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Is emergency department crowding associated with increased "bounceback" admissions?

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Abstract

Objective—Emergency department (ED) crowding is linked with poor quality of care and worse outcomes, including higher mortality. With the growing emphasis on hospital performance measures, there is additional concern whether inadequate care during crowded periods increases a patient's likelihood of subsequent inpatient admission. We sought to determine if ED crowding during the index visit was associated with these "bounceback" admissions.

Methods—We used comprehensive, non-public, statewide ED and inpatient discharge data from the California Office of Statewide Health Planning and Development from 2007 to identify index outpatient ED visits and bounceback admissions within seven days. We further used ambulance diversion data collected from California local emergency medical services agencies to identify crowded days using intra-hospital daily diversion hour quartiles. Using a hierarchical logistic regression model, we then determined if patients visiting on crowded days were more likely to have a subsequent bounceback admission.

Results—We analyzed 3,368,527 index visits across 202 hospitals, of which 596,471 (17.7%) observations were on crowded days. We found no association between ED crowding and bounceback admissions. This lack of relationship persisted in both a discrete (high/low) model (OR 1.01, 95% CI 0.99, 1.02) and a secondary model using ambulance diversion hours as a continuous predictor (OR 1.00, 95% CI 1.00, 1.00).

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Conclusions—Crowding as measured by ambulance diversion does not have an association with hospitalization within 7 days of an ED visit discharge. Therefore, bounceback admission may be a poor measure of delayed or worsened quality of care due to crowding.

Introduction

Crowding in the emergency department (ED) is a growing problem in the United States.[1–3] Crowding has been linked with poor quality of care, including delayed administration of pain medications,[4] antibiotics,[5] and life-saving thrombolysis for acute myocardial infarction.[6] In addition, crowding is associated with worse outcomes, even increased mortality; for example, patients with acute myocardial infarction who are admitted on days when ambulances must be diverted due to ED crowding have an increased risk of near-term (30-day) and long-term (1-year) death.[7]

Another potential adverse effect of ED crowding and concomitant inadequate and delayed care is subsequent admission after initial ED discharge, sometimes informally referred to as “bounceback” admissions. Recently, much policy focus has been put on cementing quality measures around hospital readmission, defined as a patient who is admitted to the hospital, discharged, and then is admitted again within a certain timeframe for a related issue.[8] Similarly, the return and admission of a patient who is discharged as an outpatient from the ED – as opposed to from an admission in the hospital – could be increased by the lower likelihood of appropriate diagnosis, treatment, education, or discharge instructions associated with ED crowding.[9] At the same time, treating bounceback admissions as an analogue of readmission to the hospital has some questionable validity, as a trial of outpatient care may be preferable to inappropriately high admission rates.

Previous work relating any type of ED return visit (both outpatient and admitted patients) and ED crowding is limited and contradictory. Studies have found that leaving against medical advice or without being seen are both risk factors for a return visit (revisit) to the ED, and leaving without being seen is independently associated with ED crowding.[10,11] A single hospital in Montreal, Canada, found that revisit rates remained the same after an intervention that reduced ED crowding.[12] Another single site study in a large U.S. tertiary hospital found that implementation of a fast-track system that shortened length of stay and wait time did not change revisit rates.[13]

Our goal in this study is to determine if ED crowding during a patient’s initial visit, as measured by ambulance diversion, is associated with a higher rate of bounceback admissions in a statewide dataset.[14,15] We defined bouncebacks as patients who were admitted as an inpatient within 7 days of a preceding outpatient ED visit.[11,14] This work builds upon previous single-institution studies to provide more generalizable associations that can better inform policy and healthcare provision. If crowding, previously associated with inadequate and delayed care, is also associated with bounceback readmissions, this would support tracking readmissions as a proxy of decreased quality due to crowding.

Methods

Study Design

We examined all California ED discharges during 2007 from general, acute, non-federal hospitals in a retrospective cohort study to determine if ED crowding was related to bounceback admissions.

Data Sources & Selection of Participants

We obtained non-public data files from the California Office of Statewide Health Planning and Development (OSHPD) of all outpatient ED visits (ED Discharge Data) and hospital admissions (Patient Discharge Data). All non-federal healthcare facilities in California are required to report this visit information to OSHPD. Our study considered all outpatient ED visits by adults (age ≥ 18 years) in 2007, excluding visits occurring during the final week of 2007 due to lack of data for a complete seven-day follow-up.

We linked the ED and Patient Discharge files using a unique identifier (Record Linkage Number) created by OSHPD based on masked Social Security numbers. Using this linkage, we identified all bounceback admissions to an acute-care bed within seven days of a previous outpatient ED visit. The unique patient identifier allowed us to track all bounceback admissions, even if the admission was at a different hospital than the index ED visit. To avoid using multiple visits that may represent coding for a single visit,[16] we excluded multiple ED visits by the same patient on the same day, and ED visits with a hospital admission by the same patient on the same day. We also excluded ED visits without a record linkage number, as well as visits resulting in transfer to an acute care facility or hospice care, death in the ED, or unknown disposition, due to our inability to capture seven-day readmission for said visits.

Hospital-level financial and structural data were extracted from the OSHPD 2007 public utilization dataset. We only included hospitals that provided basic or comprehensive emergency services (n=290), were open for the entire year of 2007 (n=288), were eligible for diversion (n=202), which generally occurred on a county-by-county basis (e.g., counties, or local EMS agencies, determine whether or not diversion is allowed for all hospitals within their jurisdiction), and those that recorded diversion hours (n=188). Full exclusion criteria can be found in Figure 1.

The study protocol was approved by the California Committee for Protection of Human Subjects and the Institutional Review Board of the University of California at Los Angeles.

Outcome Measures

Our outcome of interest was bounceback admissions, defined as an unscheduled hospital admission from any source (ED and non-ED) within seven days of outpatient ED discharge. We chose a seven-day time frame based on prior studies of the time frame for adverse events after ED discharge,[17–19] local quality improvement efforts that tracked seven-day bounceback admissions, and our desire to limit the proportion of visits due to events unrelated to the index ED visit. In cases when patients had multiple ED visits during the seven days prior to the admission, the subsequent bounceback admission was attributed only to the most recent ED visit. We chose to focus specifically on subsequent admissions rather than ED revisits in order to focus on those patients with the most severe complications after initial ED discharge. We further performed a sensitivity analysis using a 3-day risk period to assess if the effects would be similar to our main 7-day model.

Crowding predictor

We used hospital-specific daily ambulance diversion hours on the date of the patient’s initial ED visit as a proxy measure of ED crowding. Ambulance diversion occurs when ED staff can no longer safely care for new patients and ambulances are diverted to nearby facilities. Ambulance diversion is one of the few consistent measures of crowding available and similarly defined across all California hospitals, and it is commonly used by pre-hospital and regulatory agencies to monitor crowding.[20] Because it is simple, objective, and relatively easily measured, past literature has recommended diversion as a valid proxy measure for crowding,[3,21] and it has been used in the past as a standard criterion for developing ED crowding scales.[22]

Within each county in California that allowed diversion, we obtained daily diversion logs for the entirety of 2007 from the local EMS agency including information on facility, date, and duration in minutes. Though the local EMS agency collected data on this information, the hospital was the deciding unit as to when the ED was so busy as to require ambulance diversion. In some counties more detailed information was available on the reasons for ambulance diversion beyond ED saturation, such as unavailable specialty services (e.g. CT scanner, cardiac catheterization), or internal disaster. These represented a very small percentage of diversion hours (4.75%), and we excluded them for the purposes of consistency.

Many counties in California and nationally have implemented diversion bans or initiatives to decrease diversion in the last decade.[20,23] Therefore, we interviewed each of the EMS directors to verify their diversion policies for 2007 (some of which have subsequently changed). One system in our analysis discontinued diversion midway through 2007; therefore, we included a facility-specific variable indicating whether diversion was permitted for all of 2007. Three of the 24 EMS systems with diversion were missing 2–4 weeks of data due to upgrades in tracking software, and one system was missing data for January – March. We therefore omitted data for those four counties during the period the diversion data were missing.

For each facility, we analyzed data on all episodes of ambulance diversion and summed the diversion hours on each day. As described in previous literature,[24] we defined days of high ED crowding as those within the top quartile of daily ambulance diversion hours for a specific hospital. The cutpoint was chosen because exploratory analyses suggested a threshold effect at the 75th percentile. All other days were considered as periods of normal or low ED crowding. By focusing on this intra-hospital rating system, we adjust for potential hospital-level confounding due to differing use patterns and duration of ambulance diversion that may be unrelated to ED crowding, as wide variation in the use of ambulance diversion across hospitals and EMS systems is well-documented.[25] During 2007, many hospitals (44%) experienced ambulance diversion on less than 25% of the 365 days; therefore, the percent of hospital-days categorized as having high ED crowding (17%) was less than a quarter of all hospital-days.

Covariates

We used hospital-level characteristics, patient demographic information, and clinical diagnosis categories as predictors in the bounceback model. Hospital-level predictors included teaching affiliation, trauma center status, ownership (not-for-profit, for-profit, and government), and size as determined by the number of medical and surgical beds (<100, 100–399, ≥400).

Visit-level patient demographic covariates were incorporated for age, sex, race/ethnicity, and insurance status (Medicare, Medicaid, private, self-pay/uninsured, and other). Based on previous exploratory work on this database,[24] we dichotomized race as white and non-white. The race/ethnicity variable was reported as missing or unknown in 3% of patients, and 0.04% of cases had payer information that was blank or invalid. Visit descriptors included whether the patient left against medical advice (AMA) or eloped, and whether the visit was during the week or weekend; there were no missing values for these data or for age and gender.

To adjust for discharge diagnoses, all ICD-9 codes were mapped to the Agency for Healthcare Research and Quality Clinical Categorization Software (CCS)[26] multilevel diagnosis codes. The codes were then further combined into 38 multi-level diagnosis codes based on clinical coherence and relevance to the ED that were included in the model. The derivation and rationale for this classification has been described in our previous work.[27]

Statistical Analyses

We first assessed for baseline differences between ED visits that resulted in bounceback admissions and those that did not using hospital-level random effects models for continuous variables and Cochran-Mantel-Hanzel tests stratified by hospital for categorical variables.

We then used a hierarchical logistic regression model to determine the relationship between visiting on a crowded versus non-crowded day and bounceback admission, with initial ED visit as the unit of analysis. The model included a hospital random effect, as ED visits are clustered within hospitals, with other predictors included as fixed effects. As a sensitivity analysis, we also performed a multivariate regression using diversion measured continuously.

Given previous literature indicating that subgroups of patients might be affected by crowding differently, one of our goals was also to determine if the outcome of increased rate of bounceback differed among patients with varying dispositions,[28] advanced age,[5] or those visiting hospitals of differing ownership.[16,29] We categorized ED dispositions into three groups: discharged home, left against medical advice or eloped, and discharged to intermediate care facilities, including skilled nursing homes, home health service, and intermediate or long-term care.

Data analyses were performed in SAS 9.2 (SAS Institute, Carry, NC) and the publicly available R software (Cary, NC).

Results

Our final sample consisted of 3,368,527 observations across 202 hospitals that met our inclusion criteria (Figure 1). 596,471 (17.7%) observations were on days classified as high crowding within each facility. As shown in Table 1, patients visiting hospitals on highly crowded days were slightly more likely to be non-white, be uninsured, and leave against medical advice or elope compared to patients visiting hospitals on days with low crowding. In addition, a higher proportion of visits on crowded days were to county hospitals, teaching hospitals, trauma centers, and hospitals with more than 100 inpatient beds. Discharge diagnoses in the sample are presented in Supplemental Digital Content Table 1.

Main Outcome

Our multivariate regression showed that ED crowding within hospitals was not significantly associated (OR 1.01, 95% CI 0.99, 1.02) with increased bounceback admissions (Table 2). There was also no association with increased bounceback admission when ambulance diversion was modeled as a continuous predictor (OR 1.00, 95% CI 1.00, 1.00) (Supplemental Digital Content Table 2). In our sensitivity analysis using a 3-day bounceback period instead of a 7-day period, the odds ratio was similarly non-significant at 1.00 (95% CI 0.98, 1.02; full results shown in Supplemental Digital Content Table 3).

Covariates

Several covariates were significant predictors of bounceback admission (Table 2). Patients with initial ED visits at for-profit hospitals, relative to not-for-profit hospitals, appeared to have a higher risk of having a bounceback admission (OR 1.12, 95% CI 1.03, 1.22), as did those in teaching hospitals (OR 1.16, 95% CI 1.01, 1.34). As expected, older patients had higher likelihood of a bounceback admission compared with younger patients (OR for 80+, 2.81, 95% CI 2.74, 2.89; OR for 60–79, 2.18, 95% CI 2.13, 2.22; OR for 40–59, 1.65, 95% CI 1.62, 1.68; relative to 18–39 years). Publicly insured patients, both Medicaid and Medicare, had higher odds of a bounceback admission than the privately insured (OR 1.54, 95% CI 1.51, 1.57, and OR 1.58, 95% CI 1.55, 1.62, respectively), with slightly lower odds of bounceback admission for the uninsured (OR 0.89, 95% CI 0.87, 0.91).

Subgroup analyses—Bounceback admission rates ranged from as low as 2.5% in the group of patients discharged home, to 4.9% in those who left against medical advice or eloped, and up to 10.1% of those who were discharged to intermediate care facilities (Table 3). Elderly patients had a bounceback rate of 5.2%. Patients admitted in not-for-profit hospitals had a bounceback admission rate of 2.6%, compared with patients hospitalized in county hospitals, who had a bounceback admission rate of 3.0%.

Discussion

We did not find any association between crowding (using ambulance diversion as a proxy) and bounceback admissions. We did find that bounceback admission was associated, even after controlling for crowding and other factors, with increased age, leaving without being seen, and discharge to an intermediate care facility. While previous literature on crowding has revealed deleterious effects on quality of care and patient outcomes, we find that crowding had no effect on admission in the subsequent seven days.

One possible explanation for a negative result is that diversion, which was intended as a safety measure to address potential adverse effects of crowding, achieved its anticipated outcome of mitigating crowding and therefore patients did not experience worse outcomes. Another potential explanation for our negative finding could be the more subtle effects of the smaller proportion of people affected by inappropriate discharge due to crowding, compared to the larger proportion of very ill people whose ED care and subsequent outcomes are compromised by crowding but who are immediately admitted. In addition, physicians may be compensating for crowded conditions by admitting more patients on crowded days in order to avoid complications from delayed and worse quality of care.

The demographic and structural covariates we found to be associated with bounceback admissions are consistent with previous literature, strengthening our overall findings. We found that older patients were more likely to be readmitted, which more likely correlates with clinical severity and frailty than poor quality care.[15] Similarly, patients in intermediate care facilities are also sicker than community dwelling patients, possibly explaining the association we found with bounceback readmissions. Those who left without being seen are of course subject to poorer quality care, but they might return either because they are sicker, as previous studies have shown,[10,11] or simply because they did not get the care for which they came.

The rate of bounceback ED visits has been proposed by several sources as a standard quality indicator to measure ED performance.[30–32] The measure is intended to capture poor medical treatment in the ED that would then create a need for the patient to return for further care.[33] We had hypothesized that crowding would affect this measure because crowding has been linked to negative effects on other measures of care quality, and worse care would increase the likelihood of patients needing to return for follow up. Our results do not support this hypothesis.

Other investigators have previously raised questions about the validity of bounceback admissions as a measure of ED care quality.[14] Several studies concluded that patients with subsequent ED visits were instead returning more commonly due to societal, personal, and unavoidable illness-related reasons.[11,14,15,34,35] For example, one nationwide study found that return visitors to the ED had lower illness severity than on initial visits, required no more resources, and were no more likely to result in admission.[14] Return visits have commonly been found to be for uncomplicated follow-up treatment, dehydration, psychiatric or substance abuse issues, and often disproportionately common among older adults and heavy ED users.[14,15,36]

If crowding negatively affects so many other care process measures,[4–6] but not bounceback, perhaps bounceback admissions may not truly capture the effects of delayed or inadequate care due to ED crowding as so many have claimed. Moreover, if decreased quality of ED care is not commonly in the pathway for bounceback readmissions and residual unadjusted severity of illness is, then using bounceback readmissions as a quality indicator would unfairly penalize EDs caring for the sickest patients. Certainly, it may be useful to track bounceback admissions for other purposes, but the application of this measure as a quality indicator and linking it with incentives such as pay for performance warrants careful evaluation before widespread implementation.

Limitations

There are several limitations of this study. First, we measured crowding by ambulance diversion, which is an imperfect measure, as it is purely an operational symptom of underlying granular causes of mismatch of supply and demand.[37,38] While the practice blocks access to patients en route to the ED in an ambulance, diversion status does serve as a rough proxy for existing crowding that could be experienced by the 70% of ED patients who walk in and cannot lawfully be turned away. In addition, though we normalized diversion by hospital to remove facility-level confounding, hospitals may experience crowding without activating diversion, which would bias our findings towards the null. Further, because the OSHPD data only reports the date of visit and not the time of visit, we had to sum ambulance diversion hours by date. Therefore it is possible that a patient seen on a “busy” day did not come during the crowded hours of that day and was unaffected by the crowded conditions. As described in our methods, we used diversion because it is one of the few measures available and widely used across California hospitals, and has been recommended by past literature as a valid measure for crowding.[3,21]

Other proposed indices for crowding, including the Emergency Department Work Index,[39] the National Department Overcrowding Scale,[40] the Real-time Emergency Analysis of Demand Indicators,[41] and the Work Scale,[22] require input of dynamic patient and resource variables, such as patient triage scores, ED and hospital occupancy rates, and ED staffing not available in OSHPD or most other large databases, limiting their use on a population scale.[42,43] Other measures such as wait times,[44] length of stay,[45] or boarding times,[46] for example, are not available within OSHPD data. As those measures are now being considered for national surveys and adopted nationally as quality measures, future studies will be able to amplify our work by determining if other measures of crowding are associated with increased bounceback rates.

Second, the OSHPD dataset for emergency visits does not contain information on pre-existing comorbidities, which are likely to be associated with a higher likelihood of bounceback. Third, the files also lack information on patients without a record linkage number, which could represent vulnerable populations without social security numbers at risk for bounceback admission, such as undocumented immigrants. Fourth, our study focuses on the state of California. While California represents 12% of the US population and our findings have important policy implications within context, these results cannot be generalized to other settings that may face greater or fewer strains on their emergency care system, and have different capacity in their overall health care system.

Fifth, 33% of the visits otherwise eligible for study were at hospitals that were in local EMS agency areas that did not allow ambulance diversion in 2007. It is likely that they also experienced crowding, and any systematic difference in their patients' likelihood of bounceback admission compared with the hospitals we studied could bias our results.

Finally, we chose a slightly longer 7 day window for bounceback admissions than the 72 hours commonly used to define return visits to the ED in the past.[15,34,35] However, when we conducting a sensitivity analysis limiting our risk period for admission to three days, we found that crowded conditions were still not associated with bounceback admissions.

Conclusion

We did not find any association between increased ED crowding as measured by ambulance diversion and likelihood of bounceback admissions. Our findings suggest that bounceback admissions may not be the most sensitive measure of delayed or worsened quality of care in the ED due to crowding.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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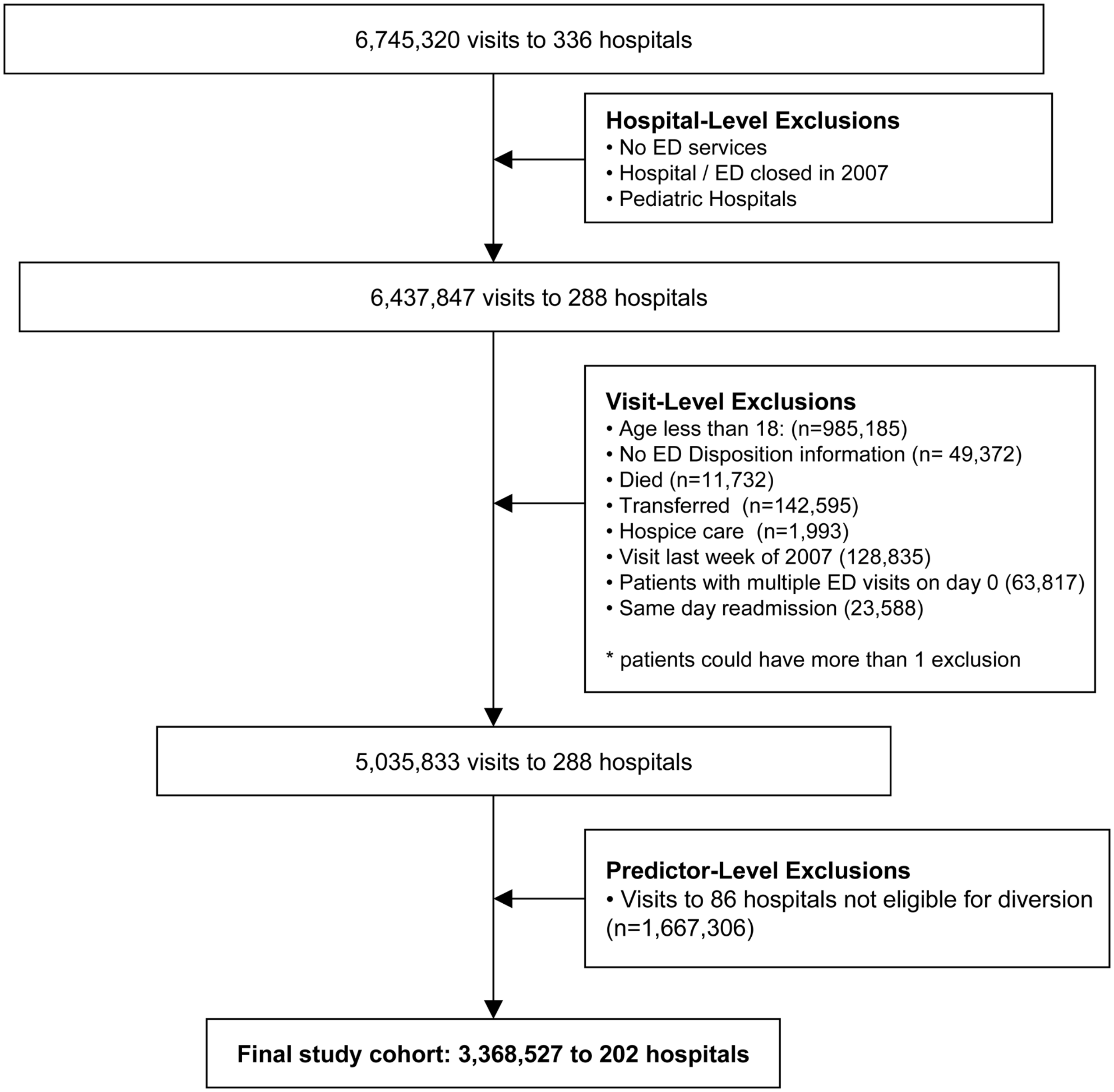

Figure 1.
Patient sample selection

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Table 1

Characteristics of patients in study sample[a]

	TOTAL n=3,368,527	High Crowding n=596,471	Low Crowding n=2,772,056
Patient Characteristics	**Column %**	**Column %**	**Column %**
Age			
18–39	43.5	43.2	43.6
40–59	34.6	34.7	34.5
60–79	15.3	15.5	15.3
80+	6.6	6.7	6.6
Female	57.1	57.1	57.1
Non-White	50.9	52.6	50.5
AMA/Eloped	2.6	3.3	2.5
Expected source of payment			
Uninsured/self-pay	17.9	18.6	17.7
Medi-Cal	16.5	16.2	16.5
Medicare	13.8	13.7	13.8
Other[b]	51.9	51.5	52.0
Hospital Characteristics			
Ownership			
Non-For Profit	74.0	74.5	73.9
For Profit	15.6	14.0	15.9
County	10.5	11.5	10.2
Teaching Hospital	14.5	16.7	14.0
Trauma Center	25.5	29.4	24.7
Med-Surg Hospital Beds			
< 100	14.0	10.6	14.7
> 100	86.0	89.4	85.3

[a]Discharge diagnoses are presented in Supplemental Digital Content Table 2.

[b]"Other" insurance includes Veterans Affairs, Champus/TRICARE, worker's compensation, automobile or disability programs, and other federal programs

Table 2

Multivariate regression of ED crowding (using hospital ambulance diversion as intra-hospital predictor) on bounceback admissions (n= 3,368,527)*

Hospital Characteristics	**OR**	**95% Lower**	**95% Upper**
High ED Crowding	1.01	0.99	1.02
Covariates			
Patient Characteristics			
Age (Ref=18–39)			
40–59	1.65	1.62	1.67
60–79	2.18	2.13	2.22
80+	2.81	2.74	2.89
Female	0.85	0.84	0.86
Non-White	0.81	0.80	0.82
AMA/Eloped	1.94	1.88	2.01
Expected source of payment (Ref = All others)			
Uninsured/self-pay	0.89	0.87	0.91
Medi-Cal	1.54	1.51	1.57
Medicare (payer in MA, MB, MC)	1.58	1.55	1.62
Hospital Characteristics			
Ownership (Ref= NFP)			
For Profit	1.12	1.03	1.22
County	0.99	0.86	1.15
Teaching Hospital	1.16	1.01	1.34
Trauma Center	1.03	0.93	1.14
Med-Surg Hospital Beds (Ref: 100–399)			
< 100	0.97	0.89	1.05

*all discharge diagnoses listed in SDC Table 2 were included in the regression

Table 3

Results of sub-group multivariate models of ED crowding on bounceback admissions[1]

			High ED Crowding	
Subgroup analyses	**Subgroup Size**	**Bounceback readmission rate**	**Adjusted OR**	**95% CI**
Discharge status[1]				
Home	3,260,717	2.5%	1.00	0.99, 1.02
AMA/eloped	88,452	4.9%	1.02	0.94, 1.10
Skilled nursing, home health service, intermediate, or long-term care	19,205	10.1%	1.00	0.88, 1.14
Age >80 years old[1]	223,789	5.2%	0.99	0.94, 1.04
Hospital type[1]				
County	352,296	3.0%	1.02	0.97, 1.08
Not-for-profit	2,491,643	2.6%	1.01	0.99, 1.03
For-profit	524,588	2.7%	1.04	0.99, 1.09

[1]All models adjusted for patient- and hospital-level covariates (except for each subgroup under analysis) as described in Table 1.