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## Administration of Emergency Medicine

### PHYSICIAN IN TRIAGE VERSUS ROTATIONAL PATIENT ASSIGNMENT

Stephen J. Traub, MD,\*† Adam C. Bartley, MS,‡ Vernon D. Smith, MD,\*† Roshanak Didehban, MS,\*†  
 Christopher A. Lipinski, MD,\*† and Soroush Saghafian, PHD§

\*Department of Emergency Medicine, Mayo Clinic Arizona, Phoenix, Arizona, †College of Medicine, Mayo Clinic, Rochester, Minnesota, ‡Department of Health Science Research, Mayo Clinic, Rochester, Minnesota, and §Harvard Kennedy School, Cambridge, Massachusetts  
 Reprint Address: Stephen J. Traub, MD, Department of Emergency Medicine, Mayo Clinic Arizona, Room 1-738, 5777 E. Mayo Boulevard, Phoenix, AZ 85054

□ **Abstract—Background:** Physician in triage and rotational patient assignment are different front-end processes that are designed to improve patient flow, but there are little or no data comparing them. **Objective:** To compare physician in triage with rotational patient assignment with respect to multiple emergency department (ED) operational metrics. **Methods: Design—**Retrospective cohort review. **Patients—**Patients seen on 23 days on which we utilized a physician in triage with those patients seen on 23 matched days when we utilized rotational patient assignment. **Results:** There were 1,869 visits during physician in triage and 1,906 visits during rotational patient assignment. In a simple comparison, rotational patient assignment was associated with a lower median length of stay (LOS) than physician in triage (219 min vs. 233 min; difference of 14 min; 95% confidence interval [CI] 5–27 min). In a multivariate linear regression incorporating multiple confounders, there was a nonsignificant reduction in the geometric mean LOS in rotational patient assignment vs. physician in triage (204 min vs. 217 min; reduction of 6.25%; 95% CI –3.6% to 15.2%). There were no significant differences between groups for left before being seen, left subsequent to being seen, early (within 72 h) returns, early returns with admission, or complaint ratio. **Conclusions:** In a single-site study, there were no statistically significant differences in important ED operational metrics between a physician in triage model and a rotational patient assignment model after adjusting for confounders. © 2016 Elsevier Inc.

□ **Keywords—**ED front-end; physician in triage; rotational patient assignment

### INTRODUCTION

Emergency department (ED) front-end operations (defined as beginning with patient arrival and ending when a provider assumes definitive care of the patient) are a crucial part of ED flow. Front-end operations are generally under complete- or near-complete control of the ED, with few external stakeholders. As such, the front-end is an area in which high-impact changes can be made relatively easily. There are multiple options in front-end redesign, including immediately placing patients into beds, utilizing triage protocols, physically streaming patients, developing surge capacity protocols, and utilizing information technology solutions (1).

Two additional options in front-end redesign include utilizing a physician in triage and associating patients with physicians via rotational patient assignment (2–11). Physician in triage usually consists of a physician and nurse team in or near the triage area. The team is often tasked with achieving rapid disposition of as many patients as possible, and beginning the evaluation and treatment of other patients before their placement into the main ED where another physician assumes definitive care. Rotational patient assignment generally consists of a predetermined (usually algorithmic) process that assigns patients to physicians or teams rather than relying on physicians or teams to assign themselves to patients. Although both have been

associated with operational improvements, there are few or no data directly comparing these interventions at a single facility.

We compared our results with a physician in triage model used during one year to the results of a rotational patient assignment model used in the next, with the goal of comparing the ED operational metrics of length of stay (LOS), left before being seen, left subsequent to being seen, early (within 72 h) returns to the ED, early returns that are admitted on the subsequent visit, and complaint ratio.

## METHODS

### *Study Design, Setting, and Population*

This is a retrospective cohort review of routinely gathered operational data at a single facility. This project was part of a quality-improvement effort, and was identified as exempt by our Institutional Review Board process, with a waiver for the requirement of informed consent.

The Mayo Clinic Arizona ED is a 24-bed ED (with 9 potential additional hallway treatment spaces) that is part of a tertiary care teaching hospital in Phoenix, Arizona. The annual ED census during the study period was approximately 26,000 visits, and the admission rate was approximately 30%. The ED was staffed 24 h/day with board-certified emergency physicians. There was no emergency medicine residency training program, although residents from other services rotated through the department and were involved in the care of approximately 5% of patients. There was no “fast track.”

We utilized a physician in triage on 23 days during the period of January 2012 to April 2012; all 23 of these days were defined as index days for this convenience sample. On those days, we did not utilize rotational patient assignment. For each of the 23 index days, we identified a matched day in the next calendar year when we utilized rotational patient assignment, but not a physician in triage. We defined a matched day as the day that was the same day of the week and within 2 calendar dates of the index day. For example, for the index day of Friday, January 20, 2012, the matched day was Friday, January 18, 2013; for the index day of Monday, March 12, 2012, the matched day was Monday, March 11, 2013. The patients seen on these 46 days (23 in each group) constituted the study population.

The physician labor pool was relatively constant between the two periods, with 20 of 24 physicians working in each period. All 24 physicians had >3 years of post-residency emergency medicine experience.

The ED utilized the Cerner Millennium electronic medical record and Cerner FirstNet electronic tracking tool during the entirety of the study period.

### *Interventions*

For physician in triage, we placed one nurse and one physician at triage from 11 AM to 8 PM, which corresponded to our busiest hours of the day. All other physicians and nurses worked in the main ED, with the exception of triage nurses. The physician in triage team was tasked with dispositioning patients when possible and beginning the appropriate workup when not. In a previous study, we found that the physician in triage at our facility made the disposition in approximately 50% of the patients he or she saw, and of those patients approximately 95% were discharged (6). Patients for whom the physician in triage did not make a disposition were evaluated, in most cases orders were placed, the patient was placed in a treatment space in the main ED when a bed became available, and the patient's definitive care was assumed by a second physician.

For rotational patient assignment, all nurses (with the exception of triage nurses) and all physicians worked in the main ED. During this period, we used an algorithm to assign patients directly to a physician. Beginning 15 minutes before each shift (30 minutes before the shifts beginning at 6 AM and 11 PM), three consecutive newly registered patients were assigned to the oncoming physician. After receiving this initial group of patients, the physician was then placed into a rotational queue with other physicians who were actively seeing new patients at that time. Patients were then assigned to physicians on a rotating basis. Physicians evaluated these patients at their own pace, but were responsible for seeing and evaluating all patients assigned to them.

### *Primary Endpoints*

LOS was defined as the time interval (in minutes) from patient registration to when he or she left the department or was placed into holding status; patients were generally placed into holding status after waiting for a bed for >4 h after admission. Left before being seen (LBBS) was defined as leaving before evaluation by a physician. Left subsequent to being seen (LSBS) was defined as leaving after being evaluated but before completion of the ED encounter; patients who left against medical advice were included in this group. Early returns to the ED (72R) were defined as those patients who returned to the ED within 72 h of their first visit. Early returns with admission (72R/A) were defined as early-return patients who were admitted on the second visit. LBBS, LSBS, 72R, and 72R/A are reported as frequency counts or percentages. Complaint ratio (CR) was defined as the rate of complaints brought to the attention of ED administration, expressed as incidents per 1,000 visits. None of these definitions changed during the study period. Our

definitions for LOS, LBBS, LSBS, and CR are generally consistent with previously reported definitions of these terms (12,13).

### Confounders

We identified the following variables as potential confounders when analyzing ED operations: patient age, sex, and Emergency Severity Index (ESI) score; ED daily volume; ED physician staffing; ED nurse staffing; ED holding; and effective hospital occupancy. Patient age was measured in integral years on the day of arrival. Patient sex was based on patient declaration. ESI was assigned by a triage nurse in standard fashion (ESI 1–5). ED daily volume was measured from 5:30 AM on the day in question to 5:29 AM the next day. ED physician staffing was measured daily in patients per physician hour based on the number of physician hours worked. ED nurse staffing was measured daily in patients per nurse hour based on the number of clinical nursing hours worked, and did not include ED nursing management, clerical help, nursing aides, or technicians. Holding was measured on a daily level in binary (yes/no) fashion. Effective hospital occupancy was defined as the quotient of the 6 AM hospital census divided by the number of staffed beds in the hospital, and is expressed as a percentage. None of these definitions changed during the study period.

### Measurements

We extracted the following data from the electronic medical record: patient age, sex, and ESI score; LOS, LBBS, LSBS, 72R, and 72 R/A; and ED daily volume. We extracted CR data and ED holding data from internal databases designed to record these events. We extracted physician and nurse staffing data from electronic scheduling tools (Tangier, Peake Software Labs; Sparks, MD and ANSOS One Staff, McKesson; San Francisco, CA) when available and handwritten logs when not.

### Data Analysis

We report age as mean  $\pm$  standard deviation (SD). We report daily ED volume, physician staffing, nurse staffing, and effective hospital occupancy as median with interquartile range (IQRs), and note mean  $\pm$  SD for comparison. We report sex as a percentage of female patients. We report ESI score as counts and percentages. We report holding as frequency of days on which any holding occurred.

In the primary analysis, we report LOS with median and IQR (with mean  $\pm$  SD for comparison), and

LBBS, LSBS, 72R, and 72 R/A as frequency counts or percentages. We report CR as incidents per 1,000 visits.

The median LOS for groups was compared by differences in median minutes using a bootstrap with 500 replications; all other outcomes were compared by differences in proportions.

In the secondary analysis, we analyzed LOS using a regression model to control for patient characteristics, ED characteristics, hospital volume, month of the year, and day of the week. A log transformation was used on LOS to account for non-normally distributed errors. Effects were estimated using generalized estimating equations to account for multiple patients being seen in the same 24-h period.

## RESULTS

There were 1,881 visits on 23 days during the physician in triage period, and 1,931 visits on 23 days during the rotational patient assignment period. Twelve patients during the physician in triage period (0.6%) and 25 patients during the rotational patient assignment period (1.3%) were missing an ESI score and were excluded from subsequent analyses. Patient characteristics for the remaining 3,775 visits are reported in Table 1, and operational confounders for the 46 days during which these patients presented are reported in Table 2.

### Primary Analysis

In an unadjusted comparison, rotational patient assignment was associated with shorter LOS than physician in triage (median difference 14 min; mean difference 21.8 min). There were no statistically significant differences in LBBS, LSBS, 72R, 72 R/A, or CR. Unadjusted results are reported in Table 3.

### Secondary Analysis

In a regression model incorporating patient characteristics and operational confounders, there was no

**Table 1. Patient Characteristics**

Demographic Characteristics	Physician in Triage (n = 1,869)	Rotational Patient Assignment (n = 1,906)
Female sex, n (%)	955 (51.1)	1,001 (52.5)
Age (years), mean (SD)	60.7 (20.8)	60.9 (20.6)
ESI, n (%)		
1	8 (0.4)	22 (1.2)
2	194 (10.4)	291 (15.3)
3	1,288 (68.9)	1,290 (67.7)
4	354 (18.9)	289 (15.2)
5	25 (1.3)	14 (0.7)

ESI, Emergency Severity Index; SD, standard deviation.

**Table 2. Operational Confounders**

Confounder*	Physician in Triage (n = 23)	Rotational Patient Assignment (n = 23)
ED daily volume		
Median (IQR)	85 (76–88)	84 (78–91)
Mean (SD)	82.1 (11.5)	84.2 (7.9)
Physician staffing		
Median (IQR)	1.4 (1.3–1.4)	1.4 (1.3–1.5)
Mean (SD)	1.3 (0.2)	1.4 (0.1)
Nurse staffing, n		
Median (IQR)	0.3 (0.3–0.3)	0.4 (0.3–0.4)
Mean (SD)	0.31 (0.4)	0.35 (0.04)
Effective hospital occupancy		
Median (IQR)	0.84 (0.8–1.0)	0.77 (0.7–0.9)
Mean (SD)	0.87 (0.1)	0.77 (0.1)
Holding		
No	21	23
Yes	2	0

ED, emergency department; IQR, interquartile range; SD, standard deviation.

\* See text for discussion of confounder definition and units.

statistically significant difference in the geometric mean LOS between rotational patient assignment and physician in triage (204 min vs. 218 min; difference of 6.25%; 95% confidence interval of difference –3.64% to 15.2%).

## DISCUSSION

Physician in triage and rotational patient assignment are two very different front-end processes, and both have proven successful in improving ED operations (2–11). We sought to determine if one intervention was superior to the other at our facility. We found no significant difference between physician in triage and rotational patient assignment with respect to the operational metrics of LOS (after adjusting for confounders), LBBS, LSBS, 72R, 72 R/A, or CR.

Previous work has shown that using a physician in triage can result in significant throughput gains, although it is not clear if this is due to an improved mechanism of processing patients or simply the addition of resources (2–5,14). The sequential processing of patients with a physician in triage model also requires a care transition (hand-off) between physicians, a notable area of concern in patient safety and quality (15,16).

In a previous study at our facility, although the addition of a physician in triage reduced overall LOS, we noted that the gains were seen almost exclusively in patients whose disposition was made by the physician in triage. We also noted that patients who were seen by the physician in triage and whose care was then transferred to a second physician in the main ED had a longer LOS than a control group that had not seen the physician in triage. Furthermore, in 55% of such visits, the second

physician felt it necessary to obtain additional tests or imaging (6). In summary, we found that although a physician in triage improved throughput, it seemed to affect different groups preferentially, and overall was not a perfect mechanism.

Rotational patient assignment has the benefit of eliminating the care transition inherent in the physician in triage model, as well as removing any ambiguity about which physician will be responsible for which patient. Previous work with rotational patient assignment has demonstrated improvements in arrival to provider time, patient satisfaction, and LOS (7–10).

In a previous study at our facility, we found improvement in a broad array of operational measures using rotational patient assignment, including LOS, LBBS, and CR (11). However, physicians greatly disliked having waiting-room patients assigned to them without being able to expeditiously see them in a treatment space when the ED was busy. Although several physicians chose to see patients in a small room outside of the waiting room—similar to what they may have done in the previous year if working as the physician in triage—many did not. In practice, being responsible for patients in the main ED and the waiting room simultaneously (as happened during rotational patient assignment) seemed to be viewed as worse than being responsible for only one of these areas (as happened during physician in triage).

Our department experimented with both models and chose rotational patient assignment, for several reasons. First, although our data do not support a conclusive difference in throughput, we felt that patient flow was superior with rotational patient assignment. Second, rotational patient assignment promotes a sense of fairness in patient distribution, which is important in groups (like ours) where there is no financial incentive for productivity. Third, because rotational patient assignment does not require an additional physician, it can be used 24 hours/day, whereas financial constraints usually limit the use of a physician in triage to only the busiest hours. Finally, nursing believes that the immediate assignment of a physician to every patient makes it much easier to resolve issues that arise for patients who have not yet been evaluated by a physician.

However, because every ED is unique with respect to culture and operating characteristics, we note that our choice is not a “one size fits all” solution. Physician in triage often provides expedited patient contact, and likely offers significant efficiency gains when there is a delay in moving patients from the waiting room to treatment spaces. Rotational patient assignment brings clarity to the question of which physician should be responsible for which patient, and may be useful when resolving that question will improve patient flow.

**Table 3. Unadjusted Patient Outcomes**

Outcomes*	Physician in Triage (n = 1,869)	Rotational Patient Assignment (n = 1,906)	Difference	95% CI
LOS (min)				
Median (IQR)	233 (155–323)	219 (144–304)	14	5 to 26.5
Mean (SD)	255.9 (168)	234.2 (127.6)	21.8	12.2 to 31.3
LBBS	19 (1.0%)	20 (1.0%)	–0.03%	–0.6% to 0.68%
LSBS	9 (0.48%)	9 (0.47%)	0.01%	–0.43% to 0.45%
72R	63 (3.37%)	57 (2.99%)	0.38%	–0.74% to 1.5%
72R/A	18 (0.96%)	24 (1.26%)	–0.3%	–0.96% to 0.37%
CR	6.4	4.2	2.2	–2.4% to 6.9%

CI, confidence interval; CR, complaint ratio; IQR, interquartile range; LOS, length of stay; LBBS, left before being seen; LSBS, left subsequent to being seen; 72R, early returns; 72R/A, early returns with admission; SD, standard deviation.

\* See text for discussion of outcome definition and units.

We believe that the importance of our current work lies in the finding that we did not find significant differences in ED operational metrics between these two interventions. Facilities contemplating ED front-end redesign with these two interventions may therefore be best served considering both as potential solutions, choosing one or the other based on factors such as provider preference or organizational culture rather than on the magnitude of perceived operational gains.

### Limitations

Our retrospective analysis establishes correlation, but not necessarily causation. In addition, our single-site analysis limits the ability to extend our results to other facilities.

Our noncontemporaneous comparison leaves our results (and conclusions) vulnerable to confounding by operational drift (improvements or declines in operations over time unrelated to the change being evaluated). While we attempted to account for multiple potential confounders, there were unquestionably others, both known (such as the number of nursing aides) and unknown, that we did not incorporate into our model. We do note, however, that we made no other major operational changes during the study period.

We do not comment on arrival to provider time, an important metric that is publically reported by the Centers for Medicare and Medicaid Services. When using our physician in triage model, we did not robustly capture the time of contact with the physician in triage, and therefore lack the data to adequately compare the groups.

We utilize different comparison methodologies to report and compare LOS in our primary and secondary analyses. In our primary analysis, we use arithmetic means (the sum of  $n$  terms divided by  $n$ ), and in our secondary analysis we use geometric means (the  $n$ th root of the product of  $n$  terms). Both are measures of central tendency; the former is more intuitive when directly comparing two cohorts, and the latter is better suited for our regression model.

We report our finding that there is no statistically significant difference in LOS between the two interventions after adjusting for confounders, but note that we did find a non-significant improvement in LOS of approximately 6% in rotational patient assignment vs. physician in triage. This is a difference whose magnitude, if real, would be clinically significant. Our inability (in an unpowered retrospective analysis) to exclude an operational difference—rather than concluding, as we do, that we could not find one—is a significant limitation.

At our facility, we do not accurately capture data for surge (defined as times or conditions at which the ED is at or above capacity) and therefore we cannot comment on the effects of these interventions during surge conditions. ED operations are usually significantly and negatively affected by surge, often in a nonlinear fashion. Our inability to compare these processes specifically during periods of surge—when operational excellence is most needed—is another limitation. In addition, our inability to quantify surge at our facility represents an impediment to generalizability, in that other facilities may have different surge patterns than ours.

### CONCLUSIONS

In a single institution, rotational patient assignment was associated with a statistically significant reduction in LOS compared with physician in triage in an uncontrolled comparison, but with a non-statistically significant reduction in LOS in a regression model that incorporated confounders. We did not find significant changes in other operational metrics, such as LBBS, LSBS, 72R, 72 R/A, or CR. Rotational patient assignment and physician in triage are different interventions, and each may be appropriate under certain circumstances in EDs contemplating front-end redesign.

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### ARTICLE SUMMARY

#### **1. Why is this topic important?**

ED front end interventions can greatly improve patient flow, and there are many options in front end redesign. However, there is currently little evidence directly comparing different front-end interventions at the same facility.

#### **2. What does this study attempt to show?**

This study directly compares physician in triage with rotational patient assignment at a single facility with respect to multiple operational outcomes.

#### **3. What are the key findings?**

In an unadjusted comparison, rotational patient assignment was associated with a lower length of stay than physician in triage; however, this difference was not statistically significant after adjusting for operational confounders.

#### **4. How is patient care impacted?**

Facilities contemplating physician in triage vs. rotational patient assignment as mechanisms of ED front end redesign should consider making that decision based on operational culture rather than perceived operational superiority of one intervention over another.