

ORIGINAL RESEARCH

Resident Productivity in the Emergency Department After Implementation of an Automated Patient Assignment System; a Brief Report

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Abstract: **Introduction:** The clinical diversity of patients presenting to the emergency department (ED) allows emergency medicine (EM) and non-EM residents to sharpen their clinical skills. In most EDs, residents self-assign patients at their discretion. Our institution transitioned from a self-assignment-system to an automated-system, after which we sought to determine the productivity of our non-EM residents compared to the previous system. **Methods:** In this retrospective cross-sectional study, resident productivity was measured as number of patient visits per hour and per 8.5-hour shift before and after the implementation of an automated patient assignment system in emergency department. The automated-system assigns one patient at the start of the shift, another 30 minutes later, and one patient every hour thereafter, throughout the shift. **Results:** 28 residents performed 406 total shifts prior to implementation and 14 residents performed 252 total shifts post-implementation. The average number of patient visits per hour significantly increased from 0.52 ± 0.18 (95% CI 0.45-0.59, IQR 0.43-0.60) to 0.82 ± 0.11 (95% CI 0.75-0.88, IQR 0.74-0.89) after implementation of our assignment system ($p < 0.00001$; figure 1). Additionally, the average number of patient visits per 8.5-hour shift significantly increased from 4.46 ± 1.53 (CI 3.86-5.05, IQR 3.66-5.08) to 6.52 ± 0.86 (CI 6.02-7.02, IQR 5.90-7.09) after the implementation of our system ($p < 0.00001$; figure 1). **Conclusion:** These findings warrant further evaluation of the impact of patient assignment systems on trainee education.

Keywords: Emergency medicine; internship and residency; education, medical, graduate; efficiency; patient care; rotation; emergency service, hospital

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1. Introduction

The Emergency Department's (ED) diversity of clinical pathology and patient populations along with around the clock delivery of care provides learners with a unique opportunity for a comprehensive bedside learning experience. In the fast-paced environment of the ED, residents are frequently integral parts of healthcare delivery. There are few studies investigating resident productivity in the ED and

even less research specifically devoted to non-EM resident productivity in the ED. One study found that resident productivity was not significantly linked to ED volume or time of the day, but rather resident productivity declined over the course of a shift (1). Furthermore, Jeanmonod et al. (2008) found that shorter shift lengths resulted in more patients evaluated per hour by second year residents (2).

High-volume EDs afford the opportunity for a more robust training experience (3). Moreover, higher level residents with more experience in a fast-paced environment show greater productivity than new residents (4).

Many EDs use a physician self-assignment system where physicians assign themselves directly to patients that they

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want to see and do so at their own pace (5, 6). Other EDs have instituted automated assignment systems to algorithmically distribute patients. In one facility, the automated assignment system decreased median length of stay, decreased median arrival to provider time, and decreased patients leaving before being seen by a provider (5). In an additional study, the assignment system reduced time to physician assessment and increased patient satisfaction (7).

While automated assignment systems have been shown to be effective for emergency physicians, to our knowledge, no previous study has investigated this automated assignment system with residents, either emergency medicine (EM) or non-EM. Our study aims to investigate the effects of an automated patient assignment system on improving the productivity of non-EM residents, who rotate at our ED as Preliminary Year in Internal Medicine (PGY-1) and PGY-1 transitional year residents.

2. Methods

2.1. Study design and setting

In this retrospective cross-sectional study, resident productivity was measured as number of patient visits per hour and per 8.5-hour shift before and after the implementation of an automated patient assignment system in emergency department. This study was conducted in a 27-bed Emergency Department at a large tertiary care center located in an urban setting that sees approximately 50,000 patients a year, with minimal seasonal variation in volume. Prior to implementation of the new patient assignment system, residents worked 11-hour shifts; following implementation, residents worked 8.5-hour shifts. Alterations in shift length were made independent of this study on an institutional level. Time of day and day of the week of shifts are variable and dependent on number of residents on service and availability of faculty, among other factors. Our Emergency Department, at a tertiary care center, has no emergency medicine residents, but PGY-1 internal medicine and PGY-1 transitional year residents rotate for a period of four weeks in the ED. ED volume before and after implementation was consistent with historical trends.

2.2. Data Collection

This study was exempted from institutional review board of-fice, as a completely deidentified database was used to calculate the average number of patients seen per hour and per shift by each resident before and after implementation of the automated patient assignment system. We compared the number of patients visited before and after the implementation of the new automatic assignment system, which assigns one patient at the start of the resident's shift, another patient 30 minutes later, and one patient every hour thereafter, until

the resident finishes their 8.5-hour shift. All patients were included in the new assignment system and the algorithm did not account for patient acuity. Therefore, resident physicians can be assigned multiple critical patients within these intervals but always have the support and back up of multiple different Emergency Medicine attending physicians. The previous, self-assignment system allowed residents to choose patients at their own pace with no requirement for assigning additional patients. As shift length varied between pre- and post-implementation groups, patients seen per shift in the pre-implementation group was calculated as patients per 8.5-hour shift based on their average patients visited per hour for the duration of their 11-hour shift. Patient outcomes, time to disposition, and patient satisfaction were not assessed in this study.

2.3. Statistical analysis

Data are presented as mean \pm standard deviation. Significance was determined using student's t-test. All statistical analyses were performed using Microsoft Excel (Microsoft Corp., Redmond, WA).

3. Results

Our study examined 28 residents performing 406 total shifts prior to implementation. 14 residents performing 252 total shifts were included post-implementation. The average number of patient visits per hour significantly increased from 0.52 ± 0.18 (95% CI 0.45-0.59, IQR 0.43-0.60) to 0.82 ± 0.11 (95% CI 0.75-0.88, IQR 0.74-0.89) after implementation of our assignment system ($p < 0.00001$; figure 1). Additionally, the average number of patient visits per 8.5-hour shift significantly increased from 4.46 ± 1.53 (CI 3.86-5.05, IQR 3.66-5.08) to 6.52 ± 0.86 (CI 6.02-7.02, IQR 5.90-7.09) after implementation of our system ($p < 0.00001$; figure 1).

4. Discussion

This study found that non-EM residents' productivity, measured as patient visits per hour and per 8.5-hour shift, increased after implementation of an automated electronic health record-based patient assignment system compared to a traditional self-assignment system. The implementation of this system is thought to increase productivity by reducing the ability of residents to avoid picking up less desirable or more complex patients, or delay discharge of patients so as not to pick up new patients later in the shift (6). Residents saw approximately 1 additional patient per shift; extrapolated over a one-month, 18-shift rotation, this equates to 18 additional patient encounters over the course of the rotation.

Resident education is complex and in part hinges on the quantity and diversity of patient interactions, as well as feed-



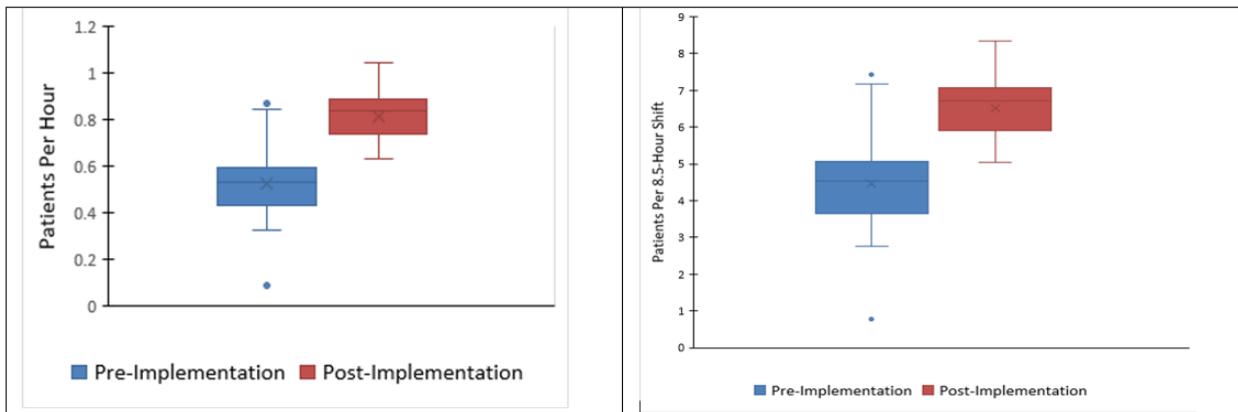


Figure 1: Box-and-whisker plots of the average patient visits per hour (left) and per 8.5-hour shifts (right) by residents in emergency department before and after implementing an automated patient assignment system.

back from supervising physicians. The Emergency Department is an excellent location for non-EM residents to care for a high volume of patients with the benefit of 24/7 attending physician oversight and presence. A natural progression is expected to occur as experience and responsibility increase as residents advance through their training. In the emergency setting, residents have been shown to take care of increasing numbers of patients while visiting patients with increasing complexity during their progression (4). Additionally, a multivariate analysis of residents' pace demonstrated that optimal productivity is obtained with consistent pace of patient assignment (8), as opposed to a rapid pace, which is hindered by increased variability as ED volume fluctuates. The automated assignment system ensures a set pace of patient assignment regardless of ED volume, eliminating bias when selecting patients. Furthermore, it also ensures complete objectivity with regards to clinical diversity, as residents are unable to avoid chief complaints or clinical scenarios they feel uncomfortable assessing. Given the randomness and objectivity of the patient assignment system, over the course of a rotation, residents will see a wide array of complaints and thus a diverse variety of pathologies in the Emergency Department.

To our knowledge, only one other study has successfully demonstrated an increase in non-EM residents' productivity in the emergency setting. Chakravarthy et al. (2015) utilized shift cards for residents' documentation of their patient load to be signed off on by their supervising attending physician each shift (9). This resulted in a significant increase in the number of patients visited; however, it may not have a systemic framework to create long-term productivity change.

5. Limitations

This study was limited by the number of residents rotating through the ED, as our institution does not have EM res-

idents; however, our sample size was large enough to be adequately powered for statistical analysis. Additionally, randomization to different assignment systems was unfeasible, as this change was institutionally implemented. However, all residents in the pre-implementation group had completed their rotation prior to the transition and all residents in the post-implementation group began their rotation following the transition. Therefore, individuals could not act as their own controls. While resident post-graduate year was not delineated, there was an even proportion of PGY-1 and PGY-2 residents in each of the groups. We did not assess the time of day, month, and year when shifts were performed, and thus, cannot conclude that shift timing was identical across groups, as this may also impact productivity.

Additionally, residents worked shorter shifts post-implementation relative to their pre-implementation counterparts (8.5 hours vs. 11 hours, respectively), which was an institutional policy change. As such, resident productivity may have been affected by shortened shift length, as studies have found a negative correlation between shift length and resident productivity (2).

6. Conclusion

The associated increase in non-EM residents' productivity with the implementation of an automated assignment system warrants larger studies examining the impact of similar assignment systems on a large scale and in Emergency Medicine residency programs. We believe that this increase in productivity provides residents with a better learning experience and ultimately, better training. Further studies are needed to confirm this educational benefit and to assess patient outcomes after implementation of such systems.



7. Declarations

7.1. Acknowledgments

None.

7.2. Authors' contributions

All authors were substantially involved in conception and design, drafting and revision of the manuscript, final approval of the manuscript, and agree to be accountable for all aspects of the work, per ICMJE recommendations.

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7.4. Conflict of interest

The authors have no conflicts of interest to report.

References

1. Jeanmonod R, Brook C, Winther M, Pathak S, Boyd M. Resident productivity as a function of emergency department volume, shift time of day, and cumulative time in the emergency department. *Am J Emerg Med.* 2009;27(3):313-9.
2. Jeanmonod R, Jeanmonod D, Ngiam R. Resident productivity: does shift length matter? *Am J Emerg Med.* 2008;26(7):789-91.
3. Shayne P, Lin M, Ufberg JW, Ankel F, Barringer K, Morgan-Edwards S, et al. The effect of emergency department crowding on education: blessing or curse? *Acad Emerg Med.* 2009;16(1):76-82.
4. Brennan DF, Silvestri S, Sun JY, Papa L. Progression of emergency medicine resident productivity. *Acad Emerg Med.* 2007;14(9):790-4.
5. Traub SJ, Stewart CF, Didehban R, Bartley AC, Saghafian S, Smith VD, et al. Emergency Department Rotational Patient Assignment. *Ann Emerg Med.* 2016;67(2):206-15.
6. Hodgson NR, Traub SJ. Patient Assignment Models in the Emergency Department. *Emerg Med Clin North Am.* 2020;38(3):607-15.
7. Patel PB, Vinson DR. Team assignment system: expediting emergency department care. *Ann Emerg Med.* 2005;46(6):499-506.
8. Joseph JW, Novack V, Wong ML, Nathanson LA, Sanchez LD. Do Slow and Steady Residents Win the Race? Modeling the Effects of Peak and Overall Resident Productivity in the Emergency Department. *J Emerg Med.* 2017;53(2):252-9.
9. Chakravarthy B, Posadas E, Ibrahim D, McArthur K, Osborn M, Hoonpongsimanont W, et al. Increasing off-service resident productivity while on their emergency department rotation using shift cards. *J Emerg Med.* 2015;48(4):499-505.

