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Associations of Emergency Department Length-of-Stay with Publicly Reported Quality-of-Care Measures

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Abstract

Objective—The Institute of Medicine identified emergency department (ED) crowding as a critical threat to patient safety. We assess the association between changes in publicly reported ED length-of-stay (LOS) and changes in quality-of-care measures in a national cohort of hospitals.

Methods—Longitudinal analysis of 2012 and 2013 data from the American Hospital Association (AHA) Survey, Center for Medicare and Medicaid Services (CMS) Cost Reports, and CMS Hospital Compare. We included hospitals reporting Hospital Compare timeliness measure of LOS for admitted patients. We used AHA and CMS data to incorporate hospital predictors of interest. We used the method of first differences to test for relationships in the change over time between timeliness measures and six hospital-level measures.

Results—The cohort consisted of 2,619 hospitals. Each additional hour of ED LOS was associated with a 0.7% decrease in proportion of patients giving a top satisfaction rating, a 0.7% decrease in proportion of patients who would "definitely recommend" the hospital, and a 6 minute increase in time to pain management for long bone fracture (p<0.01 for all). A one hour increase in ED LOS is associated with a 44% increase in the odds of having an increase in left without being seen (LWBS) (95% CI 25-68%). ED LOS was not associated with hospital readmissions (p=0.14) or time to percutaneous coronary intervention (p=0.14).

Conclusion—In this longitudinal study of hospitals across the US, improvements in ED timeliness measures are associated with improvements in the patient experience.

Introduction

The Institute of Medicine identifies emergency department (ED) crowding as a critical threat to the quality and safety of patients.[1] Crowded EDs are associated with higher mortality,[2] inadequately treated pain,[3] delays for important medications,[4] and higher complication rates.

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Previous literature on the impact of crowding and increased LOS on patient satisfaction and other quality endpoints have been limited to in small, mostly single institution, studies in non-nationally representative samples.

The Centers for Medicare Services (CMS) Hospital Compare website includes data on publicly reported and audited quality measures from a national cohort of hospitals. CMS began 'pay-for-reporting' of ED timeliness measures in 2012, including median ED LOS for patients who are admitted to the hospital for inpatient care.

In this Brief Report, we assess the association between changes in publicly reported ED LOS and quality-of-care measures in a national cohort of hospitals. We hypothesized that increases in ED LOS would be associated with worse performance on patient-oriented outcomes.

Methods

Study Design

This was a longitudinal analysis of merged 2012 and 2013 data from the American Hospital Association (AHA) Survey, CMS Cost Reports, and CMS Hospital Compare (www.hospitalcompare.hhs.gov). This analysis was approved by the IRB of xxxx University.

Data Sources and Sample Selection

We included hospitals reporting Hospital Compare timeliness measures of ED LOS for admitted patients. This is defined as the median time from emergency department arrival to emergency department departure for admitted emergency department patients.[5] We excluded facilities that were primarily pediatric, specialty, critical access, or Veterans Affairs hospitals, facilities with less than 10,000 ED admissions in either 2012 or 2013 per AHA data, and facilities that reported LOS times of zero.

Quality-of-Care Outcomes

Six measures ED quality of care were obtained from the CMS Hospital Compare website: two measures of patient satisfaction (proportion of respondents giving a score of 9 or 10 and proportion of patients that would "Definitely Recommend" the facility), hospital-wide all-cause unplanned readmission, median time to pain management for long bone fracture, percent of patients given percutaneous coronary intervention (PCI) within 90 minutes for acute myocardial infarction, and percent of patients left without being seen. All measures were reported as annual values.[6] Hospital Compare has information about the quality of care of Medicare-certified hospitals across the country, and is free to the public. A uniform hospital ID was used to link with AHA data.

Predictors

The primary predictor was the CMS measure ED LOS. Although there are CMS metrics for discharged patients, prior conceptual and empirical work suggest that ED crowding is driven by the LOS of admitted patients.[7] In a pre-planned secondary analysis, we assessed the relationship between outcomes and the CMS measure for ED boarding time, which is

defined as the median time from the decision to admit a patient to emergency department departure time of the patient. Data on these two measures are self-reported through a structured and audited process.

For all quality-of-care outcomes except LWBS, the 12-month measurement periods overlapped completely with the 12-month measurement period of ED LOS and boarding time. Due to a change in the data reporting methodology of Hospital Compare, the measurement period for LWBS overlapped with ED L OS and boarding time by 9 months (LWBS Jan-Dec; LOS, admitted and boarding time Oct-Sep).

Covariates

In prior work, we identified important hospital level characteristics that were related to performance on the CMS ED timeliness measures.[8] We included annual ED and hospital admissions, case mix index and ICU occupancy obtained from CMS Cost Reports and hospital-wide occupancy obtained from CMS Hospital Compare. We also controlled for changes in ownership (public, not-for-profit, or for-profit), trauma center status (by level), and availability of psychiatric inpatient and consultation services from the AHA survey. We excluded facility characteristics that were unlikely to change over two years (e.g., designation as a Council of Teaching Hospital academic medical center). Hospital level data were obtained from the AHA survey, CMS Cost Reports and Hospital Compare. If trauma center services were missing, then we obtained such data from state trauma service websites.

Data Analysis

We used linear regression models of first differences (i.e. hospital level changes between 2012 to 2013) to test for relationships of change in outcome variables with change in ED timeliness measures.[9] In these models, observations for the dependent and independent variables for 2012 and 2013 are replaced variables representing the change between 2012 and 2013. This method has the advantage of removing time-invariant, unobserved variables that might be correlated with ED LOS and our outcomes of interest. For example, under-resourced hospitals might have a high ED LOS and poor patient satisfaction measures. However, the policy-relevant question that this paper focuses on is the first-differences regression, which provides a measure of the association between changes in ED LOS and changes in patient satisfaction measures. We used linear regressions for all outcomes, with one exception. The distribution of changes in the percentage of patients who left without being seen exhibited a large density at zero. Thus, we modeled this outcome using an ordinal logistic regression, where the change in percent of patients left without being seen was categorized as a decrease, no change, or increase between 2012 and 2013. The score test for the proportional odds assumption was non-significant ($p > 0.80$) for all ordinal logistic regression models.

Changes in covariates were categorized in quartiles for hospitals with complete data for both years. In some instances, covariates were missing in one or both years for some hospitals (see Table 1). To maximize our inclusion of hospitals, we took the following steps: we categorized the changes in continuous variables into quartiles and created a "missing" category for covariate data. All categorical variables included a response level for missing

data when data were not present for one or both years. Analyses were conducted using SAS 9.4 (Cary, NC USA); statistical significance was deteremined by p<0.05 and all tests were two-sided.

Results

Of 5892 hospitals included in AHA data, 2721 were excluded due to being critical access hospital, VA hospital or Indian Health Services. Another 476 were excluded as the hospital did not report volume data. Only 36 hospitals were excluded due to missing Hospital Compare Data and thus 2619 hospitals were included in our study. Baseline characteristics and LOS metrics are shown in Table 1. The median LOS in the cohort was 274 minutes (interquartile range 231-330 minutes) in 2013.

Table 2 displays regression results. Each additional hour of ED LOS was associated with 0.7% decrease (95% CI, 0.4 - 1.0; p<0.01) in proportion of patients giving a top satisfaction rating, 0.7% decrease (95% CI, 0.4 - 0.9; p<0.01) in proportion of patients who would "definitely recommend" the hospital, and an increase of 6 minutes (95% CI, 5 – 7; p<0.01) to pain management for long bone fracture. A one hour increase in ED LOS is associated with a 44% increase (95% CI, 24 to 68%) in the odds of having an increase in LWBS (versus having a decrease or no change). However, ED LOS was not associated with hospital readmissions (p=0.14) or time to revascularization (p=0.14).

In prespecified secondary analysis, we found a similar relationship between a separate measure of crowding - ED boarding time - and our outcome measures (See Appendix).

Discussion

To our knowledge, our study is the first to evaluate ED LOS and quality metrics using audited and publicly reported CMS data from a national cohort of hospitals. Our analytic approach of first differences mitigates potential confounding that may result from a cross-sectional analysis. We found an association between increases in ED LOS (for admitted patients) with decreases in patient satisfaction. In addition, an increased ED LOS was also associated with increased time for pain management for long bone fractures as well as left without being seen rates. Previous smaller studies have demonstrated similar trends.[4,10]

We did not find an association between LOS and time to revascularization for acute MI, or hospital readmission rates. There is mixed evidence about whether ED crowding is associated with worse quality of care for acute MI.[10,11] One potential explanation is that hospitals may have developed care protocols (rapid ECG acquisition and catheterization laboratory activation) for the management of acute MI that are robust to ED crowding. These results support the assumption that specific hospital strategies can mitigate the potential harms of ED crowding for particular conditions.[12]

Our study also assessed the association between ED LOS and hospital readmissions. A potential explanation for our findings is that the contributing role of ED LOS to future readmissions is minor, compared to other aspects of the patients hospital experience. (e.g.

quality of inpatient diagnostic and therapeutic management; transition-of-care plan; patient social supports and access to outpatient follow-up after hospital discharge).

Limitations

Our study has several limitations. Our variables were collected annually; thus our analysis may be insensitive to variation at smaller time intervals. However, this would result in a conservative bias (i.e. estimate likely represents lower bound of true association). We were unable to assess other Hospital Compare outcomes of potential interest, including median time to fibrinolysis and fibrinolytic therapy received within 30 minutes of ED arrival, due to a large amount of missing data. Finally, CMS Hospital Compare data are self-reported by hospitals, although the risk of inaccurate data is mitigated by CMS auditing procedures.

CONCLUSIONS

In summary, our findings indicate that improvements in ED timeliness measures are associated with improvements in the patient experience. Hospitals that make efforts to reduce crowding may benefit from the improvements associated with publicly reported ED timeliness measures, as well as with higher rates of patient satisfaction and referrals that could be associated with more efficient ED care.

Acknowledgement

First Differences Methodology

The first differences methodology can be used in cases where data are longitudinal but exhibit only two observations for each unit. (In our study, the unit is the hospital; in other studies, the unit could be a person, county, organization, etc.).

If we consider a typical regression of the form

$$y_{it} = b0 + b1^* x1_{it} + b2^* x2_{it} + x3_{it} + e_{it}$$

Where "i" indexes the hospital and "t" indexes the year (t = 1, 2), then the first differences model becomes

$$\Delta y_i = c1^* \Delta x1_i + c2^* \Delta x2_i + c3^* \Delta x3_i + \Delta e$$

Where $y_i = y_{2i} - y_{1i}$

$x1_i = x1_{2i} - x1_{1i}$

$x2_i = x2_{2i} - x2_{1i}$

$$x3_i = x3_{2i} - x3_{1i}$$

$$e_i = e_{2i} - e_{1i}$$

Note that first differencing removes variables that do not change over time. It also removes any "unobservable" variables that are fixed over time. The net result is the model provides an estimate of the change in "x" variables on the change in the outcome of interest "y."

First difference models are equivalent to econometric "fixed effects" models when the number of time periods is limited to 2.

Appendix Table

ED Boarding Times

Quality of Care Metric	Change Associated with a 1 hour increase in LOS (95% Confidence Intervals)	P value
Proportion of respondents giving hospital a 9 or 10 score	−0.56 (−0.86 to −0.26)	<.01
Proportion of respondents that would "Definitely Recommend" the hospital	−0.49 (−0.78 to −0.19)	<.01
30-day Hospital Wide Readmission Rate	0.01 (−0.06 to 0.09)	0.69
Median Time to Pain Management for Long Bone Fracture (minutes)	3.17 (2.14 to 4.19)	<.01
Proportion of acute myocardial infarction patients given PCI within 90 minutes of arrival	−0.21 (−0.87 to 0.45)	0.53
Percent of patients left without being seen (Odds comparing those with an increase in %LWOBS to those versus no change and comparing those with no change versus those with a decrease in %LWOBS)	1.21 (1.02 to 1.43)	0.03

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Table 1

Sample Cohort Characteristics

Hospital Characteristic, n (%)	N=2619(100%)
Metro location	1,985 (75.8%)
Region	
Northeast	452 (17.3%)
South	1,041 (39.7%)
West	505 (19.3%)
Midwest	621 (23.7%)
Ownership	
Public	340 (13.0%)
Not for profit	1,773 (67.7%)
For profit	506 (19.3%)
Teaching hospital	242 (9.2%)
Trauma center [*]	612 (23.4%)
Psychiatric inpatient services [*]	1,057 (40.4%)
Psychiatric consultation services [*]	1,091 (41.7%)
Annual occupancy (%), median (25th–75th percentile) [*]	57 (44-68)
Annual ICU occupancy (%), median (25th–75th percentile) [*]	59 (45-73)
Annual ED visits (n), median (25th–75th percentile)	35,753 (22,730-57,944)
Annual hospital admissions (n), median (25th–75th percentile)	8,515 (4,171-15,575)
CMS case-mix index, median (25th–75th percentile) [*]	1.49 (1.32-1.66)
ED Timeliness Measures, median (25th–75th percentile)	
ED Length of stay (minutes)	274 (231-330)
ED Boarding Time (minutes)	96 (71-136)
Quality-of-Care Outcomes, median (25th–75th percentile)	
9 or 10 score (%) [*]	70 (65-74)
Definitely Recommend (%) [*]	71 (64-76)
Median Time to Pain Management (minutes) [*]	55 (45-66)
Hospital Wide Readmission (%)	15.2 (14.7-15.8)
Heart Attack patients given PCI within 90 min (%) [*]	97 (94-100)
Left without being seen (%) [*]	1.00 (1.00-2.00)

[*]
Data are missing for trauma center n=256 (9.8%), psychiatric inpatient and consultation services n=330 (12.6%), annual occupancy n=37 (1.4%), annual ICU occupancy n=191 (7.3%), and CMS case-mix index n=9 (0.3%), 9 or 10 score n=4 (0.2%), definitely recommend n=4 (0.2%), median time to pain management n=41 (1.6%), heart attack patients given PCI within 90 minutes n=1,149 (43.9%), left without being seen n=64 (2.4%).

Table 2

Quality of Care Metric	Change Associated with a 1 hour increase in LOS (95% Confidence Intervals)	P value
Proportion of respondents giving hospital a 9 or 10 score (%)	−0.68 (−0.95 to −0.41)	<.01
Proportion of respondents that would "Definitely Recommend" the hospital (%)	−0.68 (−0.94 to −0.42)	<.01
30-day Hospital Wide Readmission Rate (%)	−0.05 (−0.11 to 0.02)	0.14
Median Time to Pain Management for Long Bone Fracture (minutes)	5.82 (4.92 to 6.71)	<.01
Proportion of acute myocardial infarction patients given PCI within 90 minutes of arrival (%)	−0.46 (−1.08 to 0.15)	0.14
Percent of patients left without being seen (Odds comparing those with an increase in %LWOBS to those versus no change and comparing those with no change versus those with a decrease in %LWOBS)	1.44 (1.24 to 1.68)	<.01

Model includes adjustment for change in annual ED and hospital admissions, case mix index and ICU occupancy, ownership, trauma center status, and availability of psychiatric inpatient and consultation services