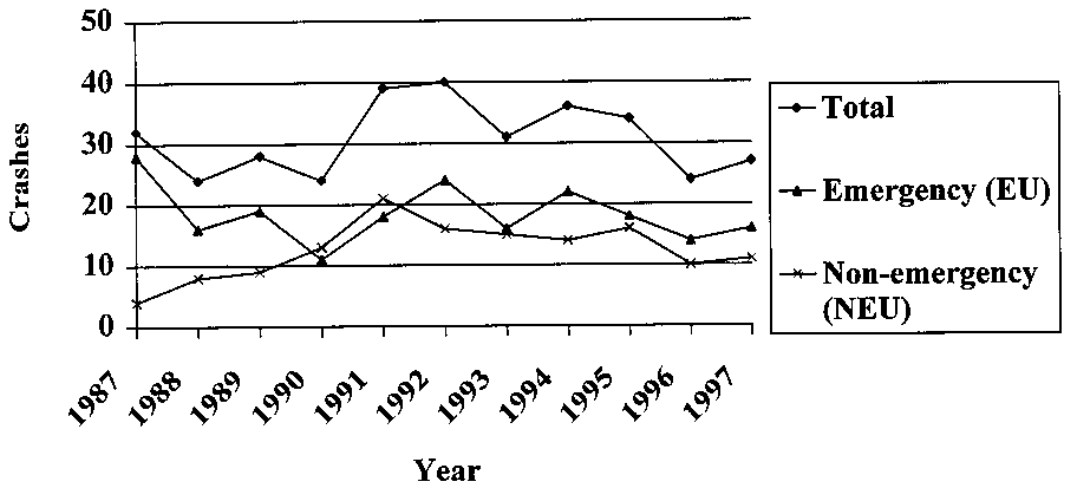

FIGURE 1. Ambulance crashes involving a fatality by year and emergency use.

Our hypothesis was that there is no association between emergency use vs nonemergency use and other fatal ambulance crash characteristics from 1987 through 1997.

METHODS

To obtain our case series we queried the U.S. NHTSA Fatality Analysis Reporting System (FARS) for all fatal crashes involving an ambulance that occurred between 1987 and 1997 inclusive. From this database 42 variables were chosen that describe driver demographics, crash configuration, vehicle description, crash severity, ambulance operator and vehicle occupant attributes, and the manner of use (emergency vs nonemergency use) at the time of the crash. Variables were selected *a priori* based on previous crash research and authors' experiences. The association of categorical variables with emergency use (EU) vs nonemergency use (NEU) was studied using Pearson χ^2 tests of significance. Emergency use was defined as use of physical emergency signals (i.e., lights and siren) while the vehicle was traveling. Variables found significant in the univariate analysis were examined in a multivariate model to determine whether several variables in combination were independently associated with EU vs NEU. Ambulance occupant attributes, including location, restraint use, and injury severity (grouped as fatal, severe, minor, and uninjured), were compared using logistic regression for odds ratio (OR) determination and Pearson χ^2. These analyses were performed with the SAS statistical package, version 6.12 (SAS Institute, Cary, NC). Proper restraint use was defined as use of either a lap belt or a combination lap and shoulder belt. Since multiple tests of significance were performed, a p-value of 0.01 was used to define significance. Data coded as "unknown" were scrutinized for selection bias and omitted from further analysis.

Three additional *a priori* analyses were performed. First, incidence data were matched with 1990 adjusted census data for persons 18 years of age and older to provide a population-based rate of fatal ambulance crashes; this represents the most accurate available data for a population approximating driving age for rate analysis. Second, as a reference point and for comparison purposes, the 1997 FARS data set of all public motor vehicle fatal crashes was queried for similar variables. Finally, the 56 U.S. state and territorial EMS bureaus were surveyed to determine the number of emergency ambulances operating in 1995 and 1997. These years were chosen to provide a convenient and concurrent picture of the number of operational ambulances while minimizing the burden of participation in an effort to improve the response rate. This survey was performed in cooperation with the National Association of State EMS Directors.

RESULTS

The FARS database contained a total of 339 ambulance crashes encompassing 405 fatalities and 838 other injuries (Fig. 1). Fatal ambulance crash characteristics did not vary greatly over the study period. Crashes were most likely to occur between noon and 6 PM (39%), on improved (99%), straight (86%), dry roads (69%), during clear weather (77%), while going straight (80%), through an intersection (53%), and striking (81%) another vehicle (80%) at an angle (56%) (Tables 1–3). A χ^2 test for equal proportions demonstrated no significant variation in crash incidence by year ($p = 0.33$), season ($p = 0.74$), or day of the week ($p = 0.57$) (Fig. 1, Tables 1 and 2). Throughout our analysis, the extremely low incidence of missing data (generally <1%) did not meaningfully affect our statistical calculations.

Sixty percent of crashes (202/339) and 58% of crash fatalities (233/405) occurred during EU. Compared with NEU fatal crashes, EU fatal crashes occurred significantly more often at intersections ($p < 0.001$), at an angle ($p < 0.001$), and with another motor vehicle ($p < 0.001$) (Table 2). Since these characteristics were strongly associated with one another (e.g., 82% of crashes at an angle occurred at an intersection vs 16% of other crashes), only the manner of collision remained statistically significant when other characteristics were included in the model.

Most crashes resulted in one fatality (84%), and most fatalities involved individuals who were not occupants of the ambulance (78%) (Tables 4 and 5). In other vehicles, between 0 and 11 occupants were injured and 0 to 4 were killed (Table 5). Thirty pedestrians and one bicyclist comprised 9% of all fatalities (Table 2). Inside the ambulance, between 0 and 6 occupants were injured and 0 to 3 were killed (Table 5).

Sixteen percent of fatal crashes resulted in the ambulance driver's being cited for a traffic violation (Table 6). The most common citations received were for "other moving violations," such as lane, signaling, turning, and intersection control violations. No difference was found between fatal EU and NEU crashes with respect to violations charged. Forty-one percent of the ambulance operators in this study had a record of prior crashes, suspensions, and/or motor vehicle citations (Table 6).

In the ambulance, most incapacitating and fatal injuries occurred in the rear compartment (OR compared with front: 2.7 [95% CI 2.0–3.7]) and involved unrestrained or improperly restrained occupants (OR compared with properly restrained: 2.5 [95% CI 1.8–3.6]). The OR for unrestrained or improperly restrained occupants for rear vs front was 2.8 (95% CI 1.8–4.2) (Table 7).

The general public motor vehicle 1997 FARS data set revealed many similarities with the ambulance subset, including violations charged and past driving records (Tables 8 and 9). Notably, nearly 60% of general public fatal crashes did not involve another motor vehicle, compared with 20% of fatal ambulance crashes. In keeping with this, there was a higher rate of crashes occurring at intersections for the ambulance subset than the general public. Also, ambulance operators involved in a fatal crash were more likely to have had a prior crash. Interestingly, the percentages of fatal crashes involving rollovers were similar for the general public motor vehicle and ambulance populations.

Twenty-six state and territorial EMS agencies responded to our survey. Of these, 13 provided the complete set of requested data. In these states, 12,040 emergency ambulances were operating in 1995 and 13,070 in 1997. Although the data are insufficient to form an accurate description of the number of operational ambulances in this country, they do correlate well with other published data, depicting approximately an 8.6% increase from 1995 through 1997.[15,16]

The mean aggregated rate of fatal ambulance crashes over the 11-year period for the 50 states and the District of Columbia was 1.78 crashes per 1,000,000 persons over 18 years of age. The median rate was 1.80 and the interquartile range was 1.57 (1.09–2.66). Alaska, Hawaii, Kansas, Montana, Nebraska, and North Dakota reported no fatal ambulance crashes during the study period; West Virginia and Vermont reported the highest rates. However, small numerators may affect the stability of these rates.

TABLE 1. Crash Demographics

	Total, *n* (%)	Nonemergency Use, *n* (%)	Emergency Use, *n* (%)	χ^2	p-value
Season					
Winter	92 (27.1%)	38 (41.3%)	54 (58.7%)		
Spring	79 (23.3%)	30 (38.0%)	49 (62.0%)		
Summer	81 (23.9%)	34 (42.0%)	47 (58.0%)		
Fall	87 (25.7%)	35 (40.2%)	52 (59.8%)		
TOTAL	339 (100.0%)	137 (40.4%)	202 (59.6%)	0.309	0.958
Day of the week					
Sunday	48 (14.2%)	19 (39.6%)	29 (60.4%)		
Monday	50 (14.8%)	20 (40.0%)	30 (60.0%)		
Tuesday	36 (10.6%)	14 (38.9%)	22 (61.1%)		
Wednesday	54 (15.9%)	24 (44.4%)	30 (55.6%)		
Thursday	47 (13.9%)	17 (36.2%)	30 (63.8%)		
Friday	49 (14.5%)	21 (42.9%)	28 (57.1%)		
Saturday	55 (16.2%)	22 (40.0%)	33 (60.0%)		
TOTAL	339 (100.0%)	137 (40.4%)	202 (59.6%)	0.893	0.989
Time of day					
0000–0600	58 (17.1%)	30 (51.7%)	28 (48.3%)		
0600–1200	68 (20.1%)	33 (48.5%)	35 (51.5%)		
1200–1800	132 (38.9%)	46 (34.9%)	86 (65.2%)		
1800–2400	81 (23.9%)	28 (34.6%)	53 (65.4%)		
TOTAL	339 (100.0%)	137 (40.4%)	202 (59.6%)	7.778	0.051

TABLE 2. Crash Configuration

	Total, *n* (%)	Nonemergency Use, *n* (%)	Emergency Use, *n* (%)	χ^2	p-value
Relationship to junction					
Intersection	180 (53.3%)	58 (32.2%)	122 (67.8%)		
Non-intersection	158 (46.8%)	79 (50.0%)	79 (50.0%)		
TOTAL	338 (100.0%)	137 (40.5%)	201 (59.5%)	11.033	<0.001
Posted speed limit					
25–35 mph	112 (33.7%)	40 (35.7%)	72 (64.3%)		
40–50 mph	102 (30.7%)	37 (36.3%)	65 (63.7%)		
55–75 mph	118 (35.5%)	57 (48.3%)	61 (51.7%)		
TOTAL	332 (100.0%)	134 (40.4%)	198 (59.6%)	4.806	0.090
Roadway alignment					
Straight	290 (85.8%)	113 (39.0%)	177 (61.0%)		
Curved	48 (14.2%)	24 (50.0%)	24 (50.0%)		
TOTAL	338 (100.0%)	137 (40.5%)	201 (59.5%)	2.080	0.149
Roadway surface type					
Concrete	29 (8.9%)	13 (44.8%)	16 (55.2%)		
Asphalt	296 (90.5%)	115 (38.9%)	181 (61.2%)		
Gravel	2 (0.6%)	1 (50.0%)	1 (50.0%)		
TOTAL	325 (100.0%)	128 (39.4%)	197 (60.6%)	0.489	0.783
Surface conditions					
Dry	232 (68.8%)	97 (41.8%)	135 (58.2%)		
Wet	78 (23.2%)	25 (32.1%)	53 (68.0%)		
Frozen	27 (8.0%)	15 (55.6%)	12 (44.4%)		
TOTAL	337 (100.0%)	137 (40.7%)	200 (59.3%)	5.006	0.082
Atmospheric conditions					
Not adverse	259 (76.6%)	107 (41.3%)	152 (58.7%)		
Adverse	79 (23.4%)	30 (38.0%)	49 (62.0%)		
TOTAL	338 (100.0%)	137 (40.5%)	201 (59.5%)	0.280	0.597
Rollover					
No	290 (85.5%)	116 (40.0%)	174 (60.0%)		
Yes	49 (14.5%)	21 (42.9%)	28 (57.1%)		
TOTAL	339 (100.0%)	137 (40.4%)	202 (59.6%)	0.142	0.706
Manner of collision					
Not a motor vehicle collision	68 (20.1%)	40 (58.8%)	28 (41.2%)		
Rear-end	29 (8.6%)	12 (41.4%)	17 (58.6%)		
Head-on	51 (15.0%)	29 (56.9%)	22 (43.1%)		
Angle or sideswipe	191 (56.3%)	56 (29.3%)	135 (70.7%)		
TOTAL	339 (100.0%)	137 (40.4%)	202 (59.6%)	25.075	<0.001
First harmful event*				13.814	<0.001
Collision with non-fixed object					
Pedestrian/pedalcycle	31 (9.1%)	14 (45.2%)	17 (54.8%)		
Motor vehicle in transport	268 (79.1%)	96 (35.8%)	172 (64.2%)		
Other†	7 (2.1%)	4 (57.1%)	3 (42.9%)		
TOTAL	306 (90.3%)	114 (37.3%)	192 (62.8%)		
Collision with fixed object‡	19 (5.6%)	12 (63.2%)	7 (36.8%)		
Non-collision					
Overturn	12 (3.5%)	9 (75.0%)	3 (25.0%)		
Other§	2 (0.6%)	2 (100.0%)	0 (0.0%)		
TOTAL	14 (4.1%)	11 (78.6%)	3 (21.4%)		

*χ^2 and p-value for first harmful event refer to comparison of three major groups.

†Parked motor vehicle, railway train, motor vehicle in transport in other roadway, transport device used as equipment.

‡Building, luminaire or light support, other post, pole, or support, curb, ditch, earth embankment, wall, guardrail, concrete traffic barrier, utility pole, fence, tree.

§Fell/jumped from vehicle, injured in vehicle.

TABLE 3. Vehicle Description

	Total, *n* (%)	Nonemergency Use, *n* (%)	Emergency Use, *n* (%)	χ^2	p-value
Vehicle role					
Noncollision	11 (3.3%)	8 (72.7%)	3 (27.3%)		
Striking	258 (76.3%)	102 (39.5%)	156 (60.5%)		
Struck	53 (15.7%)	21 (39.6%)	32 (60.4%)		
Both	16 (4.7%)	5 (31.5%)	11 (68.8%)		
TOTAL	338 (100.0%)	136 (40.2%)	202 (59.8%)	5.427	0.143
Manner leaving scene					
Driven	35 (10.7%)	21 (60.0%)	14 (40.0%)		
Towed	291 (89.3%)	113 (38.8%)	178 (61.2%)		
TOTAL	326 (100.0%)	134 (41.1%)	192 (58.9%)	5.783	0.016
Vehicle maneuver					
Going straight	270 (79.7%)	105 (38.9%)	165 (61.1%)		
Starting/stopping	13 (3.8%)	7 (53.9%)	6 (46.2%)		
Passing/merging	15 (4.4%)	4 (26.7%)	11 (73.3%)		
Turning	11 (3.2%)	5 (45.5%)	6 (54.6%)		
Other maneuver	30 (8.9%)	16 (53.3%)	14 (46.7%)		
TOTAL	339 (100.0%)	137 (40.4%)	202 (50.6%)	4.607	0.330

TABLE 4. Crash Severity

	Total, *n* (%)	Nonemergency Use, *n* (%)	Emergency Use, *n* (%)	χ^2	p-value
Extent of deformation (ambulance)					
None	8 (2.4%)	5 (62.5%)	3 (37.5%)		
Minor	26 (7.8%)	13 (50.0%)	13 (50.0%)		
Moderate (functional)	84 (25.2%)	29 (34.5%)	55 (65.5%)		
Severe (disabling)	215 (64.6%)	86 (40.0%)	129 (60.0%)		
TOTAL	333 (100.0%)	133 (39.9%)	200 (60.1%)	3.822	0.281
Number killed in crash					
1	285 (84.1%)	111 (39.0%)	174 (61.1%)		
2	45 (13.3%)	20 (44.4%)	25 (55.6%)		
3	6 (1.8%)	3 (50.0%)	3 (50.0%)		
4	3 (0.9%)	3 (100.0%)	0 (0.0%)		
SUMMED TOTAL*	405 (100.0%)	172 (42.5%)	233 (57.5%)	5.210	0.157

*For example, (1 × 285%) + (2 × 45%) + (3 × 6%) + (4 × 3%) = 405.

DISCUSSION

Our analysis of fatal ambulance crash characteristics is consistent with the earlier study by Pirrallo and Swor.[7] This suggests that a crash reduction program aimed at these characteristics should be effective and broadly applicable.

During a time when the number of operating emergency ambulances increased by approximately 8.6%, the number of fatal ambulance crashes decreased by approximately 20.6%. This suggests that the rate of fatal ambulance crashes may be decreasing.

Most crashes and fatalities occurred during EU. Emergency use has been noted as having several characteristics that differ from NEU.[3] Patients transported in an ambulance in EU experience increases in heart rate, respiratory rate, blood pressure, and endocrine function.[13] The stress of EU may extend to the ambulance operator as well. Stressful driving situations have been shown to result in more unsafe vehicle operation, particularly among untrained drivers.[14] Further, several recent studies have questioned the benefit of EU operations, in regard to both time savings and clinical outcomes.[10–13,17]

Intersections are a dangerous site for ambulances. Appropriately, they have been the subject of several interventions from company policies requiring a full stop at all controlled intersections, even during EU, to radio- or strobelight-controlled devices that change stoplights along the ambulance's route to favorable settings. Clearly, intersections, which are the predominant crash location, must remain a focal point of further research efforts to reduce the risk of fatal ambulance crashes.

Although it appears that fatal ambulance crashes share many similarities with fatal general public motor vehicle crashes, fatal crashes involving an ambulance are much more likely to occur at an intersection, at an angle, and with another vehicle. Despite their relatively high center of gravity, ambulances are

TABLE 5. Crash Severity by Vehicle

	Ambulance, *n* (%)	Other Vehicle, *n* (%)
Number injured		
0	85 (25.1%)	202 (59.6%)
1	50 (14.7%)	90 (26.5%)
2	117 (34.5%)	24 (7.1%)
3	56 (16.5%)	10 (2.9%)
4	18 (5.3%)	6 (1.8%)
5	10 (2.9%)	2 (0.6%)
6	3 (0.9%)	0 (0.0%)
7–11	0 (0.0%)	5 (1.5%)
Summed total*	592 (100.0%)	246 (100.0%)
Number killed		
0	266 (78.5%)	61 (18.0%)
1	59 (17.4%)	244 (72.0%)
2	12 (3.5%)	31 (9.1%)
3	2 (0.6%)	2 (0.6%)
4	0 (0.0%)	1 (0.3%)
Summed total	89 (100.0%)	316 (100.0%)

*See Table 4 for example of summed total.

no more likely than the general public motor vehicle to produce a fatal rollover.

We were surprised to note the high prevalence of prior citations among drivers of ambulances involved in fatal crashes. In fact, it was nearly identical to that of the general public sample of fatal crashes. Furthermore, a similar proportion of ambulance drivers were cited following a fatal crash. Keeping in mind the EMS system's obligation to public safety, it is reasonable to require a higher level of competence for ambulance operators compared with the general public. Although all states require certification or licensure for ambulance operators, many are unfamiliar with the laws of their own state.[18] This raises important questions as to the level of ambulance driver training.

Several cases demonstrate the possible influence of a poor driving history and underscore the importance of driver background checks for ambulance operators:

- New Jersey, 1987. An ambulance makes a U-turn while operating in emergency mode at 3 PM. In doing so, it sideswipes another vehicle. The driver, who is alone in the ambulance, is uninjured. One occupant in the other vehicle is killed and another suffers moderate injuries. The driver, with a prior record of one crash, one suspension, and two DWIs, is charged with reckless driving.

TABLE 6. Driving History (Ambulance Operators)

	Total, *n* (%)	Nonemergency Use, *n* (%)	Emergency Use, *n* (%)	χ^2	p-value
Violation charged in crash					
No	284 (83.8%)	116 (40.8%)	168 (59.2%)		
Yes	55 (16.2%)	21 (38.2%)	34 (61.8%)		
TOTAL	339 (100.0%)	137 (40.4%)	202 (59.6%)	5.022	0.541
Prior crashes					
No	256 (77.8%)	99 (38.7%)	157 (61.3%)		
Yes	73 (22.2%)	34 (46.6%)	39 (53.4%)		
TOTAL	329 (100.0%)	133 (40.4%)	196 (59.6%)	1.473	0.225
Prior suspensions					
No	308 (92.2%)	119 (38.6%)	189 (61.4%)		
Yes	26 (7.8%)	16 (61.5%)	10 (38.5%)		
TOTAL	334 (100.0%)	135 (40.4%)	199 (59.6%)	5.222	0.022
Prior DWIs					
No	331 (99.1%)	134 (40.5%)	197 (59.5%)		
Yes	3 (0.9%)	1 (33.3%)	2 (66.7%)		
TOTAL	334 (100.0%)	135 (40.4%)	199 (59.6%)	0.063	0.802
Prior speeding					
No	272 (81.4%)	104 (38.2%)	168 (61.8%)		
Yes	62 (18.6%)	31 (50.0%)	31 (50.0%)		
TOTAL	334 (100.0%)	135 (40.4%)	199 (59.6%)	2.902	0.088
Prior other motor vehicle convictions					
No	299 (89.5%)	116 (38.8%)	183 (61.2%)		
Yes	35 (10.5%)	19 (54.3%)	16 (45.7%)		
TOTAL	334 (100.0%)	135 (40.4%)	199 (59.6%)	3.122	0.077
High-risk driver*					
No	195 (59.3%)	67 (34.4%)	128 (65.6%)		
Yes	134 (40.7%)	66 (49.3%)	68 (50.8%)		
TOTAL	329 (100.0%)	133 (40.4%)	196 (59.6%)	7.316	0.007

*Defined as a driver with one or more prior crashes or legal actions.

- New York, 1990. On a straight, dry road at dusk, an emergency-mode ambulance strikes and kills one pedestrian and moderately injures another. The driver has one prior crash, 11 prior suspensions, one prior speeding conviction, and one prior other motor vehicle conviction, and is charged with driving with a suspended or revoked license.
- Kentucky, 1991. An ambulance overturns at noon on a rain-slicked curve while operating in nonemergency mode. Three occupants are injured. The fourth, traveling in a rear compartment child safety seat, is killed. The driver has a record of three prior suspensions and one DWI.
- Georgia, 1996. While traveling in nonemergency mode, an ambulance strikes another vehicle at an angle on a curved road. The ambulance occupants sustain moderate injuries. Three occupants of the other vehicle are injured and another is killed. The driver of the ambulance has one prior crash and one prior suspension, and is charged with using alcohol or drugs while speeding.

TABLE 7. Restraint Odds Ratios (ORs)—Ambulance

Occupant Type	Fatal/Severe Injury *n* (%)	Minor/No Injury *n* (%)
Rear vs front		
Rear	138 (38.9%)	217 (61.1%)
Front	102 (18.8%)	440 (81.2%)
OR (95% CI)	2.7 (2.0–3.7)	
Unrestrained* vs properly restrained		
Unrestrained*	172 (35.3%)	316 (64.8%)
Properly restrained	56 (17.6%)	262 (82.4%)
OR (95% CI)	2.5 (1.8–3.6)	
Unrestrained*		
Rear	122 (43.4%)	159 (56.6%)
Front	42 (21.8%)	151 (78.2%)
OR (95% CI)	2.8 (1.8–4.2)	
Properly restrained		
Rear	7 (28.0%)	18 (72.0%)
Front	49 (16.7%)	244 (83.3%)
OR (95% CI)	1.9 (0.8–4.9)	

*Unrestrained or improperly restrained.

TABLE 8. General vs Ambulance Driving History (*n* = Drivers)

	General*, *n* (%)	Ambulance, *n* (%)	χ^2	p-value
Violation charged				
No	48,593 (85.4%)	284 (83.8%)		
Yes	8,327 (14.6%)	55 (16.2%)		
TOTAL	56,920 (100.0%)	339 (100.0%)	0.69	0.408
Prior crashes				
No	44,765 (83.5%)	256 (77.8%)		
Yes	8,815 (16.5%)	73 (22.2%)		
TOTAL	53,580 (100.0%)	329 (100.0%)	7.81	0.005
Prior suspensions				
No	48,288 (88.6%)	308 (92.2%)		
Yes	6,218 (11.4%)	26 (7.8%)		
TOTAL	54,506 (100.0%)	334 (100.0%)	4.32	0.038
Prior DWIs				
No	52,707 (96.7%)	331 (99.1%)		
Yes	1,799 (3.3%)	3 (0.9%)		
TOTAL	54,506 (100.0%)	334 (100.0%)	6.03	0.014
Prior speeding				
No	42,787 (78.5%)	272 (81.4%)		
Yes	11,719 (21.5%)	62 (18.6%)		
TOTAL	54,506 (100.0%)	334 (100.0%)	1.70	0.193
Prior other motor vehicle convictions				
No	45,424 (83.3%)	299 (89.5%)		
Yes	9,082 (16.7%)	35 (10.5%)		
TOTAL	54,506 (100.0%)	334 (100.0%)	9.16	0.002
High-risk driver†				
No	31,211 (57.3%)	195 (59.3%)		
Yes	23,295 (42.7%)	134 (40.7%)		
TOTAL	54,506 (100.0%)	329 (100.0%)	0.54	0.463

*General data are for 1997 only.

†Defined as a driver with one or more prior crashes or legal actions.

TABLE 9. General vs Ambulance Crash Configuration (n = Crashes)

	General*, n (%)	Ambulance, n (%)	χ^2	p-value
Collisions				
Single motor vehicle	21,742 (58.3%)	69 (20.4%)		
Other crash configuration	15,579 (41.7%)	270 (79.6%)		
TOTAL	37,321 (100.0%)	339 (100.0%)	198.01	<0.001
Intersection				
No	28,024 (76.6%)	158 (46.7%)		
Yes	8,552 (23.4%)	180 (53.3%)		
TOTAL	36,576 (100.0%)	338 (100.0%)	165.49	<0.001
Rollover				
No	46,911 (82.4%)	290 (85.5%)		
Yes	10,009 (17.6%)	49 (14.5%)		
TOTAL	56,920 (100.0%)	339 (100.0%)	2.28	0.131

* General data are for 1997 only.

Background checks to identify drivers who require unique or more rigorous training may help to raise the standard for ambulance operator competence. An agency-based system of graduated driving privileges from scheduled NEU transport driving graduating to 911 call EU, similar in concept to the graduated driving license programs in many states, may provide an additional measure of protection.

The ORs for rear compartment vs front compartment injuries revealed that rear compartment occupants faced a significantly higher risk of serious injury or death, although this risk appears to decrease when adjustment is made for proper restraints; front compartment occupants are more likely to be properly restrained.[19] Further study is indicated to determine the reason for this higher risk. Possible factors may include the failure of rear compartment restraints to properly address the orientation of rear occupants, who often are facing sideways or backwards, the presence of unattached objects that may be thrown about the compartment during a crash, rear compartment design, and the paucity of formal crash testing and restraint requirements for emergency vehicles.[20,21]

Our study is subject to several limitations. The FARS database collects limited data on ambulances. We could not, for example, distinguish between public and private ambulances, volunteer and paid ambulances, or body types of ambulances (e.g., type I vs type III). Also, FARS does not specify whether the injured ambulance occupant was a crew member, a passenger, or a patient, or, indeed, whether a patient was even on board at the time of the crash. In addition, it cannot be determined from FARS whether the crash occurred during a call or, if so, during which segment of the call—en route to the incident scene or to the hospital. These limitations restrict the capacity to apply our findings to all EMS systems designs. Another limitation is the lack of exposure data for both ambulances and the general public motor vehicle sample. Without knowing the amount of miles driven, it is impossible to compare incidence rates for fatal ambulance crashes during EU and NEU. The crude rate model derived from the census population data is appropriate for determining and comparing overall fatal crash rates, but cannot completely substitute for miles-driven exposure data.

An additional limitation to this study concerns the driver history data. Although the data are accurate, they are not broken down into occupational and nonoccupational driving history. This prevents a determination of prior ambulance operator history.

Finally, not all states responded to our query. Of those that did, only half provided data for both years. Many states reported that they are unable to provide these data due to insufficient information systems.

CONCLUSION

Ambulances were usually the striking vehicles in fatal collisions, regardless of emergency use status. Most crashes and fatalities occurred during emergency use and at intersections. The greatest burden of serious injury and death fell upon persons not in the ambulance. Rear compartment occupants of the ambulances were more likely to be injured or killed than those traveling in the front compartment. Many ambulance operators in fatal crashes had poor driving histories. Fatal ambulance crash and injury reduction programs should address better control of intersections, screening to identify high-risk drivers, appropriate restraint use, and possible design modifications of the rear compartment.

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