The Wake Effect— Emergency Vehicle–Related Collisions

Jeff J. Clawson, MD;[1] Robert L. Martin;[2] Geoff A. Cady, REMT-P;[3] Ronald F. Maio, DO[4]

1. Medical Director, Gold Cross Ambulance and Medical Priority Consultants, Salt Lake City, Utah USA
2. Executive Director, National Academy of Emergency Medical Dispatch, Salt Lake City, Utah USA
3. EMS Consultant, Medical Priority Consultants, Salt Lake City, Utah USA
4. Assistant Professor, Department of Emergency Medicine, University of Michigan, Ann Arbor, Michigan USA

Correspondence: Jeff J. Clawson, MD
Medical Director
Gold Cross Ambulance and Medical Priority Consultants
139 East South Temple, Suite #500
Salt Lake City, UT 84111 USA

Key Words: ambulance accidents; collisions; crashes; emergency medical vehicle collisions (EMVCs); fatal accident reporting system (FARS); lights and siren (L&S); wake effect

Abbreviations:
EMVCs = emergency medical vehicle collisions
EMVs = emergency medical vehicle
FARS = fatal accident reporting system
L&S = lights and siren

Date Received: 29 April 1996
Accepted: 08 August 1996
Revisions received: 10 February 1997

Abstract

Introduction: *Emergency medical vehicle collisions (EMVCs) occurring during initial response and with patient transport have been a long-standing problem for emergency medical services (EMS) systems. Experience suggests "wake- effect" collisions occur as a result of an EMS vehicle's transit, but do not involve the emergency medical vehicle (EMV). Substantiating the existence and magnitude of wake-effect collisions may have major implications regarding the manner of EMV response.*

Hypothesis: *Paramedics will report that wake-effect collisions do occur and that they occur more frequently than do EMVCs.*

Methods: *Design: Survey analysis. Participants: Thirty paramedics employed by the Salt Lake City (Utah) Fire Department and 45 paramedics employed by Salt Lake County Fire Department. Geographic Area: Service area has population of 650,000 and is urban, suburban, and rural. Measurements: The survey consisted of three open-ended questions concerning years on the job, EMVCs, and wake-effect collisions. Analysis: The mean value for the number of EMVCs and wake-effect collisions, along with the 0.95 confidence intervals (0.95 CI) were determined.*

Results: *Seventy-three surveys were analyzed. Sixty EMVCs and 255 wake-effect collisions were reported. Overall, the mean value for the number EMVCs per respondent was 0.82 (0.60–1.05) and for wake-effect collisions, 3.49 (2.42–4.55). The mean values for EMVCs for each service were 0.86 (0.50–1.38) and 0.80 (0.50–11.0). For wake-effect collisions, the mean values were 4.59 (2.83–6.35) and 2.76 (1.46–4.06) respectively.*

Conclusions: *This study suggests that the wake-effect collision is real and may occur with greater frequency than do EMVCs. Significant limitations of this study are recall bias and misclassification bias. Future studies are needed to define more precisely wake-effect collision prevalence and the resulting "cost" in regards to injury and vehicle/property damage.*

Clawson JJ, Martin RL, Cady GA, Maio RF: The wake effect—Emergency vehicle-related collisions. ***Prehospital and Disaster Medicine*** **1997;12(4):pages to be determined.**

Introduction

Emergency medical vehicle collisions (EMVCs) occurring during lights-and-siren (L&S) response, pursuit, or transport are a curse on public safety and often are publicized and criticized in the media.[1–3] In addition, many collisions result in significant damage, serious injury, or death and provoke lawsuits and public outrage.[4–6] An increased sense of awareness of the problem has resulted in industry-wide introspection regarding the ethics of these dilemmas.[7–10] While the number of lights and siren discussions are growing, little has been done by the emergency medical services community (at large) to study this issue.[11–12] In 1985, James O. Page, reflecting on what appeared to be an industry-wide attitude regarding emergency medical vehicle collisions (EMVCs), stated that, "For some reason, most of us don't like to talk about ambulance vehicle accidents–even though most of them are preventable."[13]

Because EMVC reporting systems in most places are fragmented or non-existent, vehicle collisions involving EMS vehicles responding or transporting lights and siren in the United States or Canada are impossible to quantify.[14] However, significant data regarding some types of EMVCs, do exist, and this phenomenon is receiving increased attention in the EMS literature.[15–18] In 1994, the National Association of EMS Physicians published its position paper:

	Salt Lake City Fire Dept.	Salt Lake County Fire Dept.	Total
Overall Reported EMVCs	25	35	60
Overall Reported Wake Effects	133	122	255
Mean Individual EMVCs	0.86 (1.38–0.50)	0.80 (1.10–0.50)	0.82 (1.05–0.60)
Mean Individual Wake Effects:	4.59 (6.35–2.83)	2.76 (4.06–1.46)	3.49 (4.55–2.42)

Table 1—Descriptive statistics overall and by fire service; mean values are expressed as mean (95% confidence interval))

Use of Warning Lights & Siren in Emergency Medical Vehicle Response and Patient Transport. It established a series of positions and recommendations regarding the emergency operation of EMS vehicles. In 1987, Auerbach reported on 102 ambulance collisions that occurred during a three and one-half year period in Tennessee.[19] More recently, Elling studied 1,412 EMVCs over four years in New York state,[20] and Sharpe described 250 EMVCs for three years in Alberta, Canada.[21] The government estimate by the U.S. National Safety Coun-cil's system reported an estimated 2,400 ambulance and 5,400 fire apparatus collisions in 1990.[22]

Various EMS and insurance industry experts estimate that the number of EMVCs could approach 12,000 in a given year.[23,24] The cost of EMVCs is estimated to be in the millions of dollars and constitute the greatest cause of monetary liability loss in EMS, far eclipsing the loss due to malpractice by emergency medical technicians and paramedics. Their efforts to define the scope of this problem are only quasi-scientific, which for some, raises doubts about the validity of these numbers or their significance. A few have suggested (without supporting data) that the frequency of EMVCs in traffic is the same as is that for the non-emergency general public. However, Saunders et al reported that ambulance collision involvements per one 100,000,000 miles traveled was 3,548 nationally compared to 24,494 in San Francisco's urban environment. Understanding the potential scope and effects of EMVC occurrences may create a new awareness of this dilemma and, as a result, redefine its relative priority as an EMS-related problem.

More than 10 years ago, the authors suggested that, in addition to EMVCs, there is an emergency roadway accident phenomenon that might redefine the actual scope of effects caused by lights and siren responses and transports. Such collisions initially were dubbed "wake-effect" accidents, since they appeared to be *caused* by the passage of the emergency vehicle but did not actually *involve* the emergency vehicle.[25] If this phenomenon does occur, it would add to the potential damage caused by EMVs during lights and siren responses and transports.

Anecdotally, discussions with EMS responders at conferences and via telephone interviews revealed that the wake-effect phenomenon does exist. Most EMS responders could recollect witnessing at least one such incident. The extent of the wake-effect phenomenon forms the hypothesis of this study. In light of the absence of data to quantify the actual numbers of wake-effect collisions and their connection to EMVCs, the objectives of this study were to verify the existence of wake-effect collisions as well as to determine their relative frequency compared to reported numbers of EMVCs. This hypothesis proposes that the impact of EMVCs is understated, since it does not include the wake-effect phenomenon.

Methods

All paramedics employed by the Salt Lake City and Salt Lake County Fire Departments were surveyed using a written questionnaire. At the time of the survey, there were 30 paramedics employed with the Salt Lake City Fire Department and 45 employed with the Salt Lake County Fire Department. These paramedics served a population of approximately 650,000 during the study period. Each paramedic was queried regarding his or her number of years as an emergency medical technician (EMT) or paramedic, as well as the number of EMVCs and wake-effect collisions they recalled.

Although the completion of the survey was voluntary, through the assistance of the Utah Paramedic Association, 100% of the surveys were returned. A computer database program and spreadsheet were used to sort and analyze the survey data (Paradox for Windows 5.0, Borland, International, Scotts Valley, CA USA).

Results

All of the paramedics who received the survey responded (75/75; 100%). Two surveys were eliminated from the study because of incomplete data, leaving a sample size of 73 respondents: 29 from Salt Lake City and 44 from the Salt Lake County. The total number of actual emergency medical vehicle collisions in the sample set was 60, with the Salt Lake City paramedics reporting 25 and Salt Lake County reporting 35 (Table 1). Compar-atively, the total number of EMV-related, wake-effect collisions reported was 255: 133 by Salt Lake City and 122 by Salt Lake County. These data produce in a ratio of 1:4.25 EMVCs to wake-effect collisions for all of the paramedics in the two service areas. The urban respondents had a ratio of 1:5.3 compared to 1:3.5 for suburban/rural respondents.

The paramedics had an average of 8.1 years experience as EMS responders Salt Lake City respondents had an average of 9.2 years compared to 7.4 years for those employed by Salt Lake County. Experience levels ranged from a minimum of three to a maximum of 12 years.

Of the 73 respondents, 78% (57) reported either being involved in an EMVC personally or witnessing at least one wake-effect collision. Of that group, 55% (40) reported wake-effect collisions as occurring more frequently than actual EMVCs: 4% (3) reported that wake-effect collisions occurred in equal numbers to EMVCs; 19% (14) indicated that these collisions occurred less often than did actual EMVCs; and 22% (16) did not report either.

The mean value for the number of EMVCs per polled paramedic was 0.82 (0.86 among Salt Lake City personnel, and 0.80 for Salt Lake County personnel). This is compared to the mean value for the number of reported wake-effect collisions per polled paramedic of 3.49, with 4.59 and 2.76 in Salt Lake City and Salt Lake County respectively.

Discussion

The results validate the occurrence of wake-effect collisions and report their frequency relative to actual EMVCs. The subsequent finding that possibly there occur five times more wake-effect collisions than actual EMVCs is the antithesis of the most basic premise of medical care: "First, do no harm." Although the seriousness of wake-effect collisions was not determined in this study, even small, fender-bender collisions without injuries have other community and economic repercussions that should be considered in evaluating the costs and benefits of an lights and siren policy.

The location of the reported EMVCs and the associated wake-effect collisions were not studied nor were the prevailing weather conditions, surface street conditions, or time of the day. Auerbach reported that half of the crashes studied in Tennessee occurred at intersections, while Elling indicated that 70% of EMVCs in New York state happened on the roadway at intersections. The location of wake-effect collisions also may be important to determine. For example, do they occur more frequently at intersections, on the open roadway, or by veering off the road and striking other objects? Do they occur more frequently during response to or transport from an emergency scene? Such data could provide insight as to the causative nature of these collisions.

It should be added that no professional avoidance, low-force, or other nationally recognized driver training programs were employed by either department participating in the study during or before the term covered by the survey. Also, no automated system of traffic-light control was in use in the Salt Lake metropolitan area. These facts bring up questions of whether different types of vehicles, colors of vehicles, warning devices, or training for drivers may affect the occurrence or frequency of wake-effect collisions or, more interestingly, affect them in a way different from their effects on direct EMVCs.

The apparent presence of a wake-effect phenomenon expands understanding of the potential harm that can occur while using lights and siren as warning devices to reduce response times. The National Association of Emergency Medical Services Physicians' position, paper states that protocols for lights and siren use "should be based on a reasonable identification of situations for which a reduction in response and transport times might improve patient outcome," emphasizes the importance of applying logical medical rationale to this relatively uncharted territory of public safety decision-making.

This study establishes a preliminary relationship of EMVCs to wake-effect collisions, but is limited in its ability to quantify these relationships. Definitions of the relationships need to be determined and implemented in police reporting systems as a significant step toward quantifying these incidents. A well-designed, long-term, prospective study should involve law enforcement orientation and consistent reporting of wake-effect incidents.

While this study only involved EMS-related collisions, it is reasonable to assume that some form of wake-effect phenomena may occur as the result of fire-suppression response as well as police response or pursuit. To date, no "blame" or responsibility for such collisions has been placed on the EMS system. In discussions with responders, the blame for EMVCs is routinely placed on the public's failure to clear a path or to look for the emergency vehicle. The use of lights and siren only requests right-of-way, but does not grant right-of-way privilege, and any effort to reduce the number of EMVCs and wake-effect collisions cannot succeed if reeducating the entire population of cities, states, provinces, or nations continues to be entertained as a possible solution to these dilemmas.

Limitations

This study did not determine if EMVCs or wake-effect collisions actually occur, but rather relied on the respondents' recollections of these occurrences. Significant recall bias may exist based on the nature or severity of the crash. The authors speculate that respondents would be more likely to remember EMVCs and also more serious crashes. However, there are no data to support this speculation, nor can the relative magnitude of bias effect for type of crash compared to severity of crash be determined. The assumption is that recall bias would favor EMVC reporting and could result in an underestimation of wake- effect collisions. Misclassification bias is also a concern.

No standard definition of wake-effect collisions has been developed or validated, nor have the parameters used to classify a wake-effect collision been developed and validated. It is possible that there exists significant variations between respondents as to defining a wake-effect collision. This could constitute significant limitations to both internal an external validity of this study.

However, the similarity of mean values for wake-effect collisions among fire services, combined with overlapping of the 95% confidence intervals suggest that the concept of a wake-effect collision can be determined with some reliability. Further studies are needed to support this interpretation.

Also of concern is the difficulty in determining how many of the emergency medical vehicle collisions and wake-effect collisions are unique events. For instance, the 60 emergency medical vehicle collisions reported in this study actually may represent 30 specific crashes due to dual reporting when two (or more) EMS personnel are involved in or co-witness to an accident. The magnitude of this effect could vary between emergency medical vehicle and wake-effect collisions.

It is not known if reported wake-effect collisions actually were caused or affected by the responding emergency medical vehicle. It is possible they merely occurred coincidentally. Likewise, it is not known how many wake-effect collisions might have escaped notice. Observational differences may exist between response and transport due to the different positions of the personnel within the vehicle and their relative ability to see around and behind the emergency medical vehicle. Therefore, these data cannot be used to estimate the exact number of wake-effect collisions occurring in the study area or nationwide.

It also is not clear whether the reported emergency medical vehicle collisions occurred during a lights and siren or non-lights and siren transit mode. However, at the time of this study, it was blanket policy for all Salt Lake City and Salt Lake County fire department vehicles to respond lights and siren to emergency scenes. No accurate statement regarding travel mode can be made for transport-related incidents.

Conclusion

The results of this study support the hypothesis that a wake-effect collision phenomenon exists and that it has a measurable impact. Given the introduction of this information regarding the potential extent of wake-effect collisions, more attention to and study of the cause-and-effect relationships between EMS systems' response policies should be undertaken. Awareness of the wake-effect phenomenon also should be cause for increased focus on the methods of driving emergency medical vehicles through traffic. The implications of this study suggest that further evaluation of lights and siren use as effective warning devices and benefits of their use in comparison to wake-effect costs to society be undertaken. Furthermore, responsibility for and acknowledgment of the potential negative effects of lights and siren EMS response within a community must be addressed more professionally and openly.

The presence of the wake effect, at minimum, should increase an EMS system's responsibility to assure a more measured and professional response and transport role within the community it serves. It also reveals added potential liability to the EMS system, especially when considering the unnecessary or inappropriate use of warning lights-and-siren within the context of improving medical care and patient outcome.

In acknowledging the existence of wake effect collisions as the apparent result of emergency medical responses, the potential "price" of both initial response and patient transport now must be multiplied by a wake-effect factor to obtain the societal cost of lights and siren responses. Perhaps lyricist Billy Joel, in his appropriately titled hit song "Don't Ask Me Why," was calling to the EMS community about the wake-effect problem when he sang, "You are still a victim of the accidents you leave."[26]

Acknowledgments

Special thanks to the Utah Paramedic Association, John Zimmerman, MD, formerly of the Salt Lake City Fire Department and Ron Palmer, MSW, of the Salt Lake County Fire Department.

References

1. Safety & Risk Management Information Update. Management Focus 1993;9:4.
2. Chicago-fewer "follow that car" orders expected. *USA Today 1984;May 7.*
3. Clawson JJ: Running hot and the case of Sharron Rose. *Journal of Emergency Medical Service* 1991;16:11–13.
4. Caldwell LH: Hard lessons. *Fire Command* 1990;84:20–21.
5. Wallace Nelson, as *guardian ad lietem* for Amanda Nelson, v. USA, Case.
6. George JE, Quattrone MS: Above all-do no harm. *EMT Legal Bulletin* 1991;15:2–6.
7. Leonard WH: What a waste when the system fails. *Ambulance Industry Journal* 1991;12:38–40.
8. Wolfberg D: Lights and siren and liability. *Journal of Emergency Medical Services* 1996;12:38–40.
9. Page JO: Waking primal instinct. *Journal of Emergency Medical Services* 1993;9:18:7.
10. Meijer JE: About speed. *Journal of Emergency Medical Services* 1981;6:9.
11. National Association of Emergency Medical Physicians (NAEMSP): Position Paper: Use of warning lights and siren in emergency medical vehicle response and patient transport. *Prehospital and Disaster Medicine* 1994;9:133–135.
12. De Lorenzo RA, Eilers MA: Lights and siren: A review of emergency vehicle warning systems. *Ann of Emerg Med* 1991;20:13310–13314.
13. Page JO: EMS legal primer. *JEMS Publishing Co. Inc.*, 1985.p 2.
14. Blades K: EMVAs-A tragic but preventable paradox. *Canadian Emergency News* 1990;13:14–16.
15. Saunders CE: Ambulance collisions in an urban environment. *Prehospital and Disaster Medicine* 1994;9:133–135.
16. Pirrallo RG, Swor RA: Characteristics of fatal ambulance crashes during emergency and non-emergency operation. *Prehospital and Disaster Medicine* 1994;9:125–132.
17. Kupas D, Julla D, Pino B :Patient outcome using medical protocol to limit "red lights and siren" transport. *Prehospital and Disaster Medicine* 1994;9:226–229.
18. Hunt RC, Brown LH, Cabinum ES, Whitley TW, Prasad NH, Owens CF Jr., Mayo CE Jr.,: Is ambulance transport time with lights and siren faster than without? *Ann Emerg Med* 1995;25:507–511.
19. Auerbach PS, Morris JA, Phillips JB Jr., et al.: An analysis of ambulance accidents in Tennessee. *JAMA* 1987;258:1487–1490.
20. Elling R: Dispelling myths on ambulance accidents. *Journal of Emergency Medical Services* 1898;11:60–64.
21. Sharp D: Ambulance fatality accidents. *Research Paper Presentation—Canadian Interphase* 1990 (Research Award Recipient).
22. National Safety Council: Emergency vehicles involved in accidents. Accident Facts, 1990:79.
23. Forry S: *written communication*, September 3, 1996
24. Leonard B: *written communication*, September 10, 1996
25. Clawson JJ: Hit or myth. *Journal of Emergency Medical Services* 1989;14:8.
26. Joel Billy: Don't Ask Me Why. *Impulsive Music and April Music* (ASCAP), 1980.