**The Effect of Emergency Medicine Residents on Clinical Efficiency and Staffing Requirements**

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**Abstract**

**Objectives:** The effect of emergency medicine (EM) residents on the clinical efficiency of attending physicians is controversial. The authors hypothesized that implementing a new EM residency program would result in an increase in relative value units (RVUs) generated per hour by attending physicians and decrease staffing requirements.

**Methods:** This was a retrospective observational analysis of an emergency department before, during, and after the establishment of a new EM residency program. We analyzed the change in RVUs billed, patients seen, and hours worked by attending physicians, midlevel providers (MLPs), and residents, and addressed potential confounding factors.

**Results:** The clinical efficiency of attending physicians increased by 70%, or 4.98 RVUs/hour (from 7.12 [SD ± 1.4] RVUs/hour to 12.1 [SD ± 2.2] RVUs/hour, p < 0.001) with the implementation of an EM residency program. Overall, net department RVU generation rose by 32%, even as attending physician coverage decreased by 6.3% (p < 0.05), and MLP coverage dropped by 60% (p < 0.05). We estimated that the implementation of the residency saved 4,860 hours of attending physician coverage and 5,828 hours of MLP coverage per year. This represents an estimated $1,741,265 in annual staffing savings, comparable to the residency program’s annual operating cost of $1,821,108.

**Conclusions:** The implementation of an EM residency program had a positive effect on the clinical efficiency of attending physicians and decreased staffing requirements.
the clinical efficiency of attending physicians measured directly in terms of relative value units (RVUs)/hour has not been investigated.

The RVU was adopted by the Centers for Medicare and Medicaid Services (CMS) in 1992 as the primary tool for quantifying the work performed by physicians, in order to construct a fee schedule for reimbursement of clinical services. The American Medical Association’s Relative Value Scale Update Committee (RUC) has historically established (and periodically updates) the number of RVUs assigned to a given service. RVUs are assigned for both the documented procedures performed and the evaluation and management level of a given chart, which is determined by the detail of history and physical examination and by the complexity of medical decision-making.

To our knowledge the impact of EM residents on attending physicians’ ability to produce and bill for RVUs has not yet been studied. But whether we view EM residents as assets or liabilities in this regard has profound implications, not only for administrators of academic departments trying to resolve staffing questions, but also for national leaders debating public policy. Advocates such as the American Association of Medical Colleges continue to urge Congress that increased graduate medical education funding is necessary to expand residency positions and forestall a projected physician shortage. This quest for funding comes at a time when reimbursement for clinical services is increasingly tied to the value and cost-effectiveness of care provided. The course of debate on these matters hinges in part on whether EM residents ought to be viewed as financial liabilities that encumber their educators (and thus require subsidy), or low-cost force-multipliers that make attending physicians more efficient. To address this question, the authors hypothesized that implementing a new EM residency program would increase the RVUs/hour generated by attending physicians and decrease staffing requirements.

**METHODS**

**Study Design**

This was a retrospective observational study, and was determined by Erlanger Health System and the University of Tennessee College of Medicine Chattanooga collaborative Institutional Review Board to be exempt from review and patient consent.

**Study Setting and Population**

The study took place in an urban, academic, adult emergency department (ED) before and after the implementation of an EM residency program. The ED serves an annual volume of around 50,000 patients at a Level I trauma center and tertiary-care referral hospital. Its three-year residency program consists of 18 resident physicians, six in each year of training. It was established in July 2008 as a joint venture between three parties: the University of Tennessee College of Medicine Chattanooga (UTCMMC), Erlanger Health System (EHS – its affiliated academic medical center), and EmCare Inc., a private, for-profit national emergency physician group contracted by Erlanger Health System to provide physician and management services for its adult EDs. Medical students and residents from other specialties rotate through the ED as well; their numbers were unchanged over the study period. Documentation has been entirely electronic since 2004. Trial-defined study data were collected for all patients who presented to the ED from July 1, 2005 to December 31, 2013.

**Study Protocol**

The numbers of patient visits, admissions, and dispositions were obtained by a query of electronic medical records in ED PulseCheck (Picis, Inc., Wakefield, MA). EmCare provided the numbers of hours worked, RVUs billed, number of patients seen, and annual staffing costs for attending physicians and midlevel providers (MLPs). EHS provided the number of hours worked by EM residents and the operating costs of the residency program. Data were aggregated in quarter-annual increments and entered into a Microsoft Excel spreadsheet for analysis.

The numbers of RVUs billed, patients seen, and hours worked by attending physicians were assessed and used to calculate RVUs per hour, RVUs per patient, and patients per hour. RVUs per hour were calculated as the total RVUs billed by attending physicians divided by the total number of hours worked by attending physicians. RVUs per patient were calculated as the total number of RVUs billed by attending physicians divided by the number of patients seen by attending physicians. These include RVUs billed for services provided independently and for those provided in conjunction with residents. Physicians typically worked in a ratio of one attending physician to one senior EM resident and one first-year EM resident, with or without non-EM residents or medical students. Note that while attending physicians supervise MLPs, the RVUs billed for MLP services were considered separately. Patients per hour were calculated by dividing the number of patients seen by attending physicians (excluding MLP charts) by the number of hours worked by attending physicians.

To account for the effects of census growth, the number of patients presenting to the ED and the number of patients who left without being seen by a physician were assessed. The percentage of patients admitted to the hospital was used as a surrogate marker for overall complexity of illness in presenting patients.

Since 2005, there have been four updates to the CMS Physician Fee Schedule that included changes to the number of RVUs assigned to emergency evaluation and management services. The RVUs per hour and RVUs per patient generated by attending physicians were calculated for each of five time periods distinguished by these definition changes, to address any effect these changes might have had on RVU generation. Other changes were made during the study period to the number of RVUs assigned to procedural services commonly performed in the ED, but these were too numerous to be addressed.

**Data Analysis**

The RVUs per hour and RVUs per patient for the attending physicians were the two outcome (dependent)
variables assessed. The time periods before, during, and after residency program implementation were treated as repeated measures using mixed modeling (PROC MIXED, SAS Enterprise Guide 7.1). Adjustment variables included in the model were “attending physician” which was treated as a random effect, “ER census,” and “number of patients admitted to the hospital,” which were both treated as fixed effects. Tukey’s Studentized Range (HSD) test was used for multiple pairwise comparisons. p-values less than 0.05 were considered indicative of statistical significance. All statistical analyses were completed using SAS Enterprise Guide 7.1 software.

RESULTS

Data were gathered for 424,784 patient visits from January 2005 to December 2013. The mean number of patient visits per quarter prior to the residency was 11,560. During implementation census rose to 12,597 visits/quarter (p < 0.05). After the residency was established, there were 12,494 patient visits per quarter, an increase of 934 patients/quarter (8%; p < 0.05). Prior to the residency, a mean of 10% of patients left without being seen by a physician; after the residency was established this number dropped to 5%. The mean admission rate decreased from 29.3% prior to the residency, to 27.1% during the residency startup (p < 0.05), to 28.3% after its establishment (not statistically significant).

Attending physicians generated a mean (±SD) of 7.12 (±1.4) RVUs/hour prior to the residency program’s establishment. They generated 8.45 (±1.8) RVUs/hour during its implementation. After the full complement of residents was reached, this figure rose to 12.1 (±2.2) RVUs/hour, an increase of 4.98 RVUs/hour, or 70% (p < 0.001). Attending physicians generated 4.04 (±0.4) RVUs/patient before the residency program, 4.20 (±0.3) RVUs/patient during implementation, and 4.24 (±0.36) RVUs/patient after implementation, an increase of 0.2 RVUs/patient, or 5% (p < 0.05). The impact of the residency program on attending physician RVUs/hour, RVUs/patient, and patients/hour is shown in Figure 1.

Figure 1 shows the number of hours worked by attending physicians, resident physicians, and MLPs over the study period. Coverage before the residency program consisted of a mean of 3,870 hours/quarter by attending physicians and 2,230 hours/quarter by MLPs. Once the residency was established, coverage consisted of a mean of 3,626 hours/quarter by attending physicians (a 6.3% decrease, p < 0.05), 1333 hours/quarter by MLPs (a 60% decrease, p < 0.05), and 4,290 hours/quarter by residents.

DISCUSSION

Our results demonstrate a positive effect of EM residents on the clinical efficiency of attending physicians. That the residents themselves were the proximate cause of this change is supported by the stepwise increase in RVUs/hour as resident classes were added (see Figure 1).

This increase is demonstrated by isolating attending physicians and should not be interpreted to represent the increase in net RVU production by the department as a whole. Rather, it demonstrates a shift in RVU generation from MLPs (whose RVUs were not attributed to attending physicians) to residents (whose RVUs were attributed to attending physicians). This is illustrated in Figure 3, which shows that total RVU generation rose steadily (roughly commensurate with census growth) even while the implementation of the residency program caused the burden of RVU generation to shift from MLPs to attending physicians.

It should be emphasized that once the residency was in place, more patients were being seen and 32% more RVUs generated even as attending physicians worked 6.3% fewer hours and MLPs worked 60% fewer hours (see Figure 2). This represents a cost savings and indicates that the presence of residents increased the clinical efficiency of their supervising attending physicians. These findings cannot be reconciled with the assertion that the addition of residents increases staffing requirements.

Table 1 shows an estimate of the number of hours of coverage saved, by extrapolating the staffing, which...
would have been required to accommodate the observed increase in census. For this purpose, it was assumed that neither the patients/hour seen by attending physicians and MLPs nor the ratio of attending coverage to MLP coverage would have changed without a residency program. By this method, it was estimated that the implementation of the residency saved 4,860 hours of attending physician coverage and 5,828 hours of MLP coverage per year.

One could argue that the department may have been overstaffed prior to the residency; that the loss of MLP coverage simply forced attending physicians to use a capacity that they already had and to do so despite the presence of residents. But before the residency program was implemented, 10% of patients left without being seen; with the residents in place, this number dropped to 5%. This would seem to suggest that the addition of residents did expand the capacity of the department and that such an expansion was needed.

Another objection to the validity of these findings is that we were unable to measure or control for the effect of changes to the Medicare Physician Fee Schedule (the reasons for this are given under Methods and under Limitations). There were several such changes that increased the number of RVUs assigned for the evaluation and management of patients in the ED during the study period. However, the data do not support the conclusion that this confounded the results.

First, if changes to the fee schedule were the proximate cause of the increase in RVUs/hour, they should have affected total RVU generation by the department and not only those generated by attending physicians as we have demonstrated in Figure 3. Second, changes to the fee schedule could only have affected the number of RVUs generated per patient, not the number of patients seen per hour. Figure 1 demonstrates that our results show the opposite: patients/hour correlates closely with RVUs/hour over the course of the study period, while the change in RVUs/patient, although statistically significant, is much smaller. This suggests that the residents were the proximate cause of the increased efficiency of attending physicians and that their effect was principally to enable attending physicians to see more patients per hour, not to bill more per patient. The exact cause for the observed increase in RVUs/patient is unclear and may or may not be attributable to the residency program or to the changes to the fee schedule. Other possibilities include improved documentation, an increase in the number of procedures performed, or changes in billing practices. Last, of the four changes to the fee schedule during the study period, by far the largest increase was in 2007. But closer analysis shows that the change in RVUs/hour before and after this change was not significant; attending physicians averaged 7.04 RVUs/hour from July 2005 to December 2006 and 7.62 RVUs/hour from January 2007 to December 2009 (not statistically significant). This suggests that the changes to the fee schedule did not have a substantial effect on RVUs/hour.

If it is true, as we have shown, that EM residents are a clinical asset and not a financial burden, the results of this study raise an important question: to what extent, if any, could the financial benefit of improved clinical efficiency mitigate the cost of implementing and operating a new residency program? If it were demonstrated that EM residents could, by reducing staffing costs, “pay” for their education, the implications for public policy and for the expansion and establishment of EM residency positions would be substantial.

The annual operating cost of the EM residency program in 2013, including academic teaching and administrative services; support staff; and resident salaries, benefits, and other costs, was $1,821,108. By implementing a residency program, the ED saved an estimated 4,860 hours of attending physician coverage and 5,828 hours of MLP coverage per year. This represents an

### Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measured Before Residency</th>
<th>Measured With Residents</th>
<th>Estimated Without Residents</th>
<th>Estimated Hours Saved</th>
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<tr>
<td>Patients billed per quarter</td>
<td>10,076</td>
<td>12,377</td>
<td>12,377</td>
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<tr>
<td>Attending hours per quarter</td>
<td>3,870 (1.82 pt/hr)</td>
<td>3,626 (2.96 pt/hr)</td>
<td>4,841 (1.82 pt/hr)</td>
<td>1,215</td>
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<tr>
<td>MLP hours per quarter</td>
<td>2,230 (1.36 pt/hr)</td>
<td>1,333 (1.22 pt/hr)</td>
<td>2,790 (1.36 pt/hr)</td>
<td>1,457</td>
</tr>
</tbody>
</table>

For this purpose, it was assumed that neither the patients/hour seen by attending physicians and MLPs nor the ratio of attending coverage to MLP coverage would have changed without a residency program.

MLP = midlevel provider.
estimated $1,741,265 of saved clinical staffing cost in 2013, which is comparable to the cost of the residency program. In addition, the observed 5% increase in RVUs billed per patient represents an estimated $340,519 of billable services in 2013 and may have resulted from improved documentation, an increase in the number of procedures performed in the ED, or other changes attributable to the residency program. Further studies are needed to perform a more robust cost–benefit analysis. If in future investigation the findings of this study are confirmed, it will provide important evidence that the valuable services provided by EM residents may in some cases negate or even outweigh the cost of training them.

LIMITATIONS

The principal limitation of this study is its retrospective, uncontrolled, before-and-after design, with its attending susceptibility to confounding variables. Furthermore, it involved only a single, relatively small residency program at a single adult ED. Further studies are needed to confirm the results prospectively at facilities that differ geographically, in number of residents, ED census, or facility size or that serve a pediatric population.

While the effect of changes to the Medicare physician fee schedule emergency evaluation and management services on RVUs/hour was discussed, we were not able to precisely measure or correct for this effect. One reason for this is that data regarding the absolute number of evaluation and management charges at each level of complexity were not available. In addition, changes to the RVU schedule for procedural services could not be addressed; first, because the sheer number of different procedural services billed over the study period was prohibitive, and second, because exhaustive data regarding numbers of procedures performed and the number of RVUs billed for each procedural service were not available.

Finally, the admission rate was used as a surrogate marker of complexity and is necessarily approximate. Evaluation and management billing codes were rejected for this purpose because they depend not only on the complexity of disease, but on the level of documentation in the patients’ charts, which was likely affected by the implementation of the residency program.

CONCLUSIONS

The establishment of an emergency medicine residency program had a positive effect on the clinical efficiency of attending physicians and decreased staffing requirements.

References