

# Emergency Department Physician-Level and Hospital-Level Variation in Admission Rates

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**Study objective:** We explore the variation in physician- and hospital-level admission rates in a group of emergency physicians in a single health system.

**Methods:** This was a cross-sectional study that used retrospective data during various periods (2005 to 2010) to determine the variation in admission rates among emergency physicians from 3 emergency departments (EDs) within the same health system. Patients who left without being seen or left against medical advice, patients treated in fast-track departments, patients with primary psychiatric complaints, and those younger than 18 years were excluded, as were physicians with fewer than 500 ED encounters during the study period. Emergency physician-level and hospital-level admission rates were estimated with hierarchic logistic regression, which adjusted for patient age, sex, race, chief complaint, arrival mode, and arrival day and time.

**Results:** A total of 389,120 ED visits were included in the analysis, and patients were treated by 89 attending emergency physicians. After adjusting for patient and clinical characteristics, the hospital-level admission rate varied from 27% to 41%. At the physician level, admission rates varied from 21% to 49%.

**Conclusion:** There was 2.3-fold variation in emergency physician adjusted admission rates and 1.7-fold variation at the hospital level. In the new era of cost containment, wide variation in this common, costly decision requires further exploration. [Ann Emerg Med. 2013;61:638-643.]

Please see page 639 for the Editor's Capsule Summary of this article.

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## INTRODUCTION

### Background

In 2009, of the approximately 130.6 million visits to US emergency departments (EDs), 19.6 million patients (15%) were admitted to the hospital.<sup>1</sup> The ED admission rate has remained stable over time, but increasingly the ED is becoming hospitals' front door for admissions. The proportion of hospitalized patients admitted through the ED increased from 38.6% in 1999 to 49.7% in 2009.<sup>1</sup>

### Importance

The emergency physician's decision to admit a patient to the hospital has large cost implications and is, perhaps, the most expensive routine decision that emergency physicians make. At the hospital level, admission rate variation has been demonstrated across the United States.<sup>2</sup> Several studies have also explored physician-level variation in admission rates for specific disease entities such as pneumonia and chest pain.<sup>3,4</sup> One Canadian study showed 2-fold variation (9% to 17%) in emergency physician admission rates.<sup>5</sup> Several factors been found to explain some differences in admission rates, such as various levels of physician

risk tolerance, malpractice fear, and difference in practice styles.<sup>3-6</sup> No studies to our knowledge have explored admission rate variation in a general ED population within a group of US emergency physicians.

### Goals of This Investigation

In 3 EDs within a single health system, we explored the variation in the attending emergency physician-level and hospital-level admission rates for adult patients, excluding low-acuity patients, pediatric patients, or those with primary psychiatric complaints.

## MATERIALS AND METHODS

### Study Design and Setting

We conducted a retrospective, cross-sectional study using ED data from 3 hospitals during various periods from 2005 to 2010. The included hospitals were all within the same health system with a common electronic medical record. Data from various periods was used at the 3 hospitals during the 5-year period because of data availability from the electronic medical record. Data from hospital 1 (H1) were included from January

**Editor's Capsule Summary***What is already known on this topic*

The variation of emergency department (ED) admission rates is poorly understood and may be a source of opportunity for improved care.

*What question this study addressed*

How much variation exists across 3 EDs in 1 health system when physicians decide to admit?

*What this study adds to our knowledge*

After examining 5 years of existing data with 389,120 ED visits, with patients cared for by 89 physicians, and after adjusting for select patient factors, the authors observed marked site (27% to 41%) and physician (21% to 49%) admission rate variability.

*How this is relevant to clinical practice*

A potential opportunity to limit variation exists, though variation alone is not a sign of poor decisionmaking or care.

*Research we'd like to see*

Linking variation to patient outcomes or costs and then determining whether less variation means better results could alter systematic approaches to individual admission decisions.

2008 to July 2010. H1 is an urban Level I trauma teaching hospital with an emergency medicine residency program and is a major referral center in Washington, DC. Data from hospital 2 (H2) were included from January 2005 to June 2009; and hospital 3 (H3), from July 2006 to June 2009. Both H2 and H3 are acute care community teaching hospitals in the Baltimore area, without a dedicated emergency medicine residency training program; however, some patients are treated by non-emergency medicine rotating residents. In addition, H2 and H3 have physician assistants who care for low-acuity patients during overnight hours (Table 1). H1 is located next to a freestanding pediatric hospital and does not treat pediatric patients; H2 cares for children but does not have a separate pediatric section in its ED; and H3 has a separate pediatric ED. None of the hospitals have ED-based observation units. This study was approved by the institutional review board.

**Selection of Participants**

ED visits from the 3 hospitals during the study period were included as the study cohort. However, we excluded patients who left without being seen or left against medical advice, were treated in low-acuity fast-track departments, with primary psychiatric complaints (flagged separately in the electronic

medical record), or were younger than 18 years because admission rates would be expected to be substantively different in those populations and pediatric patients are not treated primarily in the main sections of 2 of the 3 EDs. We did not differentiate inpatient and observation admissions; both were included as admitted patients. We attributed admission decisions to the first attending emergency physicians who evaluated the patient and did not account for other health care providers who might have been involved, such as sign-out attending emergency physicians, residents, physician assistants, consultants, or referring physicians.

Attending emergency physicians from the 3 hospitals during the study period were included. After we excluded ineligible patients, number of ED encounters by physicians was calculated. Physicians with fewer than 500 ED encounters were excluded because an emergency physician with fewer than 500 ED encounters during 3 years does not represent a full- or even a part-time physician (<2 shifts/month, based on 1 patient/hour).

**Data Collection and Processing**

Available electronic data were extracted with Azzyxi (version 5.0; Microsoft Corporation, Redmond, WA) into a Microsoft Excel (2007; Microsoft Corporation) worksheet. Several fields were extracted, including the first recorded complaint for each visit; the physician associated with each encounter, defined as the first physician assigned to the patient record; patient demographics; and mode of arrival (ambulance versus nonambulance). Patient acuity as assessed by triage level (1-to-4 scale; 1=emergent to 4=less urgent) was available at H1 only and was used in a planned subgroup analysis. Chief complaints that were entered as a free-text field in the electronic record were classified with the "reason for visit classification for ambulatory care" by 1 author (J.A.).<sup>7</sup> In addition, we obtained multiple emergency physician-level variables from staffing data, which were used for descriptive purposes only. We used the last year of the study (2009) to be our calculating point; therefore, physician's age and years of experience were calculated with the year 2009. For instance, age=2009-year of birth, etc.

**Primary Data Analysis**

We first described the sample at the patient, emergency physician, and hospital level with standard descriptive statistics. Next, we conducted a hierarchic logistic regression to model each patient's admission decision as a function of patient age, sex, race, chief complaint, arrival mode, and arrival day/time. Patients were clustered within physicians, and physicians were clustered within hospital and accounted for, for repeated patient encounters by the same patient. The statistical significance of hospital effect and physician effect was tested by a log-likelihood ratio test individually. The model permitted us to account for the natural heterogeneity of hospital- and physician-level performance.<sup>8</sup>

We defined each physician's "admission rate" as number of patients admitted divided by number of patients treated. Emergency physician- and hospital-level adjusted admission rates

**Table 1.** Hospitals' characteristics with their admission rates and patients' characteristics.\*

Study Period	Total	H1	H2	H3
	January 2005–July 2010	January 2008–July 2010	January 2005–June 2009	July 2006–June 2009
Annual ED visits, average, No.		81,000	57,800	106,000
Total ED visits in the study, No.	389,120	140,842	119,308	128,970
Hospital admission rate "after exclusion" <sup>†</sup>	35	36	27	41
<b>Patient age (%), y</b>				
18–34	27	24	29	29
35–54	35	36	38	31
55–64	14	16	13	12
>65	24	24	20	28
<b>Sex</b>				
Female	58	59	53	60
<b>Race</b>				
Black	61	90	71	20
Nonblack	39	10	29	80
<b>Arrive mode</b>				
Ambulance	27	30	21	29
Other	73	70	79	71
<b>Time of arrival</b>				
Day	40	42	39	39
Evening	37	36	37	37
Night	23	22	24	24
<b>Day of arrival</b>				
Weekend	27	26	26	28
Weekday	73	74	74	72

\*Data are presented as percentage unless otherwise indicated.

<sup>†</sup>Left without being seen, left against medical advice, fast-track, patients with primary psychiatric complaints, or patients who were less than 18 years of age.

were calculated in 2 steps. First, we calculated the odds of admission with the random intercept of the logistic regression. Second, we converted the odds of admission to admission rates. The reliability of the estimates was assessed according to the variability attributable to physicians relative to the total variability of the admission rate and the average number of patients treated by the physicians.<sup>9</sup> From the included 89 physicians, only 2 worked in 2 different hospitals. These 2 physicians were treated as separate individuals in each hospital in the model, which resulted in 91 physician observations in the final model.

We also conducted a planned subgroup analysis on H1. We added patient acuity level to the logistic regression as a fixed effect to determine whether the physician variation was affected by adding additional clinical characteristics. There were few missing data so no imputation was necessary. *P* values less than .05 were considered significant. Statistical analysis was conducted with SAS (version 9.2; SAS Institute, Inc., Cary, NC).

## RESULTS

There were 743,207 ED visits during the study period; excluded visits were left without being seen and against medical advice (14,274), fast track (169,574), patients with primary psychiatric complaints (14,951), pediatrics (146,386), and treated by physicians with fewer than 500 ED encounters (8,902). A total of 389,120 ED visits were included in the analysis after applying exclusion criteria. Patients' demographics

were as follows: mean patient age was 50 years, and female and black were the predominant sex and race (58% and 59%, respectively) (Table 1). The most common chief complaint categories were chest pain (14%), shortness of breath (11%), and abdominal pain (11%).

There were a total of 215 physicians involved in 743,207 ED visits. Twenty-five physicians were excluded initially because they were treating fast-track patients only, patients with primary psychiatric complaints only, or pediatric patients only. A total of 190 physicians were involved in 389,120 ED visits.

Furthermore, 99 physicians with fewer than 500 ED encounters were excluded, which yielded 89 physicians who were included in the analysis. Mean physician age was 39 years, with 53 (60%) being men. The mean time since graduation was 9.2 years, and 86 (97%) were emergency medicine board certified. For further classification by hospital, refer to Table 2.

There was a great variation at the hospital and physician level. The adjusted admission rates differed significantly between hospitals (H1 = 36%, H2 = 27%, and H3 = 41%; *P* < .001). Similarly, the variation of the adjusted admission rate at the physician level was approximately 2.3-fold (21% to 49%), adjusted for hospital and patient and clinical characteristics (Figure).

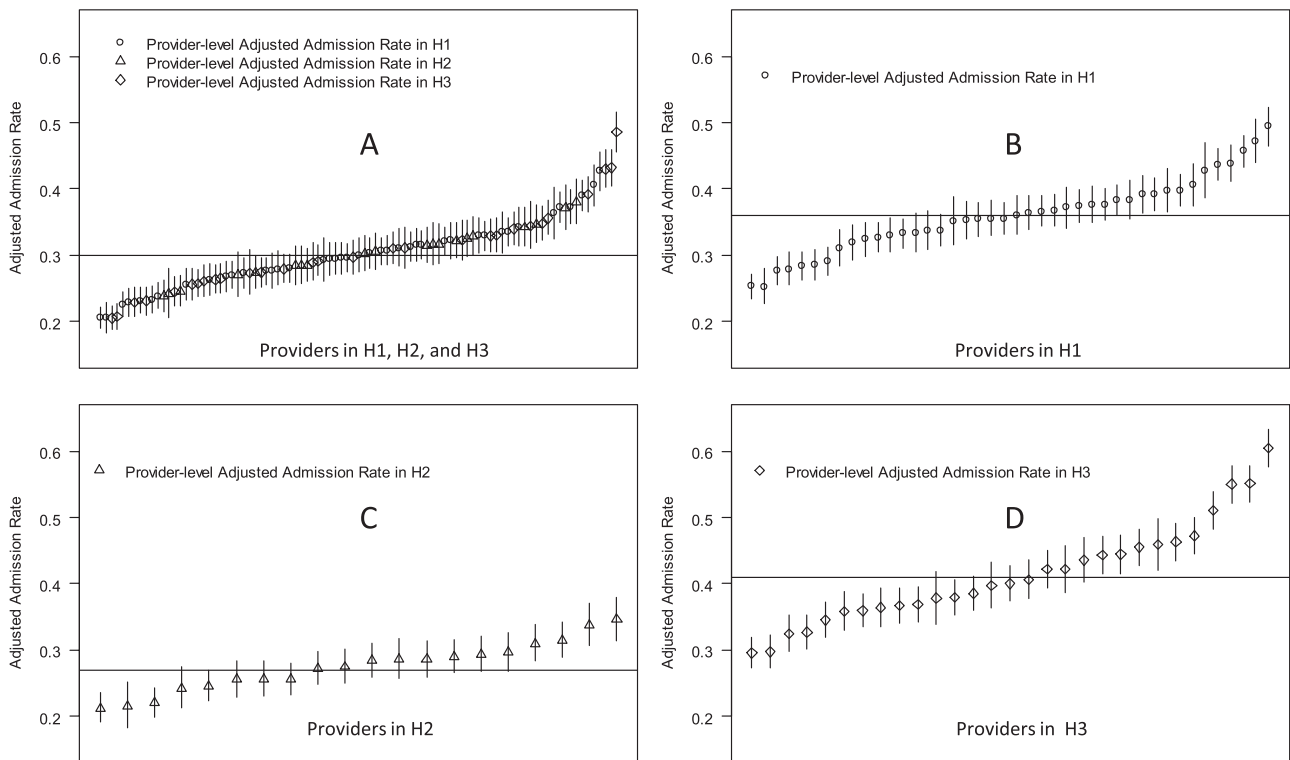
The physician-level adjusted admission rates in H1 without controlling for acuity level were 21% to 43%. By adding acuity level to the regression model, the range of adjusted admission rates did not meaningfully change these rates.

**Table 2.** Emergency physicians' admission rates and characteristics across 3 hospitals.

Characteristics	Total	H1	H2	H3
Number of physicians	89*	42	20	29
Median No. of patients per physician (interquartile range)	4,104 (2,349–5,641)	3,025 (2,093–4,635)	5,725 (3,003–9,370)	4,640 (3,359–5,958)
Physician admission rates, unadjusted, %	18–58	26–52	18–38	28–58
Physician admission rates, adjusted, % <sup>†</sup>	21–49	25–49	21–35	30–58
<b>Physician age, No. (%), y</b>				
31–40	62 (70)	27 (64)	15 (75)	21 (72)
41–50	20 (22)	12 (29)	4 (20)	5 (17)
51–60	7 (8)	3 (7)	1 (5)	3 (10)
<b>Physician sex, No. (%)</b>				
Male	53 (60)	27 (64)	11 (55)	17 (59)
<b>Experience, No. (%), y</b>				
0–5	33 (37)	21 (50)	5 (25)	7 (24)
6–10	30 (34)	9 (21)	10 (50)	12 (41)
11–15	13 (15)	6 (14)	3 (15)	5 (17)
>15	13 (15)	6 (14)	2 (10)	5 (17)
<b>Board certification, No. (%)</b>				
Yes	86 (97)	41 (98)	20 (100)	27 (93)
No	3 (3)	1 (2)	0	2 (7)

\*Two physicians worked in 2 hospitals.

<sup>†</sup>Adjusted for hospital and patient age, sex, race, mode of arrival, arrival day and time, and chief complaint, using a hierarchic logistic regression.



**Figure.** Adjusted admission rate by provider. A, Adjusted admission rate by provider adjusted for patient characteristics and hospital for all providers in H1, H2, and H3. B, C, D, Hospital-specific adjusted admission rate by provider.

**LIMITATIONS**

There are several limitations to this study. First, generalizability may be limited because it was performed in only 3 hospitals within a single health system in 1 geographic area. Another limiting factor is that differences in admission rates

may also be explained by other unmeasured variables such as patient-level factors: physiology, social situation, and other comorbidities. Adding these characteristics would be expected to reduce the variation in admissions rates, potentially resulting in an overestimate of the actual variation.

We also did not control for physician characteristics in the model or where specifically they were assigned to work in the ED. Being assigned to certain areas of the ED (ie, being primarily responsible for the severe trauma population) may demonstrate differences in admission rates that we could not control for in the model. We also were not able to control for unmeasured differences in severity of the case mix between the hospitals. For example, teaching hospitals that serve as referral centers (like H1) may have higher admission rates. Our planned subgroup analysis within H1, the only hospital with triage acuity, did not show any substantial within-hospital effect of triage acuity; however, we were not able to control for this across hospitals. We did, however, control for arrival by ambulance across the whole data set, but this is likely an imperfect measure of severity.

In addition, we excluded fast-track patients, assuming that the majority of them were discharged, which may have resulted in not capturing the complete admission practices of some physicians who may have higher admission rates for the low-acuity population. We also excluded pediatrics and patients with primary psychiatric complaints, so our findings cannot be generalized to those populations. Multiple stakeholders affect admission decisions in the ED, which are complex interactions. When we controlled for the day of the week and 8-hour shift, which may be proxies for variation in other staffing (ie, residents, physician assistants, or consultants), our results did not substantially change, indicating that time of day and other staffing may not have a large effect, but this certainly deserves more detailed study. Finally, in our model we accounted for 2 physicians who worked at 2 of the study hospitals as separate observations, which limits our ability to differentiate decisions in different settings.

## DISCUSSION

We found great variation in the decision to admit patients among the 89 emergency physicians across the 3 hospitals studied, varying 2.3-fold in the adjusted analysis. There was also large variation at the hospital level, but less so (1.7-fold).

There are several reasons that may explain the variation in the decisions to admit in this study. Some of these may have to do with the local environment and standards of care: physicians caring for patients who have better access to primary care physicians may be less likely to admit patients for equivocal reasons because emergency physicians may be more comfortable that patients will be monitored as outpatients. This may explain why the admission rate varied dramatically by hospital. The hospital with the lowest admission rate is located in a more affluent neighborhood, which may indicate better primary care access. The greater variation among emergency physicians themselves may be a function of differences in training, experience, knowledge, and willingness to use clinical decision rules; their own tolerance for risk; or fear of malpractice.

Our findings are similar to those of another recent study on emergency physician variation in admissions for pneumonia in the United States, which found a 2-fold difference in pneumonia admission decisions across 18 physicians in 1 hospital.<sup>3</sup> Another Canadian study also found 2-fold variation

in individual emergency physician admission proportions across 30 physicians in 1 hospital.<sup>5</sup> Exploring the variation in admission decisions from the ED may play a role in future cost-containment efforts. Reducing health care costs is a major national priority, and hospital costs are growing faster than nonhospital health care costs. Because the ED is increasingly becoming the location in the health care system where hospital admission decisions are made, understanding variation in this decision in future work is important.<sup>10</sup> Specifically, future studies should focus on exploring further explanations for this wide variation, whether similar admission rate variation exists in other settings, and what types of interventions may be effective in standardizing admission decisions to reduce variation.

We found 2.3-fold variation in the individual physician adjusted overall admission rates, indicating great variation among emergency physicians in the proportion of treated patients whom they hospitalize. Evaluating the causes and consequences of such significant variation needs further exploration, particularly in the context of health reform efforts aimed at reducing costs.

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*Author contributions:* JA, WJF, RS, MS, and JMP conceived the study and designed the research. WJF and MS supervised data extraction. JA extracted the data. JA, WJF, and JMP managed, analyzed, and interpreted the data. RD and JMP provided statistical advice on study design and analyzed the data. JA and JMP drafted the article, and all authors contributed substantially to its revision. JA takes responsibility for the paper as a whole.

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