Analysis of Ambulance Transports and Diversions Among US Emergency Departments

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Study objective: We describe emergency department (ED) visits in which the patient arrived by ambulance and estimate the frequency of and reasons for ambulance diversion. Using information on volume of transports and probabilities of being in diversion status, we estimate the number of patients for whom ED care was delayed because of diversion practices.

Methods: Data from the 2003 ED component of the National Hospital Ambulatory Medical Care Survey, an annual sample survey of visits to US hospital EDs, were used for the analysis. Data were provided by 405 participating EDs on 40,253 visits. Data from supplemental questionnaires to the hospital staff were used to describe volume and frequency of ambulance diversions.

Results: In 2003, patients arrived by ambulance for 16.2 million ED visits (14.2%). About 31 ambulances arrived at a US ED every minute. Of ambulance-related visits, 39% were made by seniors, 68% were triaged as emergent or urgent, and 37% resulted in hospital-admission. About 45% of EDs reported diverting ambulances at some point during the previous year. Among EDs that had any diversion, approximately 3% of operating time was spent in diversion status. In 2003, an estimated 501,000 ambulances were diverted, ie, 1 ambulance diversion per minute. Large EDs represent 12% of all EDs, 35% of all ambulance arrivals, 18% of all EDs that went on diversion, 47% of all hours spent in diversion status, and 70% of all ambulances diverted to another ED.

Conclusion: Description of current use of ED ambulance transports and likelihood of diversions should help policymakers plan for demographic changes in the population during the next 15 years. [Ann Emerg Med. 2006;47:317-326.]

0196-0644/$-see front matter

doi:10.1016/j.annemergmed.2005.12.001

INTRODUCTION

In 2003, there were approximately 114 million emergency department (ED) visits in the United States, which was the highest visit volume ever reported.[1] From 1993 to 2003, the number of ED visits rose by 26%, whereas the number of EDs decreased by 12%.[1] This increasing demand for ED services, coupled with fewer operating EDs, leads to higher visit volumes in those remaining open, which can overwhelm ED resources, as well as other parts of the hospital system. When EDs lack the capacity to provide emergency care for patients requiring treatment or admission, they commonly divert ambulances to other hospitals.[2] Another consequence of ED crowding includes emergency medical services (EMS) providers remaining with the patient until the ED staff has room to handle the case. This affects the entire EMS system by tying up EMS resources, reducing response time, delaying patient care, and creating conflict with ED staff. The health of the community is also affected by ambulance diversion in that the capacity of the ED to respond to infectious disease outbreaks, natural disasters, and terrorist attacks is reduced.

About 14% of ED patients arrive by air or ground ambulance transport.[1] Such patients tend to be older than the average ED patient [1] and likely require more resources, ranging from diagnostic tests performed and treatment provided to total time spent in the ED. Understanding how emergency care is organized and delivered, how well transitions from EMS to ED work, and the extent of resources required by ambulance cases is important for gauging not only future ED needs but also EMS services. Little has been published on national estimates of resources involved in ED transport cases. There is no national EMS database, and no national estimates exist for the frequency of ambulance diversions.

In this study, we used data from the ED component of the 2003 National Hospital Ambulatory Medical Care Survey

Editor's Capsule Summary

What is already known on this topic

Ambulance diversion has received widespread attention as an important public health problem. Although emergency departments (EDs) divert ambulances for a wide range of reasons, the inability to move admitted patients to inpatient beds has been recognized as the most important determinant of ambulance diversion. There are no reliable national estimates of the frequency of ambulance diversion.

What question this study addressed

This study used data from the 2003 National Hospital Ambulatory Medical Care Survey to describe the demographics and disposition of patients who arrived at EDs by ambulance. The authors also estimate the frequency of ambulance diversion nationally.

What this study adds to our knowledge

The authors estimate that approximately 500,000 ambulances were diverted from US EDs in 2003. The study also provides detailed information about the disposition of patients who arrive at US EDs by ambulance.

How this might change clinical practice

The demographic profile and resource use of patients arriving by ambulance is important information for ED and health system planning efforts. Furthermore, the baseline national estimate of ambulance diversion is an important step in tracking the frequency of ambulance diversion over time.

(NHAMCS) to describe the characteristics of patients transported by ambulance and the extent of resources used in their ED care. We also used supplemental survey data from the NHAMCS to describe the magnitude of ambulance diversion episodes nationwide. Using the volume of transports and the frequency and duration of diversion, we estimated, by modeling, the number of ambulances that were likely diverted in US hospitals during 2003.

MATERIALS AND METHODS

Study Design

The NHAMCS is an annual probability sample survey of US hospital EDs and outpatient departments. It was first conducted in 1992 by the Centers for Disease Control and Prevention's (CDC's) National Center for Health Statistics (NCHS). The US Census Bureau is responsible for field operations and data collection. The NHAMCS uses a 4-stage probability sampling procedure: (1) 112 geographic primary sampling units; (2) probability sample of nonfederal, short-stay, or general hospitals with EDs or outpatient departments or both, within the sampled primary sampling units, selected from a publicly available database of all US hospitals; (3) emergency service areas within 24-hour EDs and clinics within outpatient departments; and (4) sample of about 100 visits within EDs or clinics during a randomly assigned 4-week reporting period throughout the year. A published report describes the plan and operation of the NHAMCS.[3]

Setting

In 2003, the survey was conducted in 405 US EDs. The NHAMCS protocol was approved by CDC's NCHS research ethics review board.

Data Collection and Processing

The patient record form contains patient demographic data and information about the visit such as time and mode of arrival, expected source of payment, reason for visit, immediacy with which the patient should be treated, cause of injury, diagnosis, diagnostic services, therapeutic procedures, medications prescribed, visit duration, and disposition. Patient complaints were coded according to "A Reason for Visit Classification for Ambulatory Care," which is a classification scheme developed by NCHS used to code patients' complaints or reasons for seeking care.[4] Diagnoses and causes of injury were coded according to the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*).[5] For diagnostic services, procedures, and disposition, multiple responses could be recorded. Patient record forms were completed by hospital staff for 40,253 visits; for 5,913 of these, ambulance (ground or air) was recorded as the mode of arrival. The survey response rate was 85%. Mode of arrival was missing for 5.4% of visit records obtained from responding EDs; therefore, the number of ambulance transports generated from the NHAMCS is a conservative estimate. A sample weight for each visit is adjusted for survey nonresponse and applied in the analysis to produce unbiased national annual estimates of ED visits.

In 2003, 2 supplements to the NHAMCS were conducted to gather information on ambulance diversion practices and policies. The ED Staffing, Capacity, and Ambulance Diversion supplement contained questions about whether there were state or local regulations that prohibited diversion practices. Also included was a log of periods that the ED was on ambulance diversion during the 4-week reporting period and the reasons for diversion (multiple entries allowed in a checkbox format). The Bioterrorism and Mass Casualty Preparedness supplement included an item on amount of time the ED was in diversion status: "What is the total number of hours that your hospital's emergency department was on ambulance diversion in 2002?" Copies of the data collection forms are available online at http://www.cdc.gov/nhamcs. When the hospital was inducted into the NHAMCS, copies of the supplements were left with staff at eligible hospitals to complete as self-report questionnaires. At the end of the reporting period, the supplements were collected and processed by the US Census Bureau. A sampling weight

that accounted for probability of selection and adjustment for nonresponse for each responding ED was applied to provide unbiased annual national estimates. The response rates for both supplements were 85% to 86%. Among EDs that responded, about 2.7% of EDs were missing information on the hours of diversion. There is no standard definition of "diversion," and communities vary with respect to diversion policies. In the NHAMCS, a diversion period is defined as each time the ED was less than fully open to receive ambulance patients. Pilot tests of the supplements indicated that hospital staff understood the nature of the data requested and how to complete the log. Collected forms underwent expert content review and 100% independent data entry quality assurance review.

Primary Data Analysis

Data from the NHAMCS sample were weighted to produce national estimates of both visits and EDs. The weight includes 3 components: selection probability, nonresponse adjustment, and ratio adjustment to fixed totals. SUDAAN software was used for all statistical analyses.[6] Standard errors for the estimates are available from the authors on request. Estimates were not presented if they were based on fewer than 30 cases in the sample data. Estimates based on 30 or more cases are flagged to indicate that the relative standard error (ie, the standard error divided by the estimate expressed as a percent) of the estimate exceeds 30%.

The data analysis consisted of 3 parts:

1. ED visit statistics on ambulance transports: We analyzed NHAMCS visit data to produce the descriptive statistics on patient, hospital, and visit characteristics of ED visits in which the patient arrived by ambulance.
2. ED-level statistics on ambulance diversion episodes: We used responses to the NHAMCS supplements to create the estimates related to time on diversion at the national and hospital level. Information from the diversion episode log on reasons for diversion was converted to percentage of diversion hours spent for each reason using the duration of each episode entry.
3. Number of ambulances diverted: We used NHAMCS data to estimate the volume and frequency of ambulance diversions by modeling information on ambulance arrivals and the number of hours that an ED is in diversion status. Almost all diversion hours (99.7%) occurred in EDs located in metropolitan statistical areas; therefore, the computation is limited to EDs in metropolitan statistical areas. The best assessment of diversion practices in each hospital in 2003 is from the item about diversion hours in the previous year; therefore, the computation is limited to EDs that had any diversion hours reported for 2002. This computation also assumes that the percentage of time on diversion equates to the percentage of total annual ambulance transports to the ED that were diverted (the distribution of diversions by time of day is fairly equivalent to the distribution of ambulance arrivals). Because NHAMCS data reveal that percentage of time on diversion and volume of ambulance transports vary by annual ED visit volume, the computation is performed for each of 3 sizes of visit volume separately. Finally, because 90% of diversion hours are most likely to occur during the day or evening (based on the NHAMCS diversion log data), limiting the computation to the most frequent times (8 AM to 1 AM) will result in the best estimate of the number of diversions. The number of diversions was estimated using the following model:

$$N_d = \sum R_i \times P_i$$

where R_i is the rate of ambulance arrival for the i^{th}-size ED ($i=1$ to 3) and P_i is the probability of being on diversion for the i^{th}-size ED.

This formula is operationalized as the number of ambulance arrivals multiplied by the proportion of time on ambulance diversion separately for the 3 sizes of EDs and then summed for a total number of diversions. ED size was determined by the estimated annual visit volume in 2003 for each sample hospital. There is no uniform definition of ED size; therefore, we defined ED size as small (<20,000 visits), medium (20,000 to 50,000 visits), and large (>50,000 visits).

Sensitivity Analysis

Because P_i in the above formula comes from the probability of being on diversion in 2002 rather than in 2003, a sensitivity analysis on the number of ambulances diverted in 2003 was performed by varying the proportion of time that EDs were on diversion for each size of ED (P_i) using the corresponding lower and upper limits of the 95% confidence intervals (CIs), which means that N_d was computed 2 additional times: when the P_is were all at their lowest limit and again when they were all at their highest limit (based on the 95% CI). Although the extreme limits are unlikely to occur simultaneously, the resulting range is more likely to contain the true value of N_d than a single point estimate if the assumption of similarity between 2002 and 2003 diversion hours is violated.

RESULTS

Analysis of ED Visit Data on Ambulance Transports

In 2003, there were 16.2 million ED visits (14.2%) in which the patient arrived by ambulance; this figure corresponds to 44,300 per day and 1,800 per hour. The peak time of arrival for ambulance transports was 10 AM to 1 PM, with a smaller peak occurring from 5 PM to 7 PM (Figure 1). The majority of patient visits were for illness (59.3%), whereas 40.7% were for injury, poisoning, or adverse effects of medical treatment. Although the rate for all ambulance arrivals was fairly consistent across days of the week (average of 31 arrivals per minute daily), transports for illness visits were highest on Mondays, whereas transports for injuries were highest on Saturdays (Figure 2).

The proportion of all ED visits in which the patient arrived by ambulance varied by patient age, ethnicity, region, metropolitan statistical area status, and ED size (Table 1). Immediacy with which the patient should be treated was categorized into 4 groups: emergent (<15 minutes), urgent

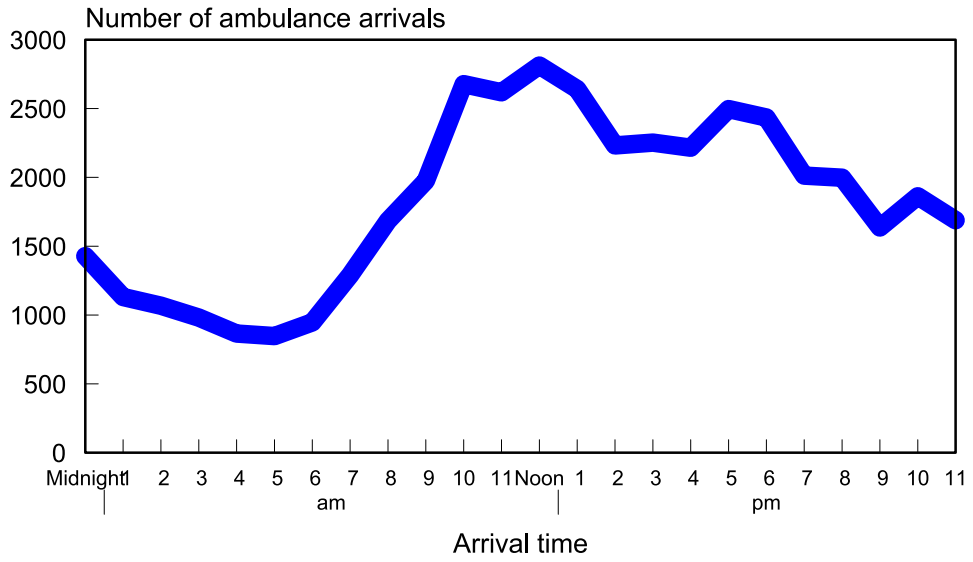
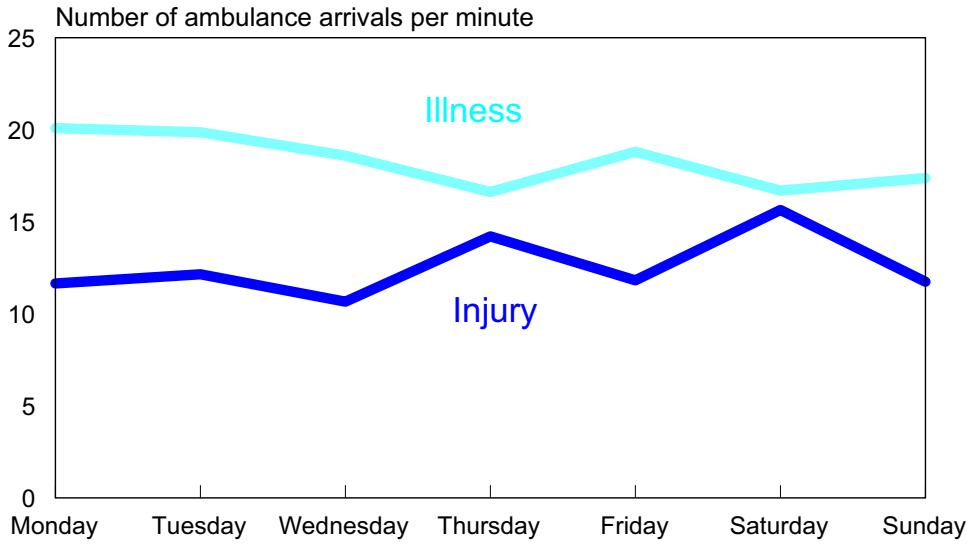


Figure 1. Number of ambulance arrivals to EDs by hour of day, United States, 2003.



Note: Chi-square significant ($p<.01$).

Figure 2. Rate of ambulance arrivals to EDs by day of the week and type of patient condition, United States, 2003.

(15 to 60 minutes), semiurgent (1 to 2 hours), and nonurgent (2 to 24 hours). Almost 7 of 10 transport cases were triaged as emergent or urgent, and the probability of arriving by ambulance increased with the level of urgency (Table 1).

The most frequently mentioned principal reasons for the visit, primary diagnoses, and causes of injury for visits in which the patient arrived by ambulance are presented in Tables 2 and 3. The top 10 diagnoses accounted for 33.9% of all transport cases. Almost 7 of 10 transports for injury were due to unintentional injury, whereas 1 of 10 was due to intentional injury.

Transport cases had an average of 6.5 different diagnostic tests and services ordered or performed, which is 40% higher than nontransport cases. Imaging was ordered for 63.3% of transport cases, including magnetic resonance imaging or computed tomographic scans ordered at 17.0% of visits. Therapeutic procedures were provided at 63.3% of visits in which the patient arrived by ambulance, including administration of intravenous fluids at 46.5% of visits. The mean time in the ED for ambulance patients was 4.5 hours (95% CI 4.2 to 4.8 hours), including a mean waiting time to consult a physician of 32.0 minutes (95% CI 29.0 to 35.1

Table 1. Annual number, distribution percentage, and annual rate of ED visits in which the patient arrived by ambulance and percentage of all visits that were ambulance arrivals by selected characteristics: United States, 2003.

Selected Patient, Hospital, and Visit Characteristics	Annual Visits in Thousands, No.	Distribution, %	Ambulance Arrivals, %	Visits/100 Persons/y, No.*†	95% CI
All visits by ambulance	16,165	100.0	14.2	5.7	5.1–6.3
Patient characteristics					
Age, y					
<15	939	5.8	3.8	1.5	1.3–1.7
15-24	1,677	10.4	9.5	4.2	3.6–4.8
25-44	3,715	23.0	11.3	4.5	3.9–5.1
45-64	3,624	22.4	17.3	5.3	4.7–5.9
65-74	1,966	12.2	27.5	10.9	9.3–12.5
≥75	4,244	26.3	40.9	26.2	22.9–29.5
Sex					
Female	8,763	54.2	14.4	6.0	5.4–6.6
Male	7,402	45.8	14.0	5.3	4.7–5.9
Race‡					
White only	12,345	76.4	14.4	5.4	4.8–6.0
Black only	3,381	20.9	13.7	9.5	7.9–11.1
Asian only	262	1.6	12.9	2.2	1.6–2.8
Other race§	177	1.1	13.6	2.4	1.2–3.6
Ethnicity					
Hispanic or Latino	1,608	9.9	10.9	4.1	3.1–5.1
Non-Hispanic or Latino	14,559	90.1	14.7	5.9	5.3–6.5
Hospital characteristics					
Ownership					
Voluntary	12,114	74.9	14.7	4.2	3.6–4.8
Government	2,484	15.4	11.8	0.9	0.7–1.1
Proprietary	1,568	9.7	14.8	0.5	0.3–0.7
Geographic region					
Northeast	4,036	25.0	16.9	7.5	6.1–8.9
Midwest	3,977	24.6	15.8	6.2	4.8–7.6
South	5,327	33.0	11.9	5.2	4.4–6.0
West	2,825	17.5	14.2	4.3	3.3–5.3
Metropolitan status					
Metropolitan statistical area	13,773	85.2	14.8	5.8	5.2–6.4
Non–metropolitan statistical area	2,393	14.8	11.4	5.1	3.7–6.5
ED size					
Small (<20,000 annual visits)	2,916	18.0	10.7	1.0	0.8–1.2
Medium (20,000-50,000 annual visits)	7,529	46.6	15.0	2.6	2.2–3.0
Large (>50,000 annual visits)	5,721	35.4	15.7	2.0	1.6–2.4
Visit characteristics					
Expected source of payment§					
Medicare	6,075	37.6	32.8	17.2	15.0–19.4
Private	3,807	23.6	9.2	2.0	1.8–2.2
Medicaid/SCHIP	2,365	14.6	9.7	7.9	6.7–9.1
Uninsured	2,203	13.6	12.8	5.3	4.5–6.1
Other	1,715	10.6	13.9	N/A	N/A
Immediacy with which the patient should be treated					
Emergent	5,392	33.4	31.2	1.9	1.7–2.1
Urgent	5,597	34.6	13.9	2.0	1.8–2.2
Semiurgent	1,703	10.5	7.5	0.6	0.4–0.8
Nonurgent	744	4.6	5.1	0.3	0.3–0.3
Unknown or no triage	2,730	16.9	14.3	1.0	0.8–1.2

SCHIP, State Children's Health Insurance Program; *N/A* not applicable.
Numbers may not add to totals, because of rounding.

*Visit rates for age, sex, race, and region are based on the July 1, 2003, set of estimates of the civilian noninstitutional population of the United States as developed by the Population Division, US Census Bureau. These population estimates reflect Census 2000 data and are available from the US Census Bureau.

†Population estimates of metropolitan statistical area status are based on data from the 2003 National Health Interview Survey (NHIS), NCHS, adjusted to the US Census Bureau definition of core-based statistical areas as of December 2003. See http://www.census.gov/population/www/estimates/metrodef.html for more about metropolitan statistical area definitions.

‡The race groups, white, black, Asian, and other race (ie, Native Hawaiian or other Pacific Islander, American Indian or Alaskan Native, and multiple races) include persons of Hispanic and non-Hispanic origin. Persons of Hispanic origin may be of any race. Race-specific estimates are tabulated according to 1997 Standards for Federal Data on Race and Ethnicity, allowing multiple entries across race categories. The percentage of visit records with multiple races indicated is small and lower than what is typically found for self-reported race.

§Denominators used in computing estimates of visit rates by expected source of payment were obtained from the 2003 NHIS. Individuals reporting multiple insurance categories in the NHIS were counted in each category they reported, with the exception of Medicaid and SCHIP, which were combined into a single category. Denominator data were not available for the "Other" payment category.

minutes). The difference leads to an average time in the ED after initial physician evaluation of 4.1 hours. More than a third of transported patients were admitted to the hospital, including critical care units (Table 4). Transport cases comprised about 4 of every 10 patients admitted from the ED. Approximately 6 of 10 transported patients were treated and released.

Frequency of ambulance transports to EDs increased with annual ED visit volume. On any given day, the average number of transports per hospital by ED size was as follows: small 2.8 (95% CI 1.6 to 4.0); medium 13.8 (95% CI 12.4 to 15.2), and large 31.0 (95% CI 26.5 to 34.5).

Analysis of ED-Level Ambulance Diversion Episodes

According to NHAMCS supplement data, almost half of all EDs (44.9%) experienced ambulance diversion periods some time during the previous year. This percentage was about 2.5 times higher for medium sized and large EDs compared with small EDs (Table 5). EDs located in metropolitan statistical areas were more likely to have any diversions hours and accounted for 99.7% of all diversion hours observed; implying that amount of time on diversion was much smaller in non–metropolitan statistical area EDs. About a half-million diversion hours were reported, with approximately half of all diversion hours occurring in large volume EDs (Table 5). About 8% of EDs (all in metropolitan statistical areas) spent more than 5% of their time in diversion status (Figure 3). Among hospitals that had any diversions in 2002, approximately 2.9% of annual operating time was spent in diversion status. This proportion increased to 7.6% for large EDs (Table 5). Information from the diversion status log indicates that more than 90% of all diversion periods occurred between 8 AM and 1 AM.

The most common reasons for initiating diversion, based on percentage of time on diversion, were no appropriate inpatient beds (51.1%), high number of ED patients (49.8%), and complexity of ED cases (18.5%). Staffing shortage and equipment failure were less common. Half of all EDs and several large EDs had no diversion hours in the previous year. There are several reasons why a hospital may have no diversion hours, unrelated to the reasons often cited for going on diversion. Approximately 8.8% of hospitals reported state or local laws prohibiting diversion. Other hospitals have self-formed policies that disallow an option of diverting or rerouting ambulances (eg, children's hospitals).

Volume of Ambulances Diverted

Although it is difficult to measure how many ambulances were actually diverted, given the data collection methodology in the NHAMCS, it is possible to approximate an estimate from the various data elements that were collected as described in the Materials and Methods section. The analysis was limited to (1) EDs with any diversions in metropolitan statistical areas, (2) the volume of ambulance arrivals during the busiest part of the 24-hour day (8 AM to 1 PM) by ED size (small 548,700, medium 3,709,800, and large 3,265,800), and (3) the percentage of busiest time on diversion by ED size (small 2.7%, medium 3.6%, and large 10.8%). We obtained an estimate of approximately 501,000 ambulances diverted in 2003 (small ≈15,000, medium ≈134,000, and large ≈352,000), corresponding to approximately 1 ambulance diverted for each diversion hour experienced.

A sensitivity analysis on the number of diversions in 2003, varying the assumption that the volume of diversion hours in 2003 was similar to that of the previous year, provides a range of annual diversion estimates between 314,000 and 688,000. A conservative estimate is that 860 ambulances per day are diverted across the United States, but the number could be as high as 1,886 ambulances per day. Because large EDs spend more of their operating time in diversion status, they represent the lion's share of ambulances diverted. In summary, it appears that although large EDs represent 12% of all EDs and 35% of all ambulance arrivals, they also represent 18% of all EDs that went on diversion, 47% of all hours spent in diversion status, and 70% of all ambulances diverted to another ED.

LIMITATIONS

The limitations of the portion of the study describing ambulance transports are that data are not collected on out-of-hospital EMS care or on whether multiple patients arrive in the same ambulance, so it is assumed that each arrival is a different ambulance transport. For the ambulance diversion section of the article, there are limitations of the estimates provided, and there is no standard definition of diversion. The estimate of the volume of ambulances diverted is conservative because there were several hours in the middle of the night that were excluded from the analysis when diversions may have taken place, and a few diversions may have occurred in non–metropolitan statistical area EDs. The estimate of the volume of ambulance diversion hours depends on the assumption that diversion patterns in 2003 are similar to those of 2002. Provisional data from the 2003 ambulance diversion episode log indicate that this is a reasonable assumption. Nevertheless, the sensitivity analysis performed on the diversion estimate shows a range of possible estimates, should this assumption not be met.

DISCUSSION

This report describes the magnitude and frequency of ambulance transports and diversions at US EDs. Although mode of arrival to the ED was collected and reported from the 1999 and 2000 NHAMCS, it did not receive wide attention, even though NHAMCS data represent the only national estimate of ambulance transports to the ED. The relative proportion of ED visits in which the patient arrived by ambulance remained constant from 1999 to 2003 (14.2%)[1,7]; however, the number of arrivals increased from 14.6 million to 16.2 million, representing an 11% increase between 1999 and 2003.

Between 2003 and 2020, the percentage of the noninstitutional civilian population expected to be 65 years

Table 2. Annual number and distribution percentage of ED visits in which the patient arrived by ambulance, by the 10 leading principal reasons for visit and diagnosis groups, United States, 2003.

Condition Characteristics	Code	Annual Visits in Thousands, No.	Distribution, %
All visits by ambulance		16,165	100.0
Principal reason for visit	RVC code*		
Chest pain and related symptoms (not referable to body system)	S050	1,274	7.9
Shortness of breath	S415	926	5.7
Stomach pain, cramps, and spasms	S545	866	5.4
Motor vehicle crash, type of injury unspecified	J805	817	5.1
Accident, not otherwise specified	J810	679	4.2
Convulsions	S205	511	3.2
General weakness	S020	468	2.9
Labored or difficult breathing (dyspnea)	S420	464	2.9
Fainting (syncope)	S030	367	2.3
Other symptoms and problems relating to psychological and mental disorders	S165	363	2.3
All other reasons		9,430	58.3
Primary diagnosis group	*ICD-9-CM* code(s)†		
Chest pain	786.5	861	5.3
Contusion with intact skin surface	920-924	800	4.9
Heart disease, excluding ischemic	391-392.0, 393-398, 402, 404, 415-416, 420-429	714	4.4
Sprains and strains of neck and back	846, 847	533	3.3
Convulsions	780.3	468	2.9
Syncope and collapse	780.2	463	2.9
Abdominal pain	789.0	431	2.7
Pneumonia	480-486	417	2.6
Drug dependence and nondependent abuse of drugs	308-309	406	2.5
Fractures, excluding lower limb	800-819	395	2.4
All other diagnoses		10,677	66.1

Numbers may not add to totals, because of rounding.
*Based on "A Reason for Visit Classification for Ambulatory Care" (RVC).[4]
†Based on the *ICD-9-CM*.[5]

Table 3. Annual number and distribution percentage of injury-related ED visits in which the patient arrived by ambulance by the 10 leading causes of injury: United States, 2003.

Intent and Mechanism of Injury	Cause-of-Injury Code*	Injury-Related Visits in Thousands, No.	Distribution, %
All injury-related visits		6,579	100.0
Motor vehicle traffic (unintentional)	E810-819	1,699	25.8
Falls (unintentional)	E880-886, E888	1,558	23.7
Assault (intentional)	E960-969	375	5.7
Adverse effects of medical treatment	E870-879, E930-949	281	4.3
Struck against or struck accidentally by objects or persons (unintentional)	E916-917	217	3.3
Self-inflicted (intentional)	E950-959	212	3.2
Poisoning (unintentional)	E850-869	206	3.1
Natural and environmental factors (unintentional)	E900-909, E928.0-928.2	110	1.7
Mechanism unspecified (unintentional)	E887, E928.9, E929.8, E929.9	93	1.4
Cutting or piercing instruments or objects (unintentional)	E920	92	1.4
All other causes		1,736	26.4

*Based on the *ICD-9-CM*.[5]

Table 4. Annual number and percentage of ED visits in which the patient arrived by ambulance, by disposition: United States, 2003

Disposition	Visits in Thousands, No.*	Visits, %
All visits	16,165	N/A
Admit to hospital	5,989	37.1
Refer to other physician or clinic for follow-up	5,410	33.5
Return if need, PRN or appointment	4,253	26.3
Return to referring physician	1,730	10.7
Admit to ICU or CCU†	839	5.2
Transfer to other facility	730	4.5
No follow-up planned	568	3.5
DOA/died in ED	256	1.6
Admit to ED for observation	124	0.8
Other or unknown	754	4.7

CCU, Critical care unit; *DOA*, dead on arrival; *PRN,* as needed.
*Total exceeds "All Visits" because more than 1 disposition may be reported per visit.
†ICU or CCU is a subset of those admitted to the hospital.

of age and older will increase from 12% to 16% based on US Census Bureau projections.[8] Because older persons use EMS medical transport services more than younger persons, a disproportionately larger increase in the rate of ambulance arrivals can be expected just by the projected increased population of older persons. Applying the current ambulance use rate to the increased volume of persons in 2020 and assuming the relationship with age continues yields a 7% increase in the population rate of ambulance arrivals at EDs, the volume of these transports could grow from 16.2 million to 20.2 million, representing a 25% increase in EMS volume caused solely by the aging of the US population. Data from the National Association of State EMS Directors indicate that in 2002 there were at least 48,384 licensed EMS vehicles in the US (5 states did not report).[9] Given our estimate of 16.2 million annual transports to EDs, that equates to approximately 334 ED transports per ambulance. Therefore, by 2020, we project that the United States would need at least 60,479 EMS vehicles if the present use rate continues, which has financial implications for fire departments, hospitals, and communities that provide EMS training, staff, and equipment.

The presentation of annual estimates of EMS transports to the ED will be helpful for planning purposes because they provide benchmark national data for states to compare. In addition, data on patient demographics, conditions seen, procedures performed, and disposition will be useful in developing training for EMS and ED personnel and allocating resources. Comparing data in this report to overall ED utilization data for 2003[1] indicates that patients arriving by ambulance were more likely to have injury- rather than illness-related conditions, more diagnostic tests including imaging, 1 or more therapeutic procedures, and intravenous fluids administered. Ambulance patients were almost 3 times more likely to be admitted than were other ED patients and 4 times more likely to be admitted to a critical care unit. The average patient care time in the ED for ambulance patients was also higher than that found for ED patients in general (4.1 hours versus 2.4 hours).

What are the implications for the possibly half-million patients who were in diverted ambulances? If an ambulance passed by a closer ED to reach an open ED, the patient's care was postponed. The descriptive information on patient demographics indicates that transport patients were more likely to be elderly, with an emergent condition. Therefore, rerouted transport cases were probably also more likely older and requiring more intense services than the average ED patient. Delaying comprehensive care by minutes could result in increased morbidity and mortality.

This study is the first to estimate the volume and frequency of national ambulance diversions. Previous studies examined the volume of diversion episodes locally. The US Government Accountability Office (GAO) conducted site visits in 6 urban areas and visited 4 hospitals within each area and found that 2 of 3 hospitals in their survey went on diversion at least once during fiscal year 2001 and that 2 of 10 of these hospitals were on diversion for more than 10% of the time.[10] The magnitude of diversion hours in 2002 in metropolitan statistical areas found in this analysis is similar to that found for 2001 in the GAO study, except the NHAMCS data found slightly more EDs having up to 5% of their time on diversion and slightly fewer having more than 20% of their time on diversion.

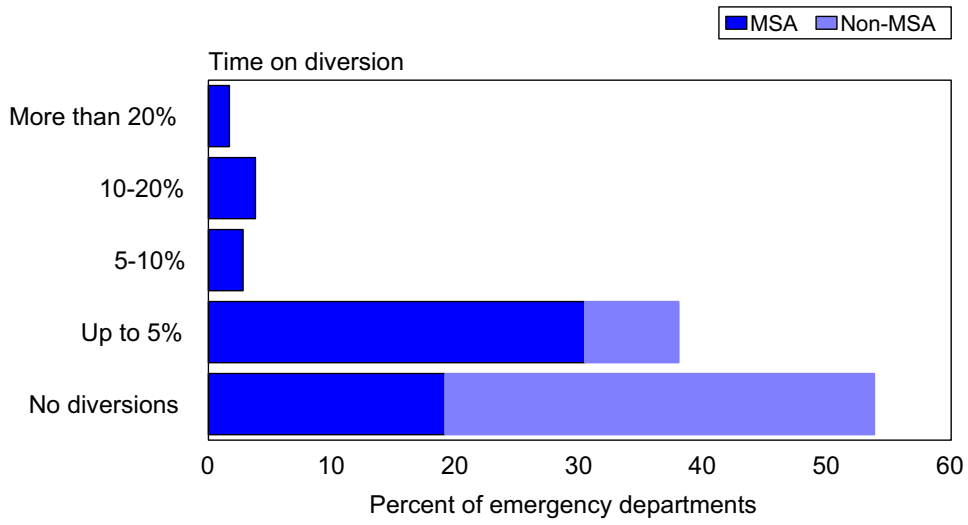
The crisis in ED crowding and anecdotal stories of ambulance diversion were prominent in the news the day before the 2001 terrorism attacks on the World Trade Center and the Pentagon. Since 2001, research indicates that systemic changes in hospital (rather than ED) functioning can dramatically reduce the need for ambulance diversion. To address bed availability, some hospitals increased the number of ED observation beds, initiated clinical protocols to help reduce admissions from the ED, freed ICU capacity, smoothed the elective surgery schedules and inpatient discharges, and hired hospitalists. Bed-use committees were created in many hospitals to expedite patient flow through the hospital.[11] Some communities attempted to solve the problem of diversion with political mandates banning its use.[12,13] Others efforts include engaging the EMS community to improve getting patients to requested EDs,[14] sending daily diversion statistics to hospital chief executive officers and ED directors,[15] increasing the number of adult ICU beds,[16] and establishing an inpatient based emergency acute care unit.[17]

Understanding the current state of EMS use and

Table 5. Distribution percentage of EDs and volume of ambulance diversion hours by selected ED characteristics.

ED Characteristic	Distribution of All EDs, %	EDs With Any Diversion Hours, %	Annual Number of Diversion Hours Reported	Among EDs With Any Diversion Hours: Distribution, %	Among EDs With Any Diversion Hours: Mean Annual Number of Diversion Hours	Among EDs With Any Diversion Hours: Operating Time on Diversion, %*
All EDs	100.0	44.9	539,700	100.0	258	2.9
Geographic region						
Northeast	16.2	48.0	89,500	16.6	247	2.8
Midwest	29.6	40.4	119,100	22.1	220	2.5
South	38.9	44.3	167,700	31.1	211	2.4
West	15.4	51.0	163,300	30.3	418	4.8
Metropolitan status						
Metropolitan statistical area	57.7	65.0	538,200	99.7	308	3.5
Non–metropolitan statistical area	42.3	17.5†	1,500	0.3	†	†
Ownership						
Voluntary	62.6	47.7	447,100	82.8	325	3.7
Government	25.8	35.3†	34,100	6.3	78†	0.9†
Proprietary	11.7	51.7	58,500	10.8	211†	2.4†
ED size (annual visit volume)						
Small (<20,000)	55.4	27.4	76,100†	14.1†	108†	1.2†
Medium (20,000-50,000)	33.2	65.0	208,100	38.6	207	2.4
Large (>50,000)	11.4	70.2	255,500	47.3	669	7.6

*Mean hours on diversion/(365 days×24 hours)×100.
†Figure does not meet standard of reliability or precision.



Note: Ambulance diversion data are missing for 2.7% of EDs.

Figure 3. Percent distribution of US EDs by time on ambulance diversion during 2002 and metropolitan statistical area status. *MSA*, Metropolitan statistical areas.

likelihood of diversion should help policymakers in the hospital industry and public health arenas by providing benchmarks to track changes throughout the next 15 years. For example, data collection efforts from 13 states indicate that on average, about 70% of all EMS calls result in transport to the ED.[9] Our estimate of 16.2 million transports may project to 23.1 million emergency calls each year. The NHAMCS supplement information on ambulance diversion was collected again in 2004. Future studies will evaluate any changes in national estimates of diversion. We expect diversions to decrease as hospitals continue to implement innovative methods. Awareness that diversion

problems require hospital-wide solutions should result in policies and procedures to limit diversion practices.

The authors wish to acknowledge the dedication of hospital staff who voluntarily participated in the survey and the field representatives from the US Census Bureau who collected the data. We also acknowledge Drs. Irma Arispe, Jeremy Brown, and Jennifer Madans for helpful comments on earlier versions of the manuscript.

Supervising editor: Brent R. Asplin, MD, MPH

Author contributions: CB conceived the study. CB and LM designed the study. RV edited the data. CB, LM, and RV performed the analysis. CB and LM wrote the article. CB takes responsibility for the paper as a whole.

Funding and support: The authors report this study did not receive any outside funding or support.

Publication dates: Received for publication July 21, 2005. Revisions received September 28, 2005, and November 22, 2005. Accepted for publication December 1, 2005. Available online February 17, 2006.

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