Do Warning Lights and Sirens Reduce Ambulance Response Times?

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Abstract

Objective. To determine the time saving associated with lights and siren (L&S) use during emergency response in an urban EMS system. **Methods.** This prospective study evaluated ambulance response times from the location at time of dispatch to the scene of an emergency in an urban area. A control group of responses using L&S was compared with an experimental group that did not use L&S. An observer was assigned to ride along with ambulance crews and record actual times for all L&S responses. At a later date, an observer and an off-duty paramedic in an identical ambulance retraced the route—at the same time of day on the same day of the week—without using L&S and recorded the travel time. Response times for the two groups were compared using paired t-test. **Results.** The 32 responses with L&S averaged 105.8 seconds (1 minute, 46 seconds) faster than those without (95% confidence interval: 60.2 to 151.5 seconds, $p = 0.0001$). The time difference ranged from 425 seconds (7 minutes, 5 seconds) faster with L&S to 210 seconds (3 minutes, 30 seconds) slower with L&S. **Conclusion.** In this urban EMS system, L&S reduce ambulance response times by an average of 1 minute, 46 seconds. Although statistically significant, this time saving is likely to be clinically relevant in only a very few cases. A large-scale multicenter L&S trial may help address this issue on a national level. **Key words:** emergency medical services; transportation of patients; ambulances; lights and sirens.

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The use of emergency lights and sirens (L&S) predates modern EMS by at least 50 years.[1,2] Recent studies have examined the relative benefits and risks associated with L&S use,[3–10] but there is still no national consensus on the topic. Generally, individual EMS systems develop their own L&S policies, often in the absence of any objective data to guide those efforts. In an attempt to help guide decision makers, the National Association of EMS Physicians and the National Association of State EMS Directors issued a joint position paper on L&S use in 1994. One part of that position paper called for "scientific studies evaluating the effectiveness of warning L&S. . . ."[2]

This study was conducted to determine the time saving associated with L&S use during emergency response in an urban EMS system. The hypothesis was that response times for ambulances using L&S would not differ significantly from those of ambulances not using L&S.

Materials and Methods

Design

This was a prospective study evaluating the time for ambulance response from the location at the time of dispatch to the scene of an emergency. Response times for a control group of ambulances that responded with L&S were compared with those of an experimental group that did not.

Population and Setting

This study was conducted in Syracuse, New York, a northeastern city with a population of about 170,000. Emergency medical services EMS in the city are provided by a single private service. The service responds to approximately 40,000 calls per year, and ambulances are dispatched using the Medical Priority Dispatch system (Medical Priority, Salt Lake City, UT).

Experimental Protocol and Measurements

The design of this study was similar to that previously used for a study in Greenville, North Carolina, examining ambulance transport times.[4] To obtain the control L&S data, an observer was assigned to ride along with ambulance crews for a two-week period. This observer used a digital stopwatch to obtain the actual response time—defined as wheels rolling to wheels stopped—for all L&S responses. The times were recorded to the nearest whole second. For each call, the observer also recorded the route used during the response by highlighting a city map. The day of week, time of day, road conditions, weather conditions, and lighting conditions were all recorded, as well. All of the drivers were aware of the study and of the purpose of the observer.

For the experimental, non-L&S data, a different observer was assigned to ride along with an off-duty paramedic in an ambulance identical to those used for the control responses. Drivers for the experimental runs were regular full-time field-level employees of the ambulance provider. The non-L&S responses were performed on the same day of the week, at the same time

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of day (± 5 minutes) following the exact same routes as used for the control responses. The drivers for the non-L&S responses were shown the highlighted maps, and told to travel the same route, obeying the speed limit, traffic laws, and traffic signs. The times were, again, recorded using a digital stopwatch.

Calls were excluded if any major traffic-altering event, such as road construction or a train stopped at a crossing, was encountered on either the control or the experimental response. Calls involving multiple agencies or multiple vehicle response were also excluded to avoid any confounding of the data by a "wake effect."

Analytical Methods

Because the ambulance routes were identical and the time of day and day of week were matched, mean response times of ambulances with and without L&S were compared using paired t-test. An alpha level of 0.05 was used to determine statistical significance.

Sample Size Determination

A prestudy power calculation indicated that 32 paired trials would result in a power of 0.80 to detect a 1-minute difference in response times, with a standard deviation of 90 seconds.

Human Subjects

The chair of the Institutional Review Board (IRB) for the Protection of Human Subjects approved the study as exempt from full IRB review.

RESULTS

Eleven crews and 17 different drivers were involved in the control L&S responses, and five drivers were involved in the experimental non-L&S responses. There was no difference in the experience of the two groups of drivers, with 5.3 ± 7.5 and 5.2 ± 4.3 years of local driving experience, respectively.

The mean and range of the response times for each group are shown in Table 1. The 32 responses with L&S averaged 105.8 seconds (1 minute, 46 seconds) faster than those without (95% confidence interval: 60.2 to 151.5 seconds; $p = 0.0001$). The time difference ranged from 425 seconds (7 minutes, 5 seconds) faster with L&S to 210 seconds (3 minutes, 30 seconds) slower with L&S. The data for all 32 pairs of responses are shown in Figure 1.

All of the calls for this study occurred on weekdays between the hours of 0900 and 1800. Emergency lights were used continuously for all of the control (L&S) responses; sirens were used continuously during 19 (59.4%) and intermittently during 13 (40.6%) of these control responses. The lighting, weather, and road conditions for the responses in both groups are shown in Table 2.

TABLE 1. Mean (± SD) and Range of Response Times, in Seconds

Type of Transport	Mean ± SD	Range
L&S*	292.8 ± 163.2	58–643
Non-L&S	398.7 ± 249.1	51–1,015

*L&S = lights and sirens.

DISCUSSION

The use of L&S on ambulances is founded in historical precedence, not science.[1,2] In fact, flashing red lights and sirens are known to be limited as warning devices.[1] In Syracuse, New York, ambulances using L&S siren will arrive, on average, about 1 minute, 46 seconds sooner than ambulances not using lights and siren. Although this difference in response times is statistically significant, the clinical importance of a less-than-2-minute time saving is questionable. With the obvious exceptions of patients requiring defibrillation or clearing of an obstructed airway, there are few EMS cases in which such small time differences are likely to affect patient outcome.

The time difference associated with L&S use in this system is greater than that found in Greenville, North Carolina.[4] In that system, ambulance transport times were only 43.5 seconds faster when using L&S. That study addressed only ambulance transport, not response. Time savings are likely to be even less critical in that situation, especially if paramedic-level care is available during transport. Kupas et al. demonstrated that transport without L&S is, indeed, safe for most medical patients,[5] and Lacher and Bausher reported that 39.4% of L&S transports for pediatric patients are inappropriate.[11] Interestingly, the EMS system in Syracuse has already moved away from L&S transport, with only about 1% of their calls resulting in L&S transport.

The time difference found in this system is less than that described by Ho and Casey in a Hennepin County, Minnesota, study.[6] That study found a mean time saving of 3.02 minutes with L&S response. Those authors believed that the 3-minute time savings in their system would be clinically significant. In that study, the authors used a "chase vehicle" that performed the experimental non-L&S runs by following the dispatched ambulance. That methodology may have limitations. Drivers are likely to respond to ambulances differently than to chase vehicles, even if the chase vehicle has similar markings. Also, as the authors pointed out, the chase vehicle was subjected to the wake effect of the ambulance, and that may have contributed to the difference in times.

How much time saving is clinically relevant—and for which patients—has never been prospectively studied; and there is no expert consensus on L&S time saving and clinical relevance. There are also no data about the lay public's perceptions, or expectations,

TABLE 2. Conditions during Responses

	L&S*	Non-L&S
Lighting		
Daylight	32 (100%)	30 (93.8%)
Dusk/dark	0 (0%)	2 (6.2%)
Weather/roads		
Rain/wet	3 (9.4%)	5 (15.6%)
Normal/dry	29 (90.6%)	27 (84.4%)

*L&S = lights and sirens.

about L&S use. There are studies that demonstrate that trained dispatchers using established protocols can determine which calls are most serious and require emergency response.[12–15] As more data about the amount of time L&S actually save become available, the protocols determining which patients get L&S response may be revised. For example, in a two-tiered EMS system, it is unlikely that a 2-minute delay in the second tier would be clinically significant. This is especially true in those systems where first responders are trained in basic airway management and defibrillation.

The discussions and investigations into the value of L&S are not purely academic. The use of L&S poses a grave risk to both the public and emergency personnel. Nearly 70% of fatal ambulance crashes occur during L&S use.[7] Recently, ambulance crashes in three states killed five people in one week's time.[16,17] In 1987, Auerbach et al. reported a three-and-a-half year period in which ambulance collisions in Tennessee injured 29 people. Eighteen people suffered moderate or severe injuries, and one person was killed.[8] A study published in 1994 reported 135 ambulance collisions that injured 20 people in San Francisco during a 27-month period. One was a paramedic who lost three weeks of work.[9] Both the Tennessee and the San Francisco studies suggest that the severity of the injuries suffered in ambulance collisions increases with L&S use.[8,9] These num-

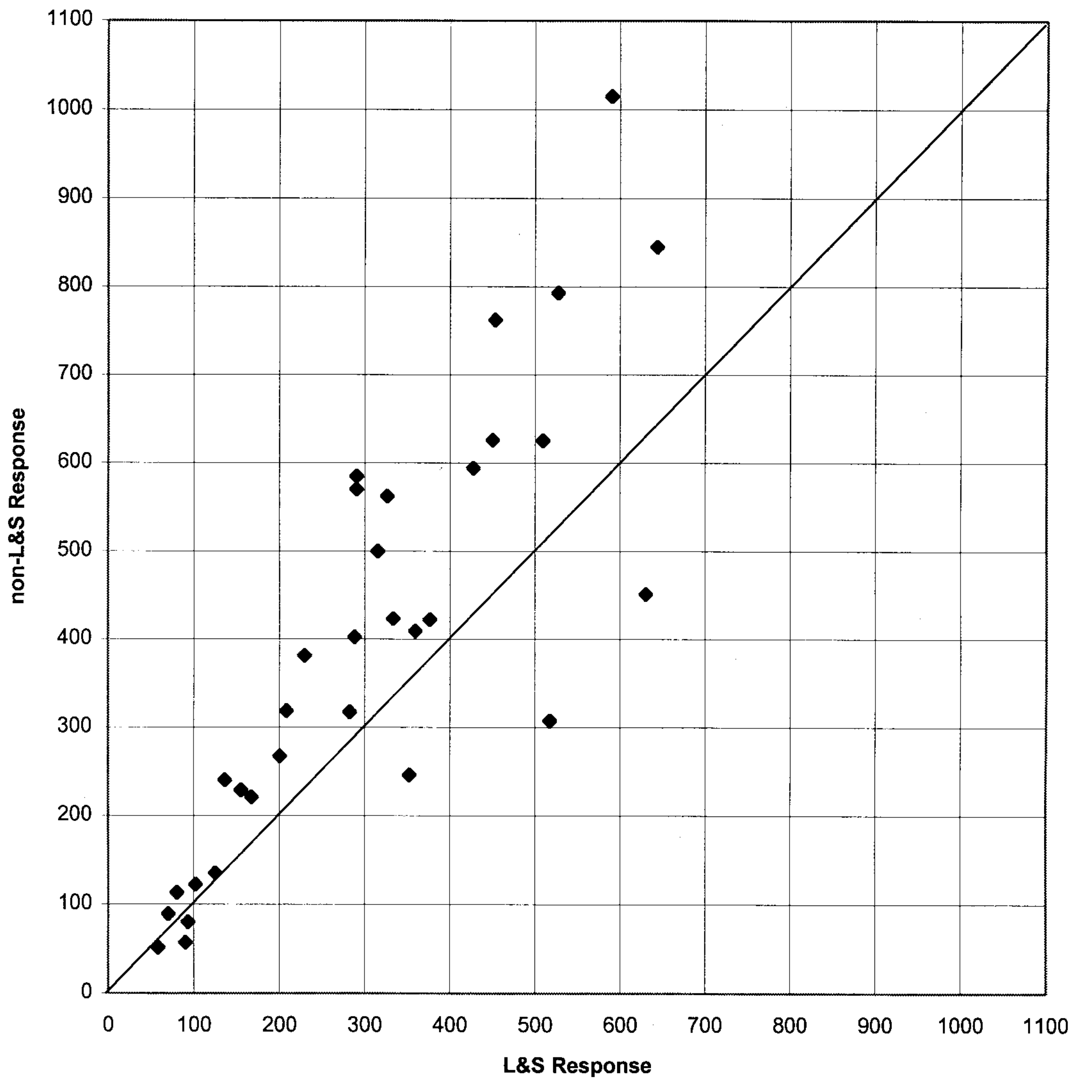

FIGURE 1. Response times (sec). L&S = lights and sirens.

bers do not include the injuries and collisions caused by the wake effect of ambulances, which may occur four times as often as ambulance collisions.[10]

Data about the time savings associated with L&S remain sparse. There have been no published studies about the effectiveness of L&S in extremely large cities, such as Chicago or New York. Nor have there been any published studies about the effectiveness of L&S in extremely rural and remote areas. Indeed, even other cities that are geographically and demographically similar to Greenville, Minneapolis, and Syracuse may find that L&S have a different impact in their systems. The EMS systems that question the applicability of this and other L&S studies to their environment should be encouraged to conduct similar studies in order to determine the impact of L&S in their systems. A large, prospective multicenter L&S study involving several cities with different populations, EMS systems, demographics, and geographies could also make an important contribution to these discussions. Such a study would require considerable cooperation between EMS agencies, professional organizations, associations, private industry, funding sources, and state and federal agencies.

LIMITATIONS

The primary limitation of this study is that the control and experimental responses could not be performed simultaneously. By performing the repeat responses on the same day of the week and at the same time of day, the study was designed to expose the non-L&S responses to the same traffic configurations as encountered during the original L&S response. One weakness of this design is the potential for differences in weather and lighting conditions such as those that occurred in this study. This study was conducted in the fall, when the daylight hours in this community grow shorter and shorter quite quickly. It is also impossible to ensure that traffic patterns were not affected by some other unknown event, such as a half-day for the schools or a closeout sale at a nearby clothing store.

Other studies have attempted to address these concerns by conducting the non-L&S response within a few minutes after the L&S response, as in the study by Ho and Casey.[6] That design assumes that traffic patterns do not change over short periods of time, and that the second vehicle is not affected by the "wake" of the responding ambulance. It also makes it unlikely that the non-L&S response would be faster than the L&S response, since the driver of the non-L&S vehicle would probably elect not to pass the L&S ambulance. In the current study, five of the responses were faster—albeit minimally—without L&S. Although this seems counterintuitive, that intuition is based on the assumption that L&S response is always faster.

Another limitation is that this is a small study. However, a pretrial power calculation indicated that the sample size would be adequate to detect a difference in response times of more than 1 minute, and in fact the study did find such a difference. The study is also limited to responses that occurred during weekday work hours. While these times were chosen based on the availability of the observers, they also represent the times during which traffic in this city is most congested. It remains unclear what the time differences during weekend or evening hours would be.

The distance traveled, the type of call (medical vs trauma), and the patient's condition were not recorded. The purpose of this study was to examine the effect of L&S on the response interval, and not as a function of these other factors. No comment can be made on how the interaction between these factors and L&S use may affect response times.

Finally, the phrase "response time" as used in this study really represents the transit time. Only the controls were true "responses," and other components of the response time (such as from call received to ambulance en route, or from arrival on scene to arrival at the patient's side) were not studied. There was no way to blind the ambulance drivers to the presence of the observer, and the drivers in the non-L&S responses knew they were not responding to actual calls. It is unclear how these issues may have affected the drivers' performances during these responses.

CONCLUSION

Lights and sirens reduce ambulance response times in this urban EMS system by an average of 1 minute, 46 seconds. Although statistically significant, this time saving is likely to be clinically relevant in only a very few cases. All EMS systems should study the effect of L&S within their environment, and a large multicenter L&S trial could help to suggest model policies for EMS L&S utilization on a national basis.

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The case conference format may be used for the presentation of interesting or unusual EMS encounters. This format can illustrate specific medical entities, unusual approaches to field management, or complex administrative issues that a field scenario may present. Authors should pay particular attention to the educational value of the manuscript, and avoid a purely descriptive approach. Features such as a team approach and innovative solutions to atypical problems should be stressed. While an abstract and specific section headings are not required, the following sections should be considered:

1. overal description of the scene, types of responding agencies and personnel, etc.
2. specific challenges encountered
3. solutions developed to address the challenges
4. discussion of medical issues involved, with review of the literature where appropriate
5. discussion of logistic and administrative issues

Title page, group authorship and acknowledgments page, references, and tables and figures (where appropriate) should follow the same format as for general manuscripts (see the "Manuscript Preparation" section of the "Instructions for Authors" following the text of most issues of *Prehospital Emergency Care.*