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ORIGINAL CONTRIBUTION

Cherry Picking Patients: Examining the Interval Between Patient Rooming and Resident Self-assignment

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Abstract

Objective: We aimed to evaluate the association between patient chief complaint and the time interval between patient rooming and resident physician self-assignment ("pickup time"). We hypothesized that significant variation in pickup time would exist based on chief complaint, thereby uncovering resident preferences in patient presentations.

Methods: A retrospective medical record review was performed on consecutive patients at a single, academic, university-based emergency department with over 50,000 visits per year. All patients who presented from August 1, 2012, to July 31, 2013, and were initially seen by a resident were included in the analysis. Patients were excluded if not seen primarily by a resident or if registered with a chief complaint associated with trauma team activation. Data were abstracted from the electronic health record (EHR). The outcome measured was "pickup time," defined as the time interval between room assignment and resident self-assignment. We examined all complaints with >100 visits, with the remaining complaints included in the model in an "other" category. A proportional hazards model was created to control for the following prespecified demographic and clinical factors: age, race, sex, arrival mode, admission vital signs, Emergency Severity Index code, waiting room time before rooming, and waiting room census at time of rooming.

Results: Of the 30,382 patients eligible for the study, the median time to pickup was 6 minutes (interquartile range = 2–15 minutes). After controlling for the above factors, we found systematic and significant variation in the pickup time by chief complaint, with the longest times for patients with complaints of abdominal problems, numbness/tingling, and vaginal bleeding and shortest times for patients with ankle injury, allergic reaction, and wrist injury.

Conclusions: A consistent variation in resident pickup time exists for common chief complaints. We suspect that this reflects residents preferentially choosing patients with simpler workups and less perceived diagnostic ambiguity. This work introduces pickup time as a metric that may be useful in the future to uncover and address potential physician bias. Further work is necessary to establish whether practice patterns in this study are carried beyond residency and persist among attendings in the community and how these patterns are shaped by the information presented via the EHR.

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A key skill for emergency physicians is the appropriate prioritization of patients; physicians must provide medical care to multiple patients while balancing time-sensitive health outcomes, efficiency, and fairness.[1] A basic objective of emergency department (ED) triage and physician assignment is to treat the most ill patients first, and among those equally ill, treat patients on a first-come, first-served basis.[2] In practice, a number of factors affect the time interval between arrival and physician assignment. Prior work

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has demonstrated that patient characteristics, such as race,[3–5] and ED characteristics, such as visit volume,[4] affect waiting times. While waiting time variance is influenced by system and nursing factors, emergency physicians also play a role in prioritization, by selecting which patients they will see in which order when multiple patients are roomed within a short period of time.

The factors that influence patient selection by the physician in these situations are not well studied, but are critical to understand. Appropriate patient prioritization and multitasking are important goals of emergency resident education.[6] Previous work has shown that, in pediatric EDs, significant practice variation in patient selection exists between pediatric and emergency medicine residents.[7] To our knowledge this has not been studied in academic EDs among adult patients.

The goal of this study was to identify and describe the relationship between patient chief complaint and resident pickup time in an academic ED, controlling for other patient presentation factors. Examining the relationship between chief complaint and time to resident self-assignment (pickup time) will reveal implicit prioritization assumptions made in practice. This knowledge will be useful to compare actual resident behavior to idealized prioritization and identify classes of patients preferred and avoided by residents. We hypothesized that significant variation in time to residents picking up a patient would exist based on chief complaint.

METHODS

Study Design

We conducted a retrospective observational study using a data set of consecutive patients from a single, academic, university-based ED with approximately 50,000 visits per year. Medical records were downloaded from the electronic health record (EHR; Epic, Verona WI). All adult patients who presented from August 1, 2012, to July 31, 2013, were included in the analysis. Patients were excluded if not seen initially by a resident physician or for incomplete encounters. This study was approved by the institutional review board.

Study Setting and Population

Residents in the ED work from one of two physician stations and are staffed in overlapping 8-hour shifts. There is 24-hour coverage at one physician station (7 AM-3 PM, 3 PM-11 PM, 11 PM-7 AM) and 16 hours of coverage at the second station (9 AM-5 PM, 5 PM-1 AM). For the majority of shifts (>90%), more than one resident was available at any given time to pick up a patient, but during some periods only a single resident was working with a single attending during single coverage hours. The ED has no "geographic" limitations, in that a patient is placed in a free bed and may be selected by any physician, regardless of room location. There were no supervisory or procedural roles for residents; all residents present in the department engaged in direct patient care with attending supervision. Residents are generally notified of patient placement via the EHR's trackboard functionality, wherein patients newly roomed are denoted with a red flag until selected by a physician. The trackboard displays patient name, age, sex, Emergency Severity Index (ESI) triage level, length of stay, and chief complaint, as well as the care team information.

While most patients are seen by a resident physician, some patients are seen exclusively by attending physicians. Attendings see patients primarily when residents are not available to see patients primarily. We excluded patients from the study if only an attending was assigned or the attending assignment time was prior to resident assignment. Examination of the data showed a small sample of patients with outlier level intervals of resident assignment. As the interval between rooming and selection increases, the chances of these observations as being spurious (i.e., a patient who was registered and roomed but never seen or seen primarily by an attending who did not assign him or herself) increases. Thus, patients were not categorized as seen primarily by a resident if their interval of analysis was greater than 60 minutes.

Measurements

Analysis was conducted on data abstracted from the EHR. The EHR records the time of patient rooming as well as the time of self-assignment by residents. The following variables were abstracted for each patient encounter: age, race/ethnicity, sex, admission vital signs, arrival mode, chief complaint, ESI triage category, triage blood pressure, triage pulse, triage respirations, waiting room duration, and number of patients in the waiting room at the time of resident assignment. These variables were preselected for analysis in advance based on author consensus, consistency with cited previous literature, and availability for analysis. Pickup time was defined as the time interval (in minutes) between room assignment and when a resident physician assigned him or herself to the patient

Chief complaint in our EHR is stored as a string (text) variable chosen from a predefined list of possible complaints. Our data set included more than 250 chief complaints. To examine the most pertinent, we grouped all complaints with less than 100 visits among the study population into an "other" category representing 18.6% of patient encounters, effectively limiting the analysis to the 71 most common complaints. We chose to preserve the chief complaints as recorded by our EHR as opposed to coding them into groups as this reflects the information available to the residents at time of patient pickup.

Initial analysis revealed that three of these 71 complaints (trauma, motor vehicle collision, and bicycle collision) were all associated with significantly longer than expected pickup times. In reviewing ED processes, the study team felt that this finding most likely results from these complaints being used for Level 1 and Level 2 trauma team activations. For trauma activations, patient arrival is announced via overhead announcement, and residents often attend to the patient before electronically assigning themselves in the EHR, thus leading to artificially high pickup times. For this reason, these three complaints were censored from the data set prior to analysis.

Data Analysis

A parametric hazard model was used to examine the association between the explanatory variables and the pickup time. Analyses were conducted using Stata 14 (StataCorp, College Station, TX). In an exploratory data analysis, the balance between type I and type II error is an important consideration. We prospectively selected only variables we felt likely to have an association with the primary outcome in an attempt to minimize type I error while still including all relevant covariates. Including all levels of categorical variables separately, our model had 139 covariates, with 30,382 observations, for a total of 219 observations per covariate, well above the traditional guideline of 10–20 subjects per variable for accurate regression estimations.[8]

Since pickup time is positive and right-skewed, linear regression is not appropriate because several necessary assumptions are violated. We chose, therefore, to analyze pickup time as time-to-event or duration data using a parametric proportional hazard model.[9] This type of model assumes an underlying functional form of the duration distribution and then estimates the multiplicative or proportional effect of each explanatory variable on the underlying distribution.[10] We tested six underlying distributions (exponential, Weibull, gompertz, lognormal, log logistic, and generalized gamma), and while the results were qualitatively similar between the models, we found the Weibull distribution to provide the best model fit. All model results presented are based on the Weibull distribution model.

Table 1
Baseline Distribution and Model Parameters for Covariates

Variable	Baseline Distribution, *N* (%) or Mean (95% CI)
Age (yr)	
0–9	4,630 (15.24)
10–19	2,932 (9.65)
20–29	3,847 (12.66)
30–3	3,474 (11.43)
40–49	3,699 (12.17)
50–59	4,235 (13.94)
60–70	3,469 (11.42)
70–79	2,029 (6.68)
80–89	1,556 (5.12)
≥90	511 (1.68)
Race	
White	23,609 (77.71)
Native American/Alaskan native	132 (0.43)
Asian	760 (2.5)
Black or African American	3,154 (10.38)
Hispanic ethnicity	1,644 (5.41)
Other/declined to answer	1,083 (3.56)
Acuity (ESI triage code)	
1 (high)	190 (0.63)
2	7,151 (23.54)
3	18,584 (61.17)
4	4,188 (13.78)
5 (low)	269 (0.89)
Arrival mode	
Self	22259 (73.26)
EMS	7844 (25.82)
Police	79 (0.92)
Systolic blood pressure (mm Hg)	
Normal	1,733 (5.7)
100	28,626 (94.22)
>150	23 (0.08)
Temperature (°C)	
Normal	28,728 (94.56)
>38	1,654 (5.44)
Respiratory rate (breaths/min)	
Normal	26,872 (88.45)
<12	243 (0.8)
>24	3,267 (10.75)
Pulse (beats/min)	
Normal	22,967 (75.59)
<50	138 (0.45)
>100	7,277 (23.95)
Sex	
Female	16,063 (52.87)
Male	14,319 (47.13)
Waiting room census	2.11 (2.08–2.13)
Wait time prior to room (minutes)	16.67 (15.77–16.39)

ESI = Emergency Severity Index.

RESULTS

The total number of ED patients seen during the study period was 45,3112. Of these, 49 (0.1%) were excluded for missing data, and 14,416 (31.8%) were excluded as not primarily seen by a resident. An additional 465 (1.0%) were excluded for traumatic complaint, leaving 30,382 (67.1%) patients who met inclusion criteria. Demographic data and distribution of covariates are presented in Table 1. Figure 1 provides a histogram of pickup time values; the median pickup time was 6 minutes (interquartile range = 2–15 minutes). Table 2 lists the chief complaints with at least 100 cases, the number of patients seen during the year, and the unadjusted pickup time. Furthermore, Table 2 shows the model hazard ratios by chief complaint. Figure 2 shows the model adjusted pickup times for the top and bottom 10 chief complaints along with 95% confidence intervals (CIs). Of note, ankle injury, allergic reaction, and wrist injury were associated with the lowest pickup times, while vaginal bleeding, numbness/tingling, and abdominal problem were associated with the longest pickup times. Data Supplement S1 (available as supporting information in the online version of this paper) lists model parameters for all covariates.

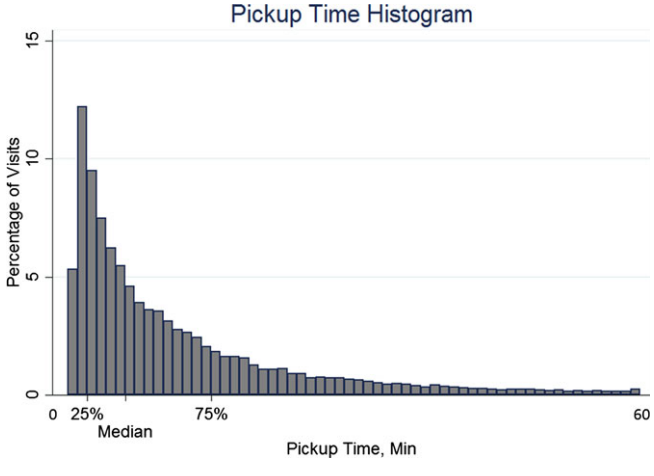

Figure 1. Pickup time histogram.

Table 2
Baseline Distribution of Pickup Time by Chief Complaint, Model Hazard Ratios

Chief complaint	Baseline Distribution, *N* (%)	Unadjusted Median Pickup Time (Interquartile Range)	Hazard Ratio (95% CI)
Abdominal pain	3,146 (10.35)	6 (2–15)	NA (baseline)
Abdominal problem*	103 (0.34)	8 (2–18)	0.83 (0.69–0.99)
Abnormal labs	233 (0.77)	6 (2–17)	0.94 (0.82–1.08)
Alcohol intoxication	111 (0.37)	7 (3–14)	0.97 (0.80–1.18)
Allergic reaction*	265 (0.87)	4 (2–10)	1.38 (1.22–1.56)
Altered mental status	380 (1.25)	7 (2–14)	1.02 (0.91–1.14)
Ankle injury*	182 (0.6)	4 (2–9)	1.48 (1.26–1.73)
Anxiety	139 (0.46)	6 (3–15)	0.95 (0.80–1.13)
Arm pain	114 (0.38)	6 (2–14)	1.10 (0.91–1.33)
Arrhythmia	138 (0.45)	5 (2–13)	1.14 (0.95–1.36)
Back pain*	633 (2.08)	8 (3–18)	0.88 (0.81–0.96)
Burn	126 (0.41)	5 (2–10)	1.24 (1.01–1.52)
Chest pain	1,926 (6.34)	6 (2–14)	1.03 (0.97–1.09)
Chest pressure	163 (0.54)	8 (3–17)	0.89 (0.77–1.04)
Confusion	119 (0.39)	8 (4–15)	0.99 (0.85–1.16)
Cough	559 (1.84)	6 (2–14)	1.01 (0.92–1.11)
Dehydration	102 (0.34)	5 (2–14)	1.08 (0.88–1.32)
Dental problem*	111 (0.37)	9 (3–20)	0.83 (0.69–0.99)
Depression	106 (0.35)	6.5 (2–14)	0.93 (0.77–1.13)
Diarrhea	216 (0.71)	7 (3–18)	0.90 (0.79–1.03)
Difficulty breathing*	291 (0.96)	6 (2–12)	1.22 (1.09–1.36)
Dizziness	513 (1.69)	7 (2–16)	0.94 (0.85–1.03)
Dyspnea*	1,431 (4.71)	7 (2–13)	1.08 (1.02–1.15)
Ear pain	144 (0.47)	6 (2–13)	1.00 (0.84–1.18)
Edema	112 (0.37)	9 (3–17.5)	0.87 (0.73–1.03)
Eye problem	225 (0.74)	5 (2–15)	1.01 (0.88–1.17)
Fall	1,205 (3.97)	7 (2–14)	1.02 (0.95–1.09)
Fatigue/ malaise	248 (0.82)	7.5 (2–19.5)	0.92 (0.82–1.04)
Fever	1,311 (4.32)	6 (2–14)	0.97 (0.90–1.04)
Finger injury*	167 (0.55)	4 (2–11)	1.25 (1.05–1.49)
Flank pain*	418 (1.38)	5 (2–13)	1.18 (1.07–1.31)
Hand injury	117 (0.39)	5 (2–11)	1.24 (1.02–1.49)
Head injury	373 (1.23)	6 (2–12)	1.04 (0.94–1.16)
Headache*	955 (3.14)	7 (2–18)	0.93 (0.87–1.00)
Hip pain	130 (0.43)	5 (2–14)	1.06 (0.88–1.27)
Hyperglycemia	155 (0.51)	5 (2–13)	1.10 (0.93–1.30)
Hypertension	123 (0.4)	8 (3–19)	0.94 (0.81–1.11)
Infection	247 (0.81)	8 (3–17)	0.88 (0.78–0.99)
Knee pain	147 (0.48)	5 (2–16)	1.02 (0.87–1.21)
Laceration/ wound	646 (2.13)	5 (2–12)	1.04 (0.95–1.14)
Leg injury*	122 (0.4)	4 (1–10)	1.25 (1.01–1.55)
Leg pain	277 (0.91)	7 (2–16)	0.95 (0.84–1.08)
Leg problem	207 (0.68)	6 (2–13)	1.08 (0.94–1.24)
Motor vehicle collision	518 (1.7)	10 (5–14)	0.90 (0.83–0.98)
Nausea/ vomiting	580 (1.91)	7 (2.5–17)	0.91 (0.84–0.99)
Neck pain	159 (0.52)	7 (2–22)	0.85 (0.73–0.99)
Numbness/ tingling*	141 (0.46)	10 (3–22)	0.81 (0.70–0.94)
Other	5,657 (18.62)	6 (2–15)	1.01 (0.96–1.05)
Overdose*	216 (0.71)	5 (2–9)	1.32 (1.14–1.53)
Pain	121 (0.40)	8 (3–19)	0.89 (0.75–1.04)
Palpitations	194 (0.64)	6 (2–15)	1.11 (0.96–1.28)
Psychiatric problem	378 (1.24)	6 (3–16)	0.94 (0.84–1.05)
Rash	157 (0.52)	6 (2–13)	1.03 (0.88–1.21)
Rectal bleed	298 (0.98)	7 (3–14)	1.02 (0.91–1.15)
Seizure	385 (1.27)	6 (2–14)	0.97 (0.87–1.07)
Shoulder pain	109 (0.36)	5 (2–12)	1.15 (0.93–1.42)
Sore throat	214 (0.70)	5 (2–13)	1.09 (0.93–1.27)
Stroke symptoms*	130 (0.43)	4 (2–11)	1.37 (1.15–1.62)
Suicidal	382 (1.26)	6 (2–14)	1.02 (0.92–1.14)
Syncope	358 (1.18)	8 (2–17)	0.91 (0.82–1.01)
Tube problems	223 (0.73)	6 (3–15)	0.96 (0.85–1.10)
UTI symptoms	155 (0.51)	7 (3–14)	0.96 (0.82–1.12)
Vaginal bleeding*	108 (0.36)	11 (3–21.5)	0.77 (0.65–0.92)
Vision problem	142 (0.47)	9 (3–18)	0.87 (0.76–1.01)
Vomiting	625 (2.06)	5 (2–13)	1.05 (0.96–1.16)
Weakness	312 (1.03)	8 (3–17.5)	0.89 (0.80–1.00)
Wheezing*	109 (0.36)	4 (2–10)	1.38 (1.13–1.68)
Wound check	161 (0.53)	6 (3–14)	1.01 (0.87–1.17)
Wrist injury*	114 (0.38)	4 (1–11)	1.38 (1.13–1.68)

Increasing hazard ratios correspond to decreased pickup time.
UTI = urinary tract infection.
*Hazard ratios significant at an alpha of 0.05.

DISCUSSION

In our ED, we found that even after controlling for key confounders, the length of time between a patient being roomed and the resident picking up the patient varies across chief complaints, with residents assigning themselves more rapidly to complaints that are typically associated with quick dispositions and more slowly to more complex complaints that are typically associated with extensive evaluations.

To our knowledge, the interval between rooming and physician assignment has not been previously examined as a proxy for physician preference. Given the variability we observed, this may be useful for future examinations of assignment behavior. Our findings call attention to the interaction between the EHR and physician behavior. The electronic "trackboard," ubiquitous in the modern ED, provides a specific subset of filtered patient information to providers prior to assignment. Our results suggest that this information affects physician behavior and not necessarily for the benefit of patients or departmental efficiency. The factors influencing this prioritization and the potential effects on physician productivity and patient outcomes have not been studied. While the overall difference in pickup time is likely of

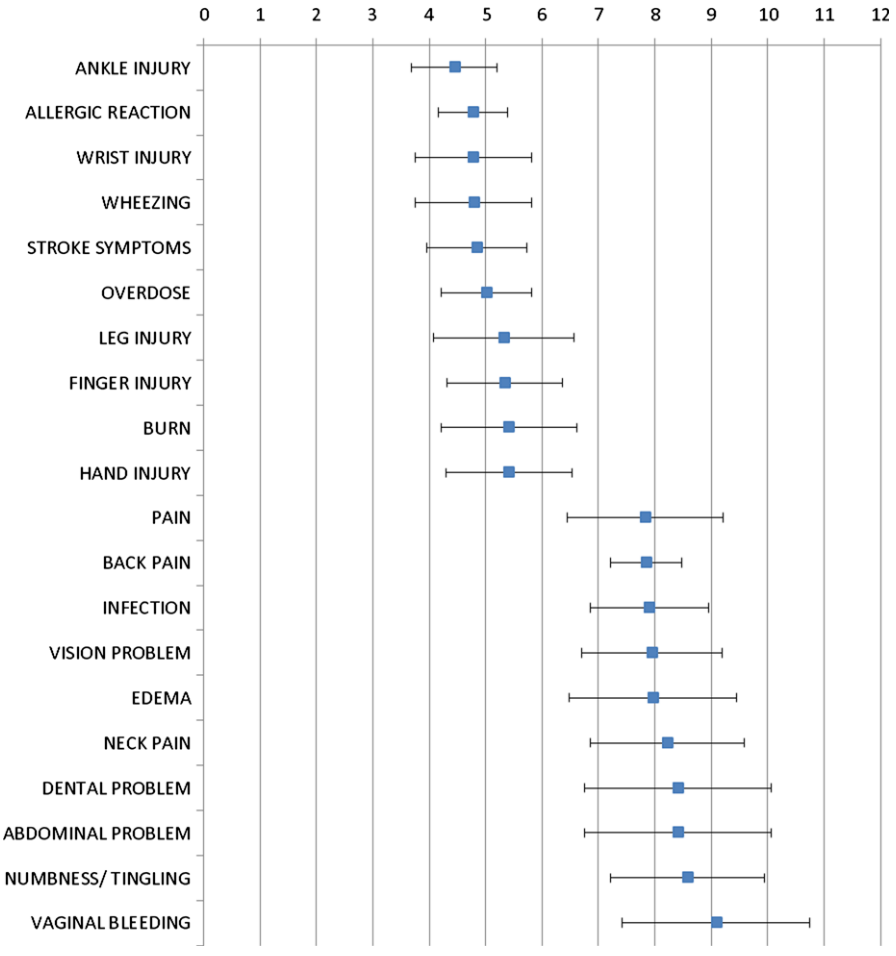

Figure 2. Adjusted median time to pickup by chief complaint. *Blue squares* represent model-adjusted medians, with 95% CI represented by *error bars*. Only the top and bottom 10 complaints are shown for clarity.

minimal clinical significance, this metric may be useful in the future to study the interactions between potential conscious or unconscious bias and patient outcomes.

The observed pattern leads to several theories that can be tested in future studies. One possible driver of assignment behavior is that residents may choose chief complaints that they associate with "easy" dispositions. Alternatively, residents may wish to avoid diagnostic uncertainty and thus avoid patients with more nebulous chief complaints. They may be looking to avoid chief complaints they associate with excess work or uncomfortable patient interactions. Resident preference may be driven not by bias toward avoiding individual cases, but by a desire to maximize flow or departmental efficiency. Whatever the explanation, this finding calls attention to the multiple human factors that affect resident prioritization of patients. While our study examined residents in aggregate, the preferential behavior documented could be more pronounced among some residents than others. Examination of resident-specific case mix may be necessary to ensure adequate experience for all graduates in institutions such as ours where residents have unrestricted patient pickup in a group staffing setting.

Emergency medicine residents must learn to prioritize the order in which they see new patients and are in a unique position for self-reflection as they develop their own practice styles. Consideration of our data and possible explanations may reveal biases that can then be examined for appropriateness in the goal of providing the best possible medical care. Studies like this one can help facilitate exploration of the possibilities in a quantifiable way, but further research is needed. Emergency physicians are frequently called upon to make decisions with limited information, of which prioritization via self-assignment is just one example. Many human factors influence these decisions, and better understanding of them could result in better care for patients.

LIMITATIONS

Due to our EHR's data structure, we were unable to stratify our analysis based on whether or not multiple residents were available to pick up an individual patient. It is possible that resident behavior is different in a group environment (where delaying pickup may lead to another resident seeing the patient) versus single coverage. The vast majority of our data occurred in a group environment, and data were controlled for hour of day of presentation, which should minimize potential confounding if certain chief complaints were more likely to present during overnight hours more likely to have a

single coverage situation. It is also possible that resident behavior varied by training level or with specific faculty-resident pairings, neither of which were available within our data set which included only the time stamp of resident and attending assignment. In general, the practice pattern in the ED consists of residents individually deciding which patients to pickup and at which timing. While they receive feedback from attendings, this rarely takes the form of specific direction of pickup behavior during the shift. Such feedback, while likely rare, was not controlled for in our data set as this could not be measured retrospectively in the EHR.

In almost all cases, residents become aware of new patients by viewing basic patient information, including the chief complaint, on the trackboard in the EHR. Trauma patients meeting leveling criteria are announced by a tone on arrival. Also, critically ill patients are roomed immediately, bypassing registration, and residents are notified by nursing staff. In these cases, residents bypass the normal procedure of self-assignment prior to seeing patients and proceed directly to the room, so patients appear to have longer intervals before assignment. This effect was controlled for by dropping the three chief complaints most obviously skewed by this phenomenon, but may have contributed to distortion in the data among chief complaints more associated with arrivals that bypassed the normal system of rooming (as can be seen in Data Supplement S1, the few patients presenting with ESI codes of 1 have with unexpectedly longer unadjusted median pickup times, likely also due to this effect).

The standard practice is for residents assign themselves to patients immediately prior to entering rooms; however, we were unable to measure the gap between assignment and residents physically seeing patients. While our pickup time metric measured resident signup behavior, it does not necessarily represent a proxy for the actual time between rooming and physician arrival.

CONCLUSIONS

In this single-center study, the decision to pick up a patient appears to be motivated not only by acuity and wait time before rooming but also by chief complaint. While many factors likely influence the observed variation, these findings may indicate that residents preferentially choosing patients with simpler workups and less perceived diagnostic ambiguity. This work introduces pickup time as a metric that may be useful in the future to uncover and address potential physician bias. Further work is necessary to establish whether practice patterns in this study are carried beyond residency and persist among attendings in the community and how these patterns are shaped by the information presented via the electronic health record.

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Supporting Information

The following supporting information is available in the online version of this paper:

Data Supplement S1. Baseline distribution and model parameters for covariates.