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Education

MONTHLY PROGRESSION OF EMERGENCY MEDICINE RESIDENT EFFICIENCY: WHAT CAN WE EXPECT OF OUR RESIDENTS THROUGHOUT TRAINING?

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☐ **Abstract—Background: Developing the capacity for efficient patient care is essential during emergency medicine (EM) residency training. Previous studies have demonstrated that resident efficiency improves during each year of training. Objectives: This study assessed the progression of EM resident efficiency monthly and sought to develop a model that describes this progression in terms of patients per hour (pts/h) weighted by month of training. Methods: We performed a retrospective review of EM resident efficiency as determined by pts/h using EM resident monthly patient logs from a postgraduate year (PGY) 1–3 EM training program. Mean pts/h and standard deviation (SDs) were calculated based on month of training. One-way analysis of variance compared year-to-year training. We formulated several linear regression models to describe this progression. Results: We analyzed 51 consecutive months of patient logs from 110 residents. The mean pts/h for PGY1 was 1.201 (n = 85, SD = 0.241), for PGY2 was 1.497 (n = 82, SD = 0.218), and for PGY3 was 1.676 (n = 80, SD = 0.224). Linear regression was used to describe patients seen per hour by the month of training. A significant regression was found with an R^2 of 0.437 and $p < 0.000$. Over 36 months of training, a resident's predicted pts/h is equal to 1.113 + (0.018 × month of training). Conclusions: EM resident efficiency increases monthly, with most improvement occurring in the PGY1 year. Understanding this improvement may aid in resident performance evaluation and the understanding of predicted resident workflow.** © **2019 Elsevier Inc. All rights reserved.**

☐ **Keywords—education; efficiency; residency; productivity**

INTRODUCTION

The practicing emergency physician (EP) must have the ability to efficiently diagnose, treat, and accurately dispose multiple patients in a limited time (1). Emergency medicine (EM) residents must therefore develop the skill of efficiency to be fully prepared for independent practice. The American Board of Emergency Medicine has recognized the importance of developing efficiency during EM residency training and has incorporated milestones in the areas of multitasking and using strategies to improve health care flow into the Emergency Medicine Milestone Project (2). Despite the importance of being able to efficiently provide care in the emergency department (ED) upon completion of residency, little is known about the pace at which EM residents develop this critical skill throughout their training.

Previous studies evaluating EM resident efficiency show that efficiency as measured by patients seen per hour, and by relative value units per hour, increases as residents progress through each year of their training (3–5). Joseph et al. demonstrated that resident productivity decreases on an hourly basis while on shift (6). These studies used hourly and annual efficiency data, and therefore may be of limited applicability to educators and administrators who are looking to improve resident

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performance and optimally staff an ED through the course of an academic year.

To our knowledge, no study has evaluated the evolution of EM resident efficiency at a monthly scale, which we believe could be of value to residents, educators, and ED administration alike. From a resident perspective, the knowledge of their individual efficiency data relative to their expected efficiency may provide insight into their strengths or areas that need improvement. In addition, this type of information could be used by the resident to better delineate future employment environments that best fit their current skill level. From the educator's perspective, such data may provide an accurate reflection of individual resident progress. Lastly, data regarding resident efficiency at various stages of training could be useful for an ED administrator to optimize any additional staffing that may be necessary depending on the experience level of the resident(s).

This study sought to characterize resident efficiency as it progresses on a monthly basis and to develop a statistical model to describe this progression, using patients seen per hour as a surrogate marker for efficiency.

METHODS

This institutional review board–approved study was conducted at a suburban 3-year EM residency program that matches 14 residents per year. The primary teaching site is a hybrid community and academic level I trauma center with an ED volume that exceeds 120,000 patients per year. The average acuity of patients is distributed evenly over the course of a resident's monthly schedule. Residents keep a log of all patient encounters. At the conclusion of each shift, these patient logs are reviewed and confirmed by an attending physician. Logs include only patients where the resident was the primary caregiver and exclude patients managed after a transition of care. This information is subsequently entered into a database and beginning in their sixth month of training residents receive quarterly individual and aggregate efficiency data as measured by patients seen per hour.

Using this database, we performed a retrospective review of monthly resident efficiency data, measured as the number of patients seen per hour, between October 2011 and December 2015. We calculated the mean number of patients per hour (pts/h) and the standard deviations (SDs) for each year and month of a resident's training. A 1-way analysis of variance compared productivity year to year and then simple linear regression was used to develop a model that described this change in efficiency over the course of EM training. Segmentation analysis and additional modeling further described productivity over the course of each year of EM training.

RESULTS

Over the 51-month study period, we analyzed data from 110 residents. Post hoc analysis was done for a total of 10 residents to adjust for irregularities in training, such as a late start, extended remediation, or a leave of absence. Data analysis was not performed on 3 residents whose training extended past 36 months.

We found that EM residents can see on average 0.864 pts/h (SD = 0.124) in their first month of training and 1.620 pts/h (SD = 0.206) in their final month of training. Resident efficiency increased on a yearly basis. PGY1s saw an average of 1.201 pts/h (n = 85, SD = 0.241), while PGY2s and PGY3s saw 1.497 (n = 82, SD = 0.218) and 1.676 pts/h (n = 80, SD = 0.224), respectively. A 1-way analysis of variance was conducted comparing training year to year (Table 1).

On average, residents see an additional 0.018 (standard error of the mean 0.0005) patients per hour per month of training (Figure 1). Linear regression was used to generate a model where we regressed pts/h (criterion variable) on the month of training (MOT) (predictor variable). Analysis of the entire 36 months of training yields a model describing a resident's pts/h as 1.113 + 0.018 times the resident's MOT ($F_{1,1606}$ = 1245.90, $p < 0.000$; $R^2 = 0.437$). Segmentation analysis for each year of training resulted in the following models: PGY1 pts/h = 0.956 + (0.039 × MOT) ($R^2 = 0.337$, $p < 0.000$), PGY2 pts/h = 1.420 + (0.004 × MOT) ($R^2 = 0.015$, $p < 0.000$), and PGY3 pts/h = 1.918 + (−0.008 × MOT) ($R^2 = 0.004$, $p < 0.000$).

DISCUSSION

Consistent with previous studies, our data show that resident efficiency increases on a year-by-year basis. In addition, we concluded that resident productivity increases monthly over 36 months and that change can be described with a simple linear regression model. Analysis by year of training further shows that the most significant gain in resident productivity occurs during PGY1, with only small gains made during PGY2 and even smaller gains made during PGY3. These diminished gains in PGY3 are likely related to additional responsibilities, such as

Table 1. Year-to-Year Productivity Progression of Emergency Medicine Residents

	Added Productivity (pts/h)	Standard Deviation
PGY2 vs. PGY1	0.296	0.015
PGY3 vs. PGY2	0.179	0.014
PGY3 vs. PGY 1	0.474	0.013

PGY = postgraduate year.

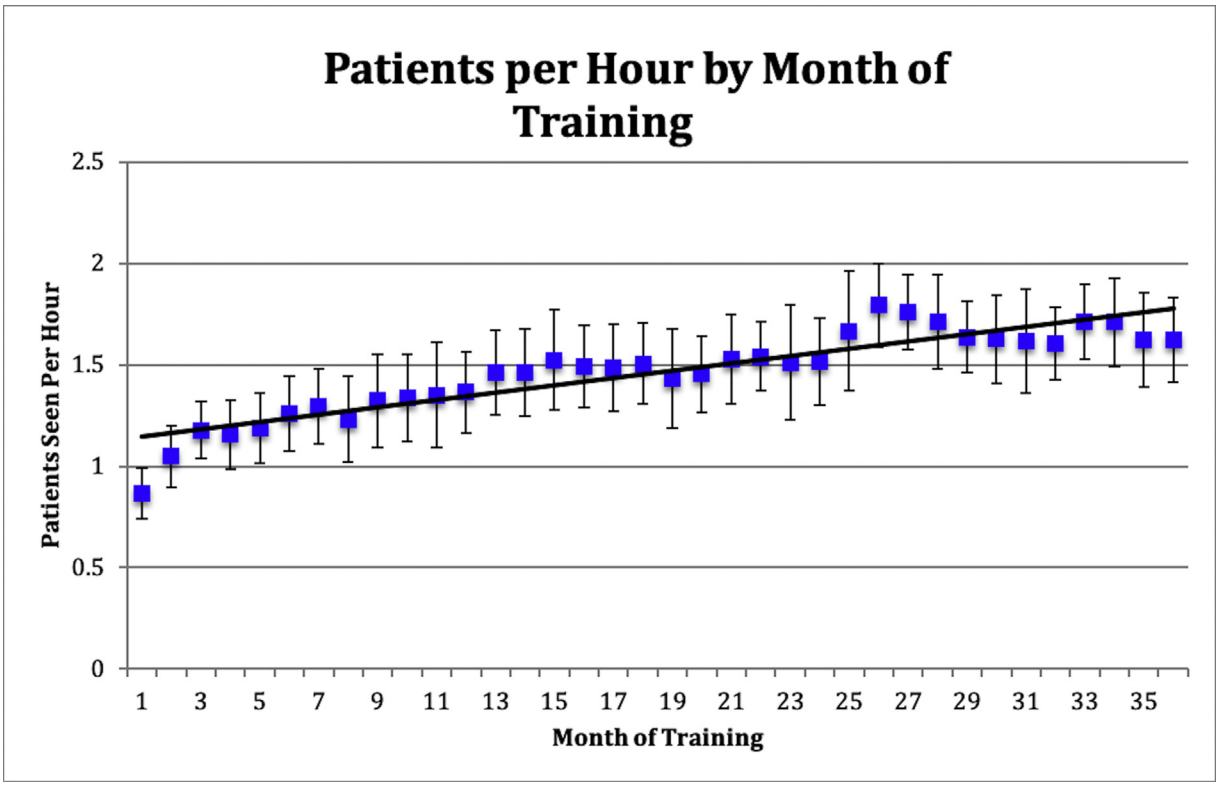

Figure 1. Patients per hour by month of training.

reading electrocardiograms, online medical direction, and teaching responsibilities, as well as a natural upper limit to efficiency. By predicting relative efficiency, both residents and faculty have a reference to guide expectations regarding pts/h seen based on the learner's current stage of training. Residents that stray significantly from the model's prediction may have multitasking difficulties that might improve with tailored didactics and focused teaching.

Based on the model, predicted efficiency for a graduating resident is 1.620 pts/h. This differs from the Emergency Department Benchmarking Alliance, which notes that an emergency physician working independently sees an average of 2.48 pts/h (7). We suspect that this difference can be attributed to multiple factors. First, residents are required to staff patients with teaching faculty, which reduces overall efficiency. In addition, residents are scheduled to work in high-acuity areas of the ED and therefore manage complex patients, which requires more physician time. Finally, Emergency Department Benchmarking Alliance survey data includes experienced emergency physicians who are likely to be more efficient than new graduates.

We believe that these models may be of value to EM educators in assessing resident performance by providing a benchmark of efficiency for each month of training. In addition, they may be useful to ED administrators to optimize emergency physician staffing in EDs in which residents train by balancing patient volumes with expected productivity. Future studies could provide more insight by examining changes in efficiency throughout a shift and with different shift times, as well as the effect of introducing curricular elements focused on multitasking and throughput.

Limitations

Our study measured efficiency by patients seen per hour and is limited by the lack of known resident relative value unit information. It was performed at a single high-volume ED that is a level 1 trauma center in the midwestern United States and therefore may limit its generalizability to other training institutions.

Residents are responsible for completion of their patient log on each shift. It is possible that inaccuracies or falsifications may result from self-reporting.

Finally, the monthly change in efficiency reflected the resident's training month, but not necessarily the number of months spent training in the ED. Each resident at our institution completes the same number of EM months

each year, and the timing of these months can vary for each resident throughout the year. However, our large sample size of 110 residents minimizes any such effect on efficiency in the ED.

CONCLUSIONS

Overall resident efficiency increases monthly, with most growth seen in PGY1, and this can be reliably predicted by a linear regression model.

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ARTICLE SUMMARY

1. Why is this topic important?

Emergency medicine residents must develop the skill of efficient patient care in order to be prepared for independent practice upon completion of their training. Understanding how efficiency improves during training could help in evaluating resident performance and developing staffing strategies for the emergency departments in which residents train.

2. What does this study attempt to show?

This study attempts to describe the rate at which resident efficiency improves during each month of residency training, in terms of patients seen per hour.

3. What are the key findings?

Emergency medicine resident efficiency improves monthly. Most improvement in emergency medicine resident efficiency occurs during the first year of training.

4. How is patient care impacted?

This data can assist emergency departments employing residents to optimize thier staffing models to provide timely patient care and improve throughput.