

The Effect of Emergency Department Crowding on Paramedic Ambulance Availability

Marc Eckstein, MD
Linda S. Chan, PhD

From the Department of Emergency Medicine (Eckstein, Chan) and the Departments of Pediatrics and Surgery (Chan), Keck School of Medicine of the University of Southern California; Los Angeles County + University of Southern California Medical Center; and the Los Angeles Fire Department (Eckstein), Los Angeles, CA.

Study objective: We determine the effect of emergency department (ED) crowding on paramedic ambulance availability.

Methods: This was a prospective longitudinal study from April 2001 through March 2002 in Los Angeles, CA. All incidents in which a Los Angeles Fire Department ambulance was out of service for more than 15 minutes while waiting to transfer a patient because of the lack of open ED beds were captured and analyzed. Data included the total time each ambulance was out of service and the hospital where paramedics were waiting for an open gurney. Analysis was performed to determine weekly and seasonal variations and preponderance at various hospitals.

Results: There were a total of 21,240 incidents in which ambulances were out of service while waiting to transfer their patients to an open ED gurney, which accounted for 1 of every 8 transports. Of these, 8.4% were in excess of 1 hour. The median waiting time per incident was 27 minutes, with an interquartile range of 20 to 40. There was a statistically significant difference in the monthly number of out-of-service incidents during the study ($P < .0001$), with the highest levels during the winter (January through March).

Conclusion: ED crowding has resulted in delays for paramedics waiting to transfer patients. This decrease in ambulance availability may have a significant effect on emergency medical services systems' abilities to provide timely response.

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INTRODUCTION

Emergency department (ED) crowding and diminishing inpatient capacity have received a great deal of attention in the medical literature and the lay press as a nationwide problem.¹⁻⁵ When paramedics transport a patient to a crowded ED, they are often confronted with the unavailability of an empty ED gurney. The paramedics must wait in the ED with their patient on the ambulance stretcher until an ED gurney becomes available. These waits can vary from only a few minutes to several hours. During this time, the paramedic ambulance is out of service to respond to additional calls. When multiple ambulances are out of service, there is a potentially significant negative effect on the ability to provide emergency medical services (EMS) to the community.

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Capsule Summary

What is already known on this topic

Although anecdotally emergency department (ED) crowding is believed to affect ambulance usage and ability, this has not been well documented in large systems.

What question this study addressed

How often paramedic ambulances in Los Angeles were out of service for 15 minutes or more while waiting for an open gurney for an emergency medical services (EMS) patient who had arrived in the ED.

What this study adds to our knowledge

In 1 year, there were 21,240 such delays; 12.5% of all transports. The frequency of delay varied markedly by hospital. The median delay was 27 minutes, and 8% of the delays were 1 hour or longer.

How this might change clinical practice

In this metropolitan area, delayed transfer of EMS patients to ED care due to crowding was frequent and took a sizable proportion of EMS units out of service at any given time.

This study describes the effect of ED crowding on paramedic ambulance availability. Causes of the problem and strategies to mitigate this issue are discussed.

MATERIALS AND METHODS

The Los Angeles Fire Department provides EMS for the 3.8 million residents of the nation's second-largest city.⁶ It has 67 advanced life support ambulances and 31 basic life support ambulances that responded to approximately 270,000 EMS calls in 2002, of which 172,981 (64%) resulted in patient transport to area hospitals. Of these transports, 131,000 (75%) are transported by advanced life support ambulances (staffed by 2 firefighter/paramedics). The remainder of patients are transported by basic life support ambulances, which are staffed by 2 firefighter/emergency medical technicians (EMTs). Paramedic units tend to transport more seriously ill patients, unless an emergency medical technician ambulance is unavailable to transport patients requiring only basic life support.

Los Angeles Fire Department ambulances transport patients to 59 EDs in the greater Los Angeles area. The computer system that displays the diversion status of each hospital is displayed on the mobile data terminal that is present on every ambulance, which allows paramedics to determine the diversion status of each hospital at all times.

When an ambulance transports a patient to an ED, the crew is expected to transfer care of the patient within 15

minutes. This transfer includes unloading the patient from the ambulance, moving the ambulance stretcher inside the ED, giving the report to the triage nurse, transferring the patient to an ED gurney, completing paperwork, and preparing the equipment for the next run.

Ambulance crews are required to notify the dispatch center if they will be unavailable for another response for longer than 15 minutes for any reason. However, fire department dispatchers must code not only the elapsed time in the ED but also the reason for the delay. Causes for these delays may include the need to decontaminate the ambulance after a critical patient, an equipment malfunction, an extenuating circumstance such as an investigation about patient care, or a delay because of the unavailability of an open gurney in the ED. Fire department dispatchers enter the time that the ambulance becomes unavailable and the reason (code) for this delay in the ED, which is then captured in the dispatch computer system. The computer automatically captures the time the ambulance becomes available for the next call when paramedics update their status on their mobile data terminal.

Unless a patient requires a specialized tertiary care facility (eg, trauma center, pediatric critical care center), he or she is typically transported to the closest, most appropriate ED.⁷ If that ED is on diversion, then paramedics can transport to an alternate facility if it can be reached within 15 minutes by using lights and sirens. If there are no "open" EDs within this time, paramedic ambulances must transport to the closest facility, regardless of its diversion status.

According to the policies set by the Los Angeles County Department of Health Services, a hospital may request ambulance diversion because of ED saturation if ED resources are fully committed and are not immediately available for additional incoming patients transported by advanced life support units, which may be due to an excessive volume of ED patients or a lack of available inpatient beds for ED patients awaiting admission.⁸

When paramedics transport to an ED that is already on diversion, there may not be an open gurney to which the patient may be transferred. Paramedics must then wait with their patient until a gurney becomes available. Once this elapsed time exceeds 15 minutes, paramedics must notify dispatch that the ambulance is out of service and they are unable to respond to additional calls until further notice.

From April 2001 through March 2002, each incident of an ambulance being out of service because of the unavailability of an open ED gurney was prospectively

captured through the Los Angeles Fire Department dispatch system computers. Incidents in which ambulance crews remained unavailable for the next response at a hospital for any reason other than the unavailability of an open ED gurney were not included in our data collection. The ambulance unit, the ED, the date, the time the unit went unavailable, and the time they went back in service were captured. This data set was then exported to an electronic database (Microsoft Excel, Microsoft Corporation, Redmond, WA) for analysis. Descriptive statistics, including the median and interquartile range for the various outcome measures of interest, were derived. The monthly number of incidents in which ambulances were out of service was tested for significance throughout the study period by using the ∂^2 test.

Before this study, no such data collection mechanism existed to collect the amount of time that paramedics were out of service while waiting for open ED gurneys. However, data on diversion hours in EDs has been routinely collected. Although this set of data does not provide a direct measure of ambulance out-of-service time, it nevertheless provides a description of the crowding problem in Los Angeles EDs. Thus, we examined the monthly ED diversion hours for the past 4 years, from January 1999 through December 2002, to show the extent of the crowding situation in EDs in Los Angeles and its temporal trend. We used the 12-month periodicity (seasonality) time series model to determine whether the 4-year series is stationary or nonstationary relative to the 12-month seasonality. BMDP Statistical Software

(The BMDP Statistical Software, Inc., Los Angeles, CA) was used for all statistical analysis.

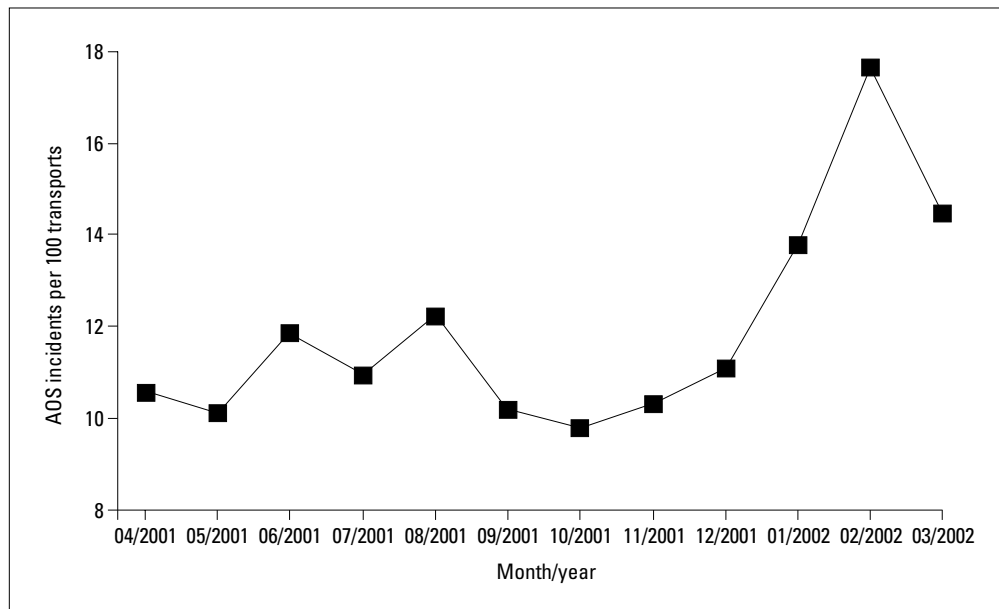
Approval for the study was granted by the institutional review board of the University of Southern California.

RESULTS

During the 12-month study period, there were a total of 21,240 incidents in which ambulances were out of service while waiting in excess of 15 minutes to transfer their patients to an open ED gurney. During the same period, there were 172,981 patients transported to area hospitals by Los Angeles Fire Department ambulances. The monthly number of out-of-service incidents per 100 transports ranged from a low of 9.7 in October 2001 to a high of 17.6 in February 2002 (Figure 1), which translates to a range of 1 out-of-service incident for every 10.3 transports in October 2001 to 1 for every 5.6 transports in February 2002.

We also examined the waiting times for paramedics to transfer a patient to an ED gurney until they were available for another response. The median waiting time per incident was 27 minutes, and the interquartile range was 20 to 40 minutes. The longest single wait for an ambulance to transfer the patient and become available for another response was 405 minutes (6.75 hours). The day with the lowest number of out-of-service hours was December 25. The monthly number of incidents with ambulances out of service waiting for an open ED

Figure 1. Ambulance out-of-service incidents per 100 transports. AOS, Ambulance out-of-service.



gurney was significantly different throughout the study period ($P < .0001$), with the highest levels during the winter (January through March).

Figure 2 displays the total number of hours ambulances were out of service throughout the study period at the 20 EDs accounting for the greatest cumulative number of out-of-service hours out of all EDs to which the Los Angeles Fire Department transports patients. Three hospitals had distinctly higher ambulance out-of-service hours. Among these 3 hospitals, the mean number of out-of-service hours per hospital during the study period was 1,262, whereas the mean number of out-of-service hours among the other 60 hospitals was 128. Thus, ambulances were almost 10 times more likely to be out of service waiting for an open bed at 1 of the 3 hospitals with the highest cumulative hours ambulances were out of service compared with any other ED.

As a reflection of how crowded area EDs were during the study period, the number of ED diversion hours and the percentage of time during 2002 that an ED was on diversion for the top 20 EDs among the 59 hospitals in the greater Los Angeles area are presented in the Table. Six hospitals were on diversion more than 50% of the time. The hospital with the highest number of diversion hours was on diversion more than 70% of the time.

The relationship between ambulance out-of-service hours and ED diversion hours for the 12-month study period is shown in Figure 3. It demonstrates that ambulance out-of-service followed the same pattern as ED diversion.

Figure 4 shows the pattern of ED diversion hours over the past 4 years in Los Angeles from 1999 through 2002. Analysis of the mean of the series indicated that it is a nonstationary series with a significant increasing trend ($P < .0001$) over the 4-year period.

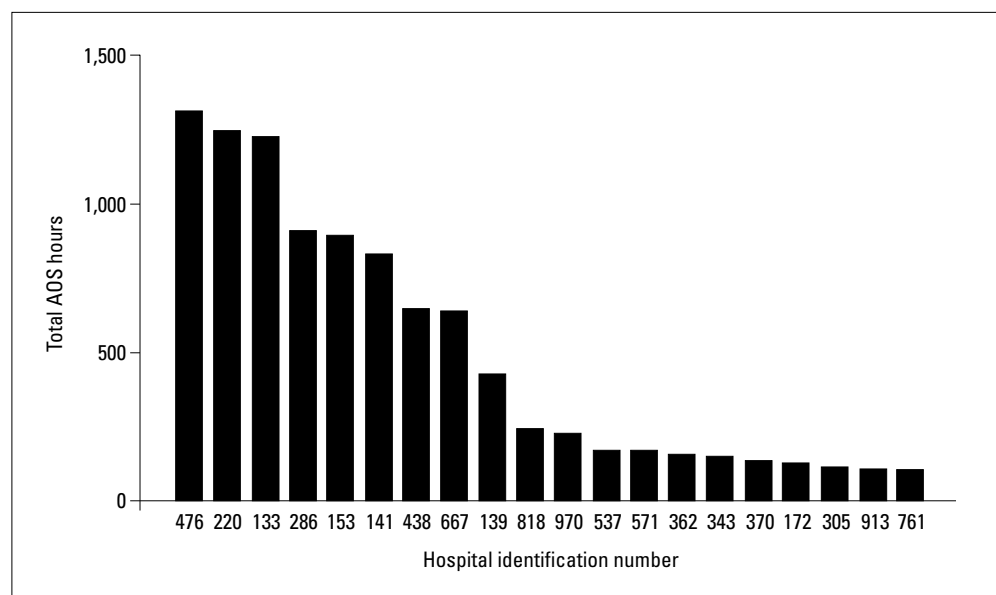
DISCUSSION

A recent study from California EDs found that patients waited an average of almost 1 hour before being treated by a physician.⁹ Our data show that similar delays now exist for paramedics to transfer care of their patients, having to wait for an open ED gurney.

Although hospitals accounting for the longest periods of out-of-service time were concentrated in some of the most densely populated areas of the city, transfer of care delays occurred across all areas of Los Angeles, which demonstrates that it is not isolated to inner-city hospitals or large teaching hospitals. The resultant number of times that ambulances must respond into these areas to cover for the ambulances waiting in EDs is likely to be significant and crosses the entire socioeconomic spectrum.

Citizens might assume that if there is an ambulance in their neighborhood fire station, it is available to respond in case of a medical emergency. However, our data show that this is often not the case, not because of paramedics responding to another call but because of having to wait in an ED for an open bed, sometimes for several hours.

Figure 2.
Total ambulance out-of-service hours for the top 20 hospitals in 2001.



The problems of ED crowding and ambulance diversion result from myriad causes. The effect of the lack of inpatient beds, particularly monitored and ICU beds, cannot be overstated. Patients are presenting to EDs more seriously ill. As recently reported, critical visits

per ED in California increased by 59% during the past decade,¹ whereas the number of staffed critical care beds decreased by 4%.¹⁰ During this same period, the number of licensed EDs in the state decreased by 12%, whereas the total number of ED visits increased by 12%, resulting in a 27% increase in total number of visits per ED.¹ In Los Angeles County, CA, there has been a 21% decrease in the number of EDs during the past decade.¹¹

Table.
The top 20 EDs ranked by number of diversion hours during the 12-month study period.

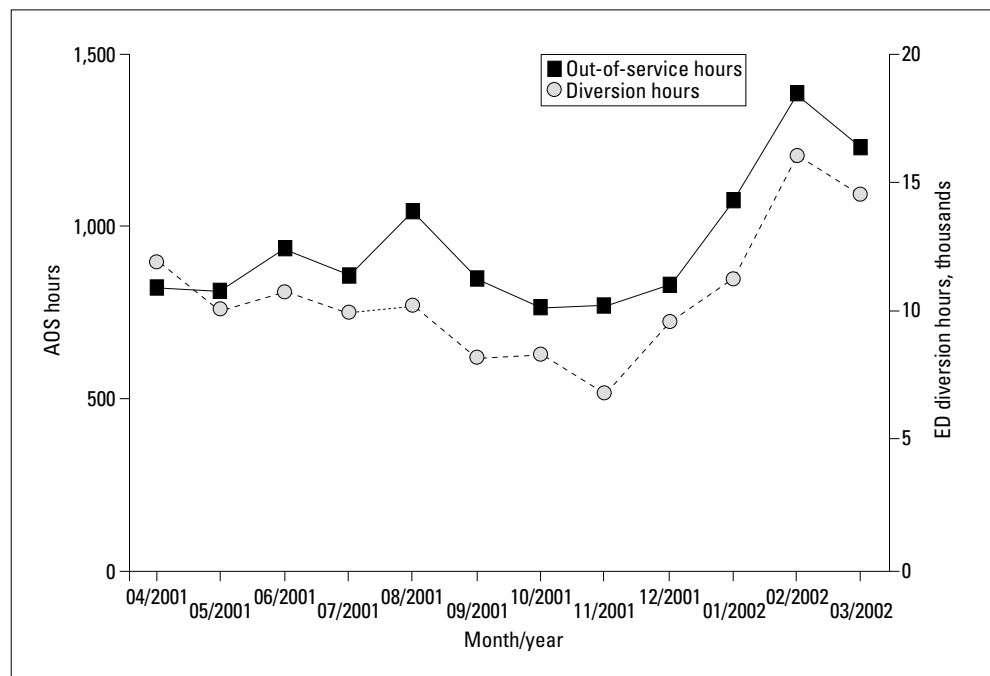
Hospital Identification	No. of Diversion Hours	Percentage of Time Hospital Was on Diversion*
133	6,180	70.5
438	5,496	62.7
220	5,289	60.4
476	5,196	59.3
248	4,876	55.7
571	4,567	52.1
667	4,014	45.8
537	3,885	44.3
875	3,723	42.5
575	3,700	42.2
381	3,683	42.0
216	3,401	38.8
514	3,303	37.7
799	3,277	37.4
210	3,080	35.2
680	3,049	34.8
139	2,975	34.0
362	2,974	33.9
761	2,783	31.8
286	2,703	30.9

*Number of hours on diversion divided by 8,760 h (24 h x 365 d).

The issue of medicolegal responsibility warrants discussion. Under Emergency Medical Treatment and Active Labor Act legislation, a patient is considered to have “presented” to a hospital when he or she arrives on hospital grounds and requests an examination or treatment of an emergency medical condition.¹² A patient who arrives by EMS meets this requirement when EMS personnel request treatment for their patient from hospital staff. Are paramedics covered under their scope of practice to provide care or monitor patients in EDs while waiting to transfer care? The Centers for Medicare and Medicaid Services recently stated, “A hospital’s refusal to accept responsibility for a patient who arrives via EMS ... could be a violation of EMTALA,”¹³ which is true even if the patient remains on an ambulance stretcher in the ED.

Finally, our data show that some of the increases in ambulance waiting times are predictable. There appeared to be a seasonal variation of this problem, with a significant increase in ambulance waiting times during the winter and a subsequent small decrease in March. This sea-

Figure 3.
Monthly ambulance out-of-service hours and ED diversion hours.



sonal variation in ambulance waiting times parallels predictable increases in ED volume previously reported.¹⁴

The major limitation of this study is that we evaluated only the effect of ED crowding on an EMS system in one city. Although it appears that this phenomenon is widespread across the United States, similar data need to be compiled from other municipalities to evaluate the extent of this problem.

Furthermore, the effect of paramedics being unavailable because of ED crowding was not quantified in terms of prolonged response times or potential adverse effects on patient care. In addition, the instances in which ambulances were out of service for excessive periods were not individually studied. How actively paramedics worked to secure a gurney for their patients in these instances is unknown. Finally, although paramedics are permitted to go out of service at an ED because of reasons other than delays in patient transfer, it cannot be confirmed that each incident captured in our study was appropriately attributed to the unavailability of open ED beds. Prolonged delays, however, often resulted in the dispatch of an EMS field supervisor to that ED, which might have dissuaded crews from using this problem to obtain a respite from the next call.

Our data show that paramedic ambulances are routinely out of service while waiting to transfer care of patients in EDs. Although the exact effect of these delays in terms of potentially longer response times is unknown, this problem poses a significant challenge to our EMS system.

Author contributions: ME designed the study, collected the data, and wrote the bulk of the manuscript. LSC performed the statistical analyses and wrote the pertinent sections of the Materials and

Methods section and the Results section. ME takes responsibility for the paper as a whole.

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Address for reprints: Marc Eckstein, MD, Department of Emergency Medicine, Los Angeles County + University of Southern California Medical Center, 1200 N. State Street, Room 1011, Los Angeles, CA 90033; 213-485-4730, fax 213-485-8247; E-mail eckstein@usc.edu.

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Figure 4.
Time series analysis of ED diversion hours in Los Angeles, 1999 to 2002.

