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Education

COST OF AN ACTING INTERN: CLINICAL PRODUCTIVITY IN THE ACADEMIC EMERGENCY DEPARTMENT

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☐ **Abstract—Background: A few studies suggest that an increasing clinical workload does not adversely affect quality of teaching in the Emergency Department (ED); however, the impact of clinical teaching on productivity is unknown. Objectives: The primary objective of this study was to determine whether there was a difference in relative value units (RVUs) billed by faculty members when an acting internship (AI) student is on shift. Secondary objectives include comparing RVUs billed by individual faculty members and in different locations. Methods: A matched case-control study design was employed, comparing the RVUs generated during shifts with an Emergency Medicine (EM) AI (cases) to shifts without an AI (controls). Case shifts were matched with control shifts for individual faculty member, time (day, swing, night), location, and, whenever possible, day of the week. Outcome measures were gross, procedural, and critical care RVUs. Results: There were 140 shifts worked by AI students during the study period; 18 were unmatchable, and 21 were night shifts that crossed two dates of service and were not included. There were 101 well-matched shift pairs retained for analysis. Gross, procedural, and critical care RVUs billed did not differ significantly in case vs. control shifts (53.60 vs. 53.47, $p = 0.95$; 4.30 vs. 4.27, $p = 0.96$; 3.36 vs. 3.41, respectively, $p = 0.94$). This effect was consistent across sites and for all faculty members. Conclusions: An AI student had no adverse effect on overall, procedural, or critical care clinical billing in the academic ED. When matched with experienced educators, career-bound fourth-year students do not detract from clinical productivity.** © **2014 Elsevier Inc.**

☐ **Keywords—relative value unit; RVU; clinical productivity; medical student education; clinical teaching; emergency medicine; acting internship**

INTRODUCTION

Academic emergency physicians must balance the responsibility of providing efficient and effective patient care with the duty of teaching residents and medical students. Although often it may seem that the two are in direct competition, there is little evidence to suggest that clinical productivity suffers at the expense of medical education. To our knowledge, to date there are no studies investigating the effect of concurrent medical student teaching on faculty productivity in the emergency department (ED) setting. Recent work in academic EDs has shown that an increasing clinical workload does not have an adverse impact on medical education (1–4). In fact, one study suggests that faculty who are the most clinically productive are perceived by students as the best teachers (2).

The primary objective of this study was to determine whether there was a difference in faculty clinical productivity when an acting internship (AI) medical student was present on shift in an ED when compared to a shift without an AI student. Because critical care and procedural productivity may not track gross productivity with

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students present, secondary objectives included determining if differences existed in procedural and critical care billing in the same setting. In addition, individual faculty and practice site may have an effect on whether billing is affected by students. Tertiary objectives for this project included a comparison of the difference in billing between shifts with and without a student for six core medical student-teaching faculty members, at three different practice sites.

METHODS

This study was a matched case-control design comparing work relative value units (RVUs) billed by faculty working on ED shifts with (cases) and without (controls) a fourth-year AI medical student (5). The study was carried out in three clinical settings: a large, tertiary care university ED, an associated children's ED, and a mid-sized county ED. Cases and controls were matched for individual faculty members, shift location (university ED, pediatric ED, county ED), shift type (day, evening, night), and, whenever possible, day of the week. Subgroup analyses of procedural and critical care billing, gross billing by six core medical student-teaching faculty members, and gross billing at the three practice locations were performed using the same parameters.

This project was performed in a city with a metropolitan population of roughly one million people. The Department of Emergency Medicine has two emergency medicine (EM) residencies and a combined EM/pediatrics residency, and is affiliated with a state medical school. All faculty members sampled worked at all clinical sites, except Faculty E, who only worked in the children's ED. ED shifts occurred between July 1, 2011 and March 31, 2012 at the adult and pediatric EDs of a university-based tertiary care hospital with an annual ED census of ~90,000 and an affiliated mid-sized county hospital with an annual ED census of ~40,000.

All shifts included in this study were staffed by a group of six core medical student-teaching faculty members. These faculty members were self-selected junior faculty with a specific career interest in medical student teaching, who committed to a 1-year term for the program. Most faculty had 3 years or less experience teaching medical students in the clinical ED setting. Core teaching faculty were provided a small buy-down stipend of clinical shifts in exchange for the additional duties associated with the program. The baseline clinical productivity of the core teaching faculty did not differ significantly from that of the rest of the faculty.

All ED shifts were staffed consistently by the same number and experience level of residents, as well as with fourth-year students performing their mandatory EM rotation. These students were paired with a senior resident who performed the bulk of teaching and clinical supervision. In addition, an EM AI student was assigned specifically to the core medical student-teaching faculty member. AI students were accepted into the rotation once they had completed a prerequisite of at least one prior EM rotation. They saw patients independently and staffed all their patients with the core medical student-teaching faculty member with whom they were paired, who was responsible for all teaching and patient care supervision for the AI student. Residents and other faculty on shift had no teaching or supervision responsibilities associated with the AI students. Both local and out-of-state EM-bound students were enrolled in the AI. Several of the students ultimately matched into one of the residencies associated with our ED.

Case shifts were identified by reviewing AI student schedules for the study period. All AI shifts performed during the study period were included. Members of the study group then identified matching control shifts for the same time period. Shifts were retained for analysis if they were able to be matched on at least three essential criteria: 1) faculty member, 2) shift location, and 3) shift type. Whenever possible, day of the week was matched as well. If it was not possible to match the exact day of the week, we then attempted to match weekdays to weekdays and weekend days to weekend days. To minimize bias, study personnel were not involved with identifying matching control shifts for case shifts that they had worked personally.

Gross, procedural, and critical care RVUs billed by faculty members were provided by the departmental billing office. These data were reported by date of service. Because night shifts crossed two dates of service, night shifts were retained as cases and controls only if there were no charts billed by the faculty member the preceding day and if the subsequent shift had the same student, faculty member, location, and type variables (i.e., a night shift was retained if it was the first of two shifts in which both the case and control shifts were staffed by the same faculty member at the same location). For these shifts, billing totals for the second date of service were used to estimate the total billing for one night shift.

Data were collected in an Excel spreadsheet and analyzed using Stata/MP 11 (StataCorp LP, College Station, TX). Average gross RVU per shift, procedural RVU per shift, and critical care RVU per shift were calculated. Two sample *t*-tests were performed to compare total gross, procedural, and critical care RVUs generated during shifts with students to shifts without students.

The difference in billing on shifts with and without students was compared via two sample *t*-tests for each individual faculty member and at each practice location. Findings were considered significant at a p value of < 0.05.

Table 1. Mean (SD) Total, Procedural, and Critical Care RVUs Billed on Shifts with Students (Cases) as Compared to Shifts without Students (Controls)

	Case Shifts (n = 101)	Control Shifts (n = 101)	*p*-Value
Total RVU	53.59 (15.90)	53.47 (16.21)	0.95
Procedural RVU	4.30 (3.82)	4.27 (3.95)	0.96
Critical care RVU	3.36 (3.97)	3.41 (5.09)	0.94

SD = standard deviation; RVU = relative value unit.

RESULTS

A total of 140 shifts with students were identified between July 1, 2011 and March 31, 2012. Eighteen shifts were unmatchable with nonstudent shifts because they did not meet the three minimum matching criteria. Twenty-one shifts were night shifts that spanned two dates of service, and therefore, discrete billing data were not reportable. A total of 101 well-matched shift pairs (202 total shifts) were retained for analysis.

Of the shifts retained for the analysis, 56% were matched not only on the essential matching criteria of faculty member, location, and shift type, but also on day of the week. An additional 32% were matched on being a weekday or a weekend day (i.e., Tuesday/Wednesday or Saturday/Sunday). Because the sample size was relatively small, we were not able to determine whether there was a difference in case vs. control shift by day of the week. However, historically, although there was a wide range of acuity/volume/productivity on any given day of the week, there was little difference on average among weekdays or between Saturday and Sunday.

Faculty billed an average of 53.59 RVU on shifts with students and 53.47 RVU on shifts without students, $p = 0.95$. Procedural billing accounted for 4.30 RVU on student shifts and 4.27 RVU on nonstudent shifts ($p = 0.96$), and critical care accounted for 3.36 vs. 3.41 RVU ($p = 0.94$); see Table 1.

Although there was significant variation in the amount billed per shift by individual faculty member (range 43.33–64.02 RVU), no individual faculty member demonstrated a difference in billing on a student shift from billing on a shift without a student (Table 2).

Although shifts performed at the university ED billed higher than shifts at the pediatric or county ED, no practice site demonstrated an intrasite difference in billing gross, procedural, or critical care RVU on shifts with students as compared to shifts without students (Table 3).

DISCUSSION

Early studies of clinical productivity and medical student education in the academic setting have conflicting results. In 1978, Lindenmuth et al. investigated the difference in productivity between two physicians when they practiced with and without a third-year medical student (6). Using a crossover design where each physician acted as his own control, this study found that students increased the number of patients seen without increasing the length of the clinical session (6). In 1980, Pawlson et al. examined the cost of instructing students in a consumer-owned health maintenance organization (HMO), a university-administered HMO, and a fee-for-service setting (7). Comparing patient visit counts before, during, and after

Table 2. Mean Total, Procedural, and Critical Care RVUs Billed by Faculty Members on Shifts with Student (Cases) and without Students (Controls)

Faculty Member	Gross RVU	Procedural RVU	Critical Care RVU
Faculty A	Total: 53.72	Total: 3.73	Total: 2.48
n = 29 pairs	Cases: 55.32	Cases: 3.89	Cases: 3.10
	Controls: 52.12	Controls: 3.59	Controls: 1.86
Faculty B	Total: 53.92	Total: 4.15	Total: 3.87
n = 25 pairs	Cases: 54.69	Cases: 4.27	Cases: 4.59
	Controls: 53.16	Controls: 4.04	Controls: 3.15
Faculty C	Total: 49.68	Total: 4.71	Total: 4.66
n = 21 pairs	Cases: 48.36	Cases: 4.15	Cases: 3.43
	Controls: 51.01	Controls: 5.27	Controls: 5.89
Faculty D	Total: 64.02	Total: 4.86	Total: 1.74
n = 11 pairs	Cases: 59.81	Cases: 3.64	Cases: 0.82
	Controls: 68.24	Controls: 6.09	Controls: 2.66
Faculty E	Total: 43.33	Total: 2.66	*Total: 1.13
n = 6 pairs	Cases: 43.46	Cases: 4.52	Cases: 2.25
	Controls: 43.19	Controls: 0.80	Controls: 0
Faculty F	Total: 54.81	Total: 5.82	Total: 5.50
n = 9 pairs	Cases: 56.44	Cases: 6.74	Cases: 4.50
	Controls: 53.18	Controls: 4.90	Controls: 6.50

RVU = relative value unit.
* $p < 0.05$.

Table 3. Mean Total, Procedural, and Critical Care RVUs Billed by Location on Shifts with Student (Cases) and without Students (Controls)*

	Gross RVU	Procedural RVU	Critical Care RVU
University ED n = 26 pairs	Total: 61.36 Cases: 57.71 Controls: 65.00	Total: 4.86 Cases: 4.31 Controls: 5.42	Total: 4.37 Cases: 2.94 Controls: 5.80
Pediatric ED n = 28 pairs	Total: 48.50 Cases: 49.41 Controls: 47.59	Total: 4.50 Cases: 4.96 Controls: 4.03	Total: 3.17 Cases: 3.38 Controls: 2.97
County ED n = 47 pairs	Total: 52.20 Cases: 53.82 Controls: 50.58	Total: 3.84 Cases: 3.90 Controls: 3.78	Total: 2.97 Cases: 3.59 Controls: 2.35

RVU = relative value unit; ED = emergency department.
* No results significant at $p < 0.05$ level.

students were present, they determined that there was no significant change in clinical productivity (7). Total instructional costs, including faculty salaries, facilities, and overhead, were $52.40 per student per day (roughly $143 in 2011 dollars) (7,8). In 1986, a conflicting study conducted in an HMO found that students decreased primary care physician productivity at the rate of 1.1 patient visits per half day (9). In this study, student presence was also associated with improvements in perceived quality of care, patient satisfaction, and provider "joy of practice" (9). The calculated "opportunity cost" to the HMO was $16,900 per full-time equivalent student per year of medical student training (roughly $34,700 in 2011 dollars) (8). In the early 1990s, Garg et al. reported a 30–40% decrease in the productivity of teaching physicians as compared with nonteaching physicians in an ambulatory setting (10). However, two other studies conducted at the same time and in similar settings found no difference between physician productivity when students were vs. were not present (10–12).

More recent data look at the effect of resident physicians on faculty productivity, and the results are similarly conflicting. In an ambulatory clinic setting, Johnson et al. demonstrated that residents reduced attending physician productivity (13). However, Albritton et al. show that productivity in a similar environment was increased by residents and unaffected by medical students (14). A resident strike in an ED in Spain in 2000 provided a "natural experiment" in the learner–productivity interplay. Although this study is limited in population and duration, during the strike, without residents, faculty were more efficient, and patients received fewer tests and had shorter lengths of stay (15).

In our study, AI students on ED shifts did not negatively impact faculty productivity in general, nor did they affect RVUs generated from procedures or critical care. Although we did not address the success of faculty teaching during the ED shifts analyzed in this study, reviews from our AI students indicate a positive experience.

Although this dataset is small, all cases were matched with controls based on shift location, time of day, and faculty member. Although there is a considerable amount of variation in how much each faculty billed for procedures, critical care time, and in total, these differences should not affect the overall results, as case shifts and control shifts were matched on faculty member.

Although there are undoubtedly differences between individual faculty members' productivity, at least part of the difference in billing is likely due to the distribution of shifts that each individual faculty member worked at different clinical sites. For example, faculty members C and E worked the majority of their shifts in the pediatric ED, whereas faculty member D worked primarily in the University ED. This is reflected in the average RVU billed by site (Table 3). In addition, faculty shifts were not equally distributed among days, evenings, and nights. One faculty member (E) worked exclusively at night, whereas the rest worked mostly days and evenings. Although there is clear variability in patient volume based on time of day, because we chose to match on shift time, diurnal variability in volume should not change the result.

Limitations

The number of shifts analyzed in this study is relatively small. A large number of observations were dropped due to the inability to match on prespecified criteria. Although rigorous matching makes the results more robust, it also limits the analysis, especially given the large SE within each measured variable.

Due to the way RVUs were billed, namely by date of service, night shifts (11:00 p.m.–8:00 a.m.) that crossed two dates of service were included in the analysis only if they were the second of two consecutive shifts with or without a student present (i.e., the exposure was the same for both shifts). This excluded a large number of night shifts from the analysis. Although it is possible that the difference in billing with and without a student

on a night shift is greater than the difference in billing with and without a student on a day or evening shift, this is unlikely.

Similarly, though we attempted whenever possible to match the day of the week, we were not able to do so consistently. Although the difference between weekdays and weekends is likely fairly predictably high, the variability between any two shifts in the ED is, on average, likely larger than the variability associated with the day of the week. We were able to match at least one weekday and weekend day for 88% of all the shifts retained.

We did not adjust the results for other learners in the department. As this is a large academic department, on any given shift there are anywhere from two to six residents, and sometimes an additional fourth-year student on his or her first ED rotation. Although we did not adjust for the presence of other learners, core resident shifts are staffed consistently at all sites. Because the shifts were matched by shift type, the number of residents who were present on shift would have been similar in case and control shifts. The presence of an additional fourth-year student was not accounted for because fourth-year students who are not acting interns staff their patients with, and receive the bulk of their teaching directly from, senior EM residents.

Finally, billing with students on shift likely depends heavily on the actual student as well as the interaction between the student and the faculty member. Even though all of the students included in this analysis had completed at least one EM rotation prior to their AI in our department, there was a broad range of clinical ability and proficiency. It is possible that students who were perceived by faculty as less independent or less competent were discouraged from seeing as many patients as their clinically stronger peers. These students would have been relegated to a more observational role, likely having little to no effect on billing. A student identified by one faculty member as less competent may not perform the same with a different faculty member. Additionally, how far along a student was in the rotation may have affected his or her performance, the faculty member's perception of student performance, and the subsequent effect on billing.

The medical record and documentation were different at the three practice sites. At the county ED, students performed documentation on an electronic medical record, which was reviewed, edited, and signed by the attending. At the other two sites, the attending primarily dictated all charts for which the student was primarily responsible. Because there was no difference between student and nonstudent shifts at any of the sites, the difference in documentation likely had no effect on the results.

This study also does not evaluate the effect of less vs. more experienced medical student and resident learners. Third- or fourth-year medical students on their first EM rotation may have a greater effect on attending productivity. Further study needs to be performed in this area.

CONCLUSION

Although clinical productivity is generally thought to suffer in the face of medical student teaching, we did not detect a difference in our small sample. Although there is evidence that high clinical productivity does not adversely affect teaching quality, very few recent data exist to describe how clinical teaching actually affects clinical productivity (2). Although a handful of studies have addressed the issue, they were performed decades ago in very different fiscal and clinical practice environments (6,7,9,10,12). To the best of our knowledge, this study is the first to date to address this issue in the ED setting.

Although we have shown that there is no difference in faculty productivity between ED shifts with or without an AI student in our setting, further research must be done on how the number and experience of simultaneous learners might affect billing. We must also consider factors that might favorably impact the interaction between individual faculty members and students.

Clinical productivity is only one measure of academic productivity. Although there seems to be no detrimental effect of the presence of an AI student on billing, other measures of academic productivity (such as research and service demands) are likely affected by the activity of clinical teaching. Further efforts to determine the effect of clinical teaching on other academic metrics such as publication rate, committee membership, and service obligations should be evaluated.

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ARTICLE SUMMARY

1. Why is this topic important?

Little is known about how a teaching responsibility may impact the clinical productivity of an academic emergency physician. Such information is critically important in creating effective staffing models for academic emergency departments. Additionally, as many academic models utilize a productivity bonus, quantifying the effect of teaching on productivity could better inform an equitable pay structure for such bonuses.

2. What does this study attempt to show?

This study attempts to determine the effect of teaching an acting internship medical student on the clinical productivity of an academic emergency physician by comparing relative value units (RVUs) billed for similar shifts with and without acting internship students.

3. What are the key findings?

In this case control study, there was no significant difference in gross RVU charges, critical care charges, or procedural charges for shifts with acting internship students compared to shifts without acting internship students.

4. How is patient care impacted?

These findings suggest that in an academic setting, with the infrastructure necessary for teaching, acting internship medical students may be included without an adverse effect on productivity. We did not study the effect of teaching on patient care.