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DOI: 10.1377/hlthaff.2020.00670
HEALTH AFFAIRS 40,
NO. 2 (2021): 251–257
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Variation In Emergency Department Admission Rates Among Medicare Patients: Does The Physician Matter?

ABSTRACT Hospitalizations account for the largest share of health care spending. New payment models increasingly encourage health care providers to reduce hospital admissions. Although emergency department (ED) physicians play a major role in the decision to admit a patient, the extent to which admission rates vary among ED physicians even within the same hospital remains poorly understood. In this study we examined physician-level variation in ED admission rates for Medicare patients. We found meaningful variation in admission rates: The mean physician-level adjusted admission rate was 38.9 percent and ranged from 32.2 percent to 45.6 percent for physicians at the tenth and ninetieth percentiles, respectively, of the estimated distribution within the same hospital. In contrast, the predicted risk for admission based on patient characteristics varied little among these physicians, suggesting that the variation in admission rates was not due to differences in patients seen. Our results suggest that strategies targeting physician decision making could modify (by either increasing or decreasing when appropriate) rates of admissions.

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Each year there are approximately 9 million hospital admissions originating from the emergency department (ED) for people ages sixty-five and older, representing more than 70 percent of hospital admissions among the elderly.¹ These admissions come at an extraordinary cost to Medicare, with inpatient care for Medicare beneficiaries accounting for 31 percent of Medicare spending.² Rates of admission vary widely both across areas of the country and across hospitals.^{3–8} Although excess use of the hospital likely affects all age groups, overuse of the hospital may have disproportionate consequences for the elderly.^{9–13}

Prior studies have documented evidence of variation in admission rates for the Medicare population, but these studies generally have focused on regional and hospital-level variation.^{3–8}

Although geographic variation has been broadly described throughout the health care system, it is increasingly recognized that to change behavior, interventions to reduce variation need to be directed at decision makers, not geographic regions.¹⁴ In the case of hospital admissions originating from the ED, although there are many factors and external pressures (for example, the preference of the primary care physician, consulting specialist, and patient's living situation) influencing the decision to admit, the decision ultimately belongs to the ED physician. The presence of substantial variation in within-hospital physician-level admission rates could indicate a role for interventions designed to target potentially low-value admissions or to modify excessively low admission rates where appropriate. However, the extent to which admission rates from the ED vary across physicians within insti-

tutions remains poorly understood.

Using data from the Medicare program, we sought to describe the extent to which variation in admission rates is driven by individual physicians and whether physicians tend to have similar rates of admissions across a spectrum of clinical conditions. We also sought to determine whether patients are de facto randomly assigned to physicians within EDs, thereby creating a natural experiment useful for evaluating the extent to which admissions vary as a consequence of physician factors.

Study Data And Methods

STUDY POPULATION AND DATA SOURCE We used Medicare fee-for-service claims for a 20 percent random sample of beneficiaries from January 1, 2012, through September 30, 2015 (when the *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision [ICD-10], was introduced) to identify all ED visits made by traditional Medicare beneficiaries. We included ED visits to nonfederal hospital EDs (that is, excluding Indian Health Service and Veterans Affairs hospitals) located in all fifty states and Washington, D.C., for beneficiaries of any age continuously enrolled in Medicare Parts A and B without end-stage renal disease and not enrolled in Medicare Advantage during the year.

To identify ED visits and the associated physician responsible for the visit, we identified all physician claims for ED visits in the Carrier files, using Healthcare Common Procedure Coding System codes 99281–5, 99291, 99292, 99234–6, 99217–9, 99220, and 99224–6 and Place of Service code 23. We excluded ED visits that occurred within thirty days of a prior ED visit to exclude revisits that might have been related to an initial ED encounter. In addition, we excluded ED visits with claims submitted by physician assistants or nurse practitioners because cases are less likely to be randomly allocated between physicians and these professionals. For more information on how the study sample was created, see online appendix exhibit 1.¹⁵

We further limited our sample to visits for medical complaints (based on ED diagnosis codes from the Carrier file), as opposed to surgical procedures, and grouped them into clinically meaningful categories using the Clinical Classifications Software for ICD-9 available from the Agency for Healthcare Research and Quality.¹⁶ We included the thirty-seven most frequently seen diagnoses, each with 30,000 or more total visits during the period examined. We also combined related conditions into larger system-level categories: cardiovascular, pulmonary, gastroin-

testinal, genitourinary, neurologic, and other. Of note, instead of creating an exhaustive and mutually exclusive categorization that included all of the study conditions, we instead sought to identify related groupings of conditions at the organ-system level that could be grouped together reasonably. To ensure adequate sample sizes for assessing admission tendencies after controlling for hospital, we then further limited the sample to visits to EDs that had at least five physicians, each of whom had at least five included visits across all conditions during the study period. To test the sensitivity of this minimum case number, we repeated the main analysis with a higher limit of twenty-five included visits per physician and found that the results did not differ substantially.

ASCERTAINING ADMISSION STATUS For each ED visit we determined whether the patient was discharged from the ED, admitted to the hospital, or admitted to “observation” status. We considered all transfers to another hospital and visits under observation status (whether in the ED or hospital unit) to be equivalent clinically to an admission. To determine disposition, we matched the identified visits from the Carrier file to inpatient and outpatient records (for both, the ED revenue center code was equal to 0981 or in the range of 0450–9). Observation visits were initially identified through billing codes for observation care in the Carrier file and then matched to a specific ED visit using the date and the ED revenue center codes in the outpatient file. We retained in our sample all visits for which we could identify an inpatient or outpatient match within two days of the ED event identified by a physician claim. Approximately 1 percent of visits had matches in both the outpatient and inpatient files, and these were classified as inpatient admissions. We also excluded visits for which we could not determine admission status (approximately 5 percent of visits).

STUDY VARIABLES

► **PATIENT CHARACTERISTICS AND COMORBIDITIES:** From enrollment files, we assessed patients’ ages (in five-year increments), race/ethnicity (defined as White, Black, Hispanic, or other), sex, dual eligibility for Medicare and Medicaid, and disability as the original reason for Medicare eligibility. To measure patient comorbidities, we both assessed diagnoses from the Chronic Conditions Data Warehouse and calculated Hierarchical Condition Category scores. Using the Chronic Conditions Data Warehouse, we assessed whether a patient had any of twenty-six included conditions and created binary markers to indicate the presence or absence of each of these, as well as whether they had zero to five, six to eight, or nine or more

conditions. Hierarchical Condition Category scores were derived from demographic and diagnostic data in Medicare enrollment and claims files and were calculated from the claims during the twelve-month period preceding the date of the enrollee's ED visit, using software available from the Centers for Medicare and Medicaid Services.

► **PHYSICIAN CHARACTERISTICS:** For descriptive purposes, we assessed physician characteristics using data from Medicare's Physician Compare National Downloadable File.¹⁷ Variables included sex, years since medical school graduation (0–5, 6–10, 11–20, 21–30, or more than 30 years), doctor of medicine versus osteopathy, and specialty (emergency medicine, family/internal medicine, and other).

ANALYSIS To aid interpretation of physician-level results, we first examined the extent to which the sorting of patients to physicians appeared to be random, as nonrandom sorting would compromise the attribution of physician-level variation in admission rates to physician behavior as opposed to differences arising from patient factors. If patients are naturally randomly assigned to ED physicians (for example, via standard queuing mechanisms), we would expect to see little variation among physicians in patient characteristics, net of sampling error.

To test whether this appeared to be the case, we estimated a mixed-effect linear regression model predicting each patient demographic and clinical characteristic as a function of physician random effects and hospital fixed effects. The model also included day of the week and month of the year to adjust for weekly and seasonal variation in case mix and work schedules. The constraint that the physician random effect variance be nonnegative was relaxed, allowing negative variance parameters. Under perfectly random assignment, the physician variance would be 0, so because of sampling variation we expect the estimated unconstrained variance parameters to be distributed about 0, and the extent to which the distribution has a median centered at values greater than 0 provides an overall indication of the extent of nonrandomness. The inclusion of hospital fixed effects controls for differences in patient populations across hospitals and institutional practices; thus, the physician-level variance estimated by the random portion of the model reflects variation in physicians' patient characteristics about their hospitals' mean.

In addition, we also estimated an overall summary measure of patients' propensity to be hospitalized and performed the same analysis with the fitted propensity measure as the dependent variable. This propensity measure reflects a pa-

tient's probability of admission net of all physician-level (and higher) factors.

After quantifying the extent to which patient sorting is nonrandom based on observable characteristics, we next estimated the between-physician variation in admission rates, controlling for the hospital. Specifically, we fit a mixed-effect linear regression model of admission as a function of physician random effects, hospital fixed effects, year fixed effects, day of week, and month of year. The primary quantity of interest estimated by this model is the physician variance parameter, which represents the amount of variation in admission rates among physicians within a hospital that is not accounted for by the other terms in the model. To further gauge the extent to which variation among physicians in patient factors contributed to the estimated physician-level variance in admission rates, we compared estimates from models including versus excluding the summary measure of patients' propensity to be admitted.

Finally, to examine consistency in physicians' admission rates across clinical conditions, we replaced the physician random effects with physician-condition random effects. The latter was enabled by treating the regression coefficients of the indicators of each large clinical condition grouping (for example, cardiovascular, gastrointestinal, and so on) as random slopes by physician, thereby allowing a different coefficient for each condition for each physician. The condition random effects for each physician were assumed to be drawn from a multivariate normal distribution with an unstructured covariance matrix, allowing a distinct correlation coefficient of physician propensity to admit to the ED to be estimated for each pair of conditions. A positive (or negative) correlation between the physician random effects of two conditions implies that a physician who has a higher (or lower) propensity to admit a patient with one type of condition also has a higher (or lower) propensity to admit a patient with a different condition.

All analyses were conducted using SAS software, version 9.4, and SAS/STAT statistics routine, version 14.1. Institutional Review Board approval was granted by Harvard University's Committee on the Use of Human Subjects.

LIMITATIONS There were a few key limitations to our study. We were unable to determine whether the variation in admission rates that we observed was associated with differences in patient outcomes. Future research should assess the marginal value of more admissions by comparing patient outcomes between ED physicians with higher versus lower admission propensities to identify which categories of admissions can be safely targeted for reduction. We also were not

able to ascertain all potentially relevant predictors of admission, such as vital signs, presenting symptoms, or the availability of home support, from administrative claims data. We would expect, however, that similar to measured factors, unmeasurable patient risk factors would also be pseudo-“randomized” across physicians within a hospital. In addition to patient-level factors, there could be certain organizational factors relating to the physicians and institutions themselves that were not fully controlled for by our randomization. For example, some physicians may work primarily night shifts, and nonclinical factors such as time of day also may substantially affect a physician’s ability to admit or discharge patients. Medicare data do not contain time of presentation.

Medicare claims also do not allow for determination of whether patients are admitted to a dedicated ED observation unit or “inpatient”

unit. For this reason and because they both imply additional resources and longer monitoring, we combined the two and included all observation visits as admissions. Further, by holding the ED constant in our analysis, we held constant the presence of a formal observation unit.

Finally, because this analysis was limited to Medicare claims and largely an elderly population, the findings might not generalize to other payers or younger patients.

Study Results

Our study sample included 5,778,218 visits seen by 45,491 physicians at 3,480 EDs. The mean age of the patient at the time of the visit was 72.5 years. Patients were predominantly female (58.4 percent) and White (76.7 percent) (exhibit 1). The majority of physicians were male (75.3 percent), and 83.8 percent were MDs (exhibit 2). Emergency medicine physicians cared for 81.2 percent of visits compared with 12.4 percent for family/internal medicine clinicians and 6.5 percent for physicians of other specialties (exhibit 2).

Across the major clinical categories, excluding “other,” cardiovascular conditions (1,455,478 total visits) were the most common, followed by pulmonary (1,032,388 visits) and gastrointestinal (867,728 visits) (see appendix exhibit 2 for full details of the visits for each condition).¹⁵ Admission rates varied by diagnosis, as expected, ranging from a high of 94.9 percent for septicemia to a low of 8.3 percent for “other back problems” (appendix exhibit 2).¹⁵

On average, the mean rate of admissions among physicians was 38.9 percent, but adjusted admission rates varied substantially within hospitals, ranging from 32.2 percent to 45.6 percent for physicians at the tenth and ninetieth percentiles, respectively, of the distribution predicted by the estimated physician-level variance (data not shown). This 13.4-percentage-point absolute difference (95% confidence interval: 13.31 percent, 13.44 percent) greatly exceeds the differences in admission rates between patients with versus without most major clinical conditions after adjusting for other covariates. For example, the presence of chronic renal insufficiency and congestive heart failure were each associated with approximately a 7-percentage-point higher admission rate ($p < 0.001$ for both), and the adjusted difference in admission rates between patients ages 85–89 and those ages 65–69 was 8.2 percentage points ($p < 0.001$) (appendix exhibit 3).¹⁵

The models examining the extent to which the likelihood of admission varied across physicians within the same hospital also were consistent

EXHIBIT 1

Descriptive summary of patient predictors in the study of Medicare admissions to hospitals from the emergency department, 2012–15

Predictors	Percent
Age, years ^a	14.33
<65	21.83
65–70	16.40
71–75	15.22
76–80	14.73
81–85	14.14
>85	17.68
Female	58.36
Race/ethnicity	
White	76.74
Black	14.02
Hispanic	6.18
Other	3.06
Original reason for Medicare	
Age	66.06
Disability or end-stage renal disease	33.84
Medicaid recipient	26.03
Hierarchical Condition Categories score (quartiles)	
0.08–0.55	24.89
0.56–1.07	25.10
1.08–2.40	25.01
2.41–21.04	24.99
Chronic Conditions Data Warehouse conditions count	
0–5	22.61
6–8	25.17
9+	52.22
Visits per beneficiary	
1	54.10
2	22.85
3–5	19.29
6+	3.76

SOURCE Authors’ analysis of data from Medicare claims. **NOTE** $N = 5,778,218$ patients. ^aMean age is 72.5 years.

with the assumption that patients are randomly sorted among physicians within a hospital. The overall propensity for being admitted based on all of the patient predictors varied minimally across physicians, as did each of the individual patient-level characteristics (see appendix exhibit 4).¹⁵ Exhibit 3 demonstrates the distribution of physician-level variation in adjusted admission rates within hospitals compared with the predicted distribution of admission rates based on only between-physician variation in patient characteristics within hospitals. The exhibit confirms that there is substantial variation in rates of admission among physicians within a hospital that is not related to patient characteristics.

Across the large clinical groupings, we found moderate-to-high correlation in admission rates at the physician level across clinical conditions. The magnitude of these correlations ranged from 0.59 to 0.96 (for example, the correlation between admission tendency for gastrointestinal and pulmonary conditions was 0.81). That is, physicians generally had consistently higher or lower tendencies to admit (relative to other physicians in the same hospital) across conditions (exhibit 4).

Discussion

Using nationally representative data from the Medicare program, we found that there is substantial variation in rates of admissions among physicians at the same hospital that is not related to observable patient characteristics. Physicians' rates of admissions for one particular clinical condition is also predictive of their admission rates for other conditions, suggesting that variation in admission rates reflects physician-level tendencies that are consistent across different types of clinical conditions.

A particular strength of our study is that we were able to demonstrate that patients are indeed naturally randomly assigned to ED physicians. Unlike many studies outside of emergency medicine, our study can take advantage of the fact that patients largely do not select which physician they see in an ED. Our results differ from those of a recent study that found evidence of nonrandom sorting of patients to ED physicians, but that study was limited to a single academic ED and did not account statistically for the contribution of sampling error to physician-level differences in patient characteristics.¹⁸ Our study suggests that nonrandom selection of patients by physicians accounts for only a small proportion of patient allocations in EDs nationally.

Prior research has detailed wide rates of geographic variation in health care use and spend-

EXHIBIT 2

Descriptive summary of physician characteristics in the study of Medicare admissions to hospitals from the emergency department, 2012-15

Characteristics	Percent
Sex	
Female	24.72
Male	75.28
Years of experience	
0-5	9.56
6-10	16.93
11-20	30.36
21-30	20.66
>30	17.34
Missing	5.16
Specialty	
Emergency medicine	81.16
Family/internal medicine	12.36
Other	6.47
Medical credentials	
Doctor of medicine	83.81
Doctor of osteopathy	16.19

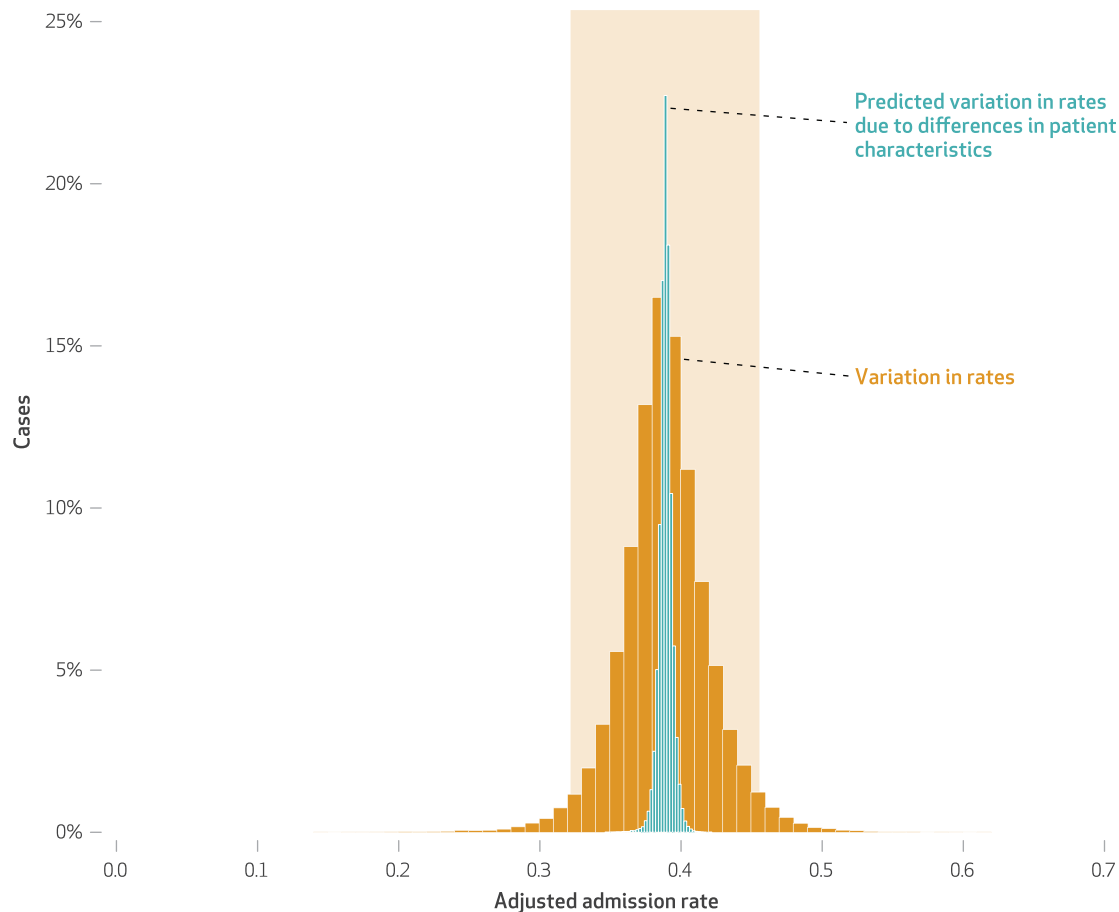
SOURCE Authors' analysis of data from Medicare claims. **NOTE** N = 45,491 physicians.

ing unrelated to patient factors or price differences. More recently, authors have begun to deconstruct the reasons for intraregional variations in care, identifying factors such as patient preference and physician-related factors.^{19,20} Studies in the ED have examined regional and hospital-level differences, largely excluding the potential impact that physician decision making may have both across and within geographic regions and hospitals. A few studies have begun to look at variation in admission rates at the physician level, although they have been limited to single institutions.²¹⁻²³ Our work builds on these prior studies by examining—on a national scale—the extent of variation explained by the physicians actually making the decisions to admit patients.

This focus has a clear policy relevance, as it points to an actionable area for interventions aimed at altering admission rates by modifying physician behavior. That there is significant variation among physicians even within the same hospital suggests that there is an opportunity to devise interventions targeted at physician decision making and that such interventions might be effective in hospitals, with some physicians having low rates and other physicians having high rates of admission. Such interventions, such as clinical pathways for specific conditions or feedback of physician admission metrics, would seek to better support ED physicians' decision making by supplying them with more information about patients' need for admission. This information would assist physicians in em-

EXHIBIT 3

Distribution of physician-level variation in adjusted hospital admission rates for Medicare patients within hospitals, 2012-15



SOURCE Authors' analysis of Medicare claims using a mixed-effect linear regression model. **NOTE** The shaded area is between the tenth and ninetieth percentiles.

playing alternative strategies to achieve the same clinical outcomes without admission or in choosing an admission when it is the appropriate dis-

position. This balance again highlights that for many conditions the “right” level of admissions is unknown.

EXHIBIT 4

Correlation in physician admission rates across clinical condition in the study of Medicare admissions to hospitals from the emergency department, 2012-15

	Cardiovascular	Gastrointestinal	Pulmonary	Neurologic	Genitourinary	Other
Cardiovascular	1.00					
Gastrointestinal	0.73	1.00				
Pulmonary	0.62	0.81	1.00			
Neurologic	0.59	0.68	0.61	1.00		
Genitourinary	0.66	0.96	0.91	0.70	1.00	
Other	0.64	0.79	0.81	0.63	0.90	1.00

SOURCE Authors' analysis of Medicare claims using a mixed-effect linear regression model of admission as a function of physician-condition random effects, hospital fixed effects, and time fixed effects. **NOTE** A positive correlation between the physician random effects of two conditions implies that a physician who has a higher (or lower) propensity to admit a patient with one type of condition also has a higher (or lower) propensity to admit a patient with a different condition.

Conclusion

Reducing unnecessary hospital admissions from the ED and their associated costs first requires an understanding of the factors driving these admissions. Efforts to ensure that patients who could benefit from hospitalization are admitted

also require a similar understanding. The wide variation in ED physicians' admission rates seen in our study suggests that physician decision making contributes considerably to whether a patient in the ED is admitted and might therefore be a fruitful target for interventions. ■

Preliminary results from this research were presented at the AcademyHealth Annual Research Meeting in Washington,

D.C., June 3, 2019. Peter Smulowitz, James O'Malley, Michael McWilliams, and Bruce Landon were supported by

the Agency for Healthcare Research and Quality (Grant No. 1R01HS025408-01).

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