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## Education

### THE EFFECT OF SIGNED-OUT EMERGENCY DEPARTMENT PATIENTS ON RESIDENT PRODUCTIVITY

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**Abstract—Background:** Transitions of care and patient hand-offs between physicians have important implications for patient care. However, what effect caring for signed-out patients has on providing care to new patients and education is unclear. **Objective:** We sought to determine whether the number of patients a physician receives in sign-out affects productivity. **Methods:** This was a retrospective cohort study, conducted at an emergency medicine residency program. A general estimation equation was constructed to model productivity, defined as new patients evaluated and relative value units (RVUs) generated per shift, relative to the number of sign-outs received, and training year. A secondary analysis evaluated the effect of signed-out patients in observation. **Results:** We evaluated 19,389 shifts from July 1, 2010 to July 1, 2017. Postgraduate year (PGY)-1 residents without sign-out evaluated 10.3 patients (95% confidence interval [CI] 9.83 to 10.7), generating 31.6 RVUs (95% CI 30.5 to 32.7). Each signed-out patient was associated with  $-0.07$  new patients (95% CI  $-0.12$  to  $-0.01$ ), but no statistically significant decrease in RVUs (95% CI  $-0.07$  to 0.28). PGY-2 residents without sign-out evaluated 13.6 patients (95% CI 12.6 to 14.6), generating 47.7 RVUs (95% CI 45.1 to 50.3). Each signed-out patient was associated with  $-0.25$  (95% CI  $-0.40$  to  $-0.10$ ) new patients, and  $-0.89$  (95% CI  $-1.22$  to  $-0.55$ ) RVUs. For all residents, observation patients were associated with more substantial decreases in new

patients ( $-0.40$ ; 95% CI  $-0.47$  to  $-0.33$ ) and RVUs ( $-1.11$ ; 95% CI  $-1.40$  to  $-0.82$ ). **Conclusions:** Overall, sign-out burden is associated with a small decrease in resident productivity, except for observation patients. Program faculty should critically examine how signed-out patients are distributed to address residents' educational needs, throughput, and patient safety. © 2018 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

**Keywords—**operations; productivity; education; residency; patient safety; burnout

#### INTRODUCTION

At the change of shift, care for existing patients is handed off between physicians. This process entails the communication of critical information necessary to provide continuity of care. These patient handoffs and transitions of care have the potential for many pitfalls, including miscommunications, that can lead to serious errors in care (1–5). In academic emergency departments (EDs), this process is particularly fraught, as residents' differing levels of experience

can amplify the potential for miscommunications (6). Given the risks to patient safety and the impact on resident education, patient hand-offs and transitions of care, supervision, and resident workload are all areas of focus of Clinical Learning Environment Review (CLER) (7). Furthermore, the Accreditation Council for Graduate Medical Education (ACGME) and its CLER program examine the natural tension in academic medical centers between the educational need of the residents and the service needs of the institution in order to care for patients. Busy emergency physicians must also balance the need to provide care for the burgeoning queue of new patients, while managing the existing patients received in sign-out. Previous studies of sign-out in the ED have highlighted specific points where communication can break down, and have proposed checklists and other methods of standardizing sign-out to prevent these errors (6–11).

### *Importance*

A major component of residency training is the experiential learning that comes from caring for patients under the supervision of faculty. Little is known about what effect taking sign-out and caring for signed-out patients has on a resident physician's ability to gain experience by seeing new, undifferentiated patients in the ED. Additionally, there are no formal guidelines that dictate how patients received in sign-out should be distributed between teams of residents.

### *Goals of This Investigation*

We sought to determine what effect taking care of signed-out patients has on emergency medicine residents' ability to see new patients, as measured by their productivity as proxy for learning. We defined productivity as the number of new patients seen per shift, as well as the number of relative value units (RVUs) generated per shift. Due to the fact that caring for signed-out patients increases the amount of work a resident must do, and increases the potential for interruptions, we hypothesized that managing a larger number of signed-out patients would be associated with decreased overall productivity. Because previous studies of resident productivity have shown a strong, positive association between training and productivity, we anticipated that any detrimental effects from sign-out on productivity would be decreased in successive years of training (12–16). As a secondary analysis, we sought to determine whether different kinds of signed-out patients (such as patients in an ED observation unit) were associated with differing effects on productivity.

## METHODS

### *Study Design and Setting*

We conducted a retrospective, observational study of resident productivity from July 1, 2010 to July 1, 2017 at an urban, academic tertiary care center in the Northeastern United States with a 3-year ACGME–approved emergency medicine training program, with 55,000 visits annually. All major imaging modalities are available on a 24-hour basis. Our ED is staffed primarily by emergency medicine residents, but also staffed with off-service first-year residents in internal medicine, obstetrics, anesthesia, and surgery transition years, who typically rotate for 2–4 weeks at a time. Resident shifts at our institution are typically 8–9 h in length, with the last hour devoted primarily to resolving remaining diagnostic questions before sign-out to the oncoming team. Residents assign themselves to the next available patient in the electronic tracking system at their own pace; however, patients with unstable vital signs, airway concerns, or trauma are preferentially assigned to postgraduate year (PGY)-2 emergency medicine residents upon arrival (17).

In our ED, residents are expected to establish a set disposition (admission, discharge, or observation) or a straightforward plan for disposition based on further testing (e.g., laboratory or imaging results) before signing out their patients to the oncoming resident. PGY-3 emergency medicine residents in our department generally perform a supervisory role, and are at liberty to apportion signed-out patients between transitioning teams as they see fit. Due to the very limited number of PGY-3 shifts, during which they see patients primarily, as well as the brief nature of off-service rotations within the ED, we only included PGY-1 and PGY-2 emergency medicine residents in our analysis. The study was deemed exempt by the hospital's Institutional Review Board.

### *Study Protocol*

Timestamps of all patient assignments to resident physicians are recorded by our ED's electronic dashboard. Resident physicians sign up for patients from a virtual chart rack immediately before evaluating a patient, and residents are assigned to patients on the dashboard by a supervising resident or attending if a they are called directly to a resuscitation. Timestamps of all sign-outs of patients between residents and of all patient disposition decisions are recorded by the dashboard.

Utilizing the dashboard's internal database of patient timestamps, we recorded the total number of patients seen per resident shift, the total number of patients a resident received in sign-out during the shift, and whether or not these patients were admitted to our ED observation

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