

Incorporating students into clinic may be associated with both improved clinical productivity and educational value

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Abstract

Background: In this study, we aimed to evaluate ambulatory clinic responsibilities that neurology clerkship students perceive as having the highest educational value and to evaluate the association between a student's presence and level of responsibility and a preceptor's clinical and financial productivity during a clinic session. **Methods:** Physician preceptors (n = 43) and medical students (n = 67) in the Johns Hopkins Neurology clerkship from 2014 to 2015 were included. Students rated their experience and responsibilities in 291 neurology clinic sessions. Productivity metrics (e.g., relative value units [RVU]/clinic) were collected for each preceptor in the presence and absence of students. **Results:** A student's rating of a clinic as an effective learning experience increased with each additional patient the student interviewed (odds ratio [OR] 1.89, $p < 0.001$), presented (OR 1.86, $p < 0.001$), or documented (OR 2.00, $p < 0.001$). The mean RVU/session for preceptors also increased based on the number of patients interviewed ($\beta = 2.64$, $p = 0.026$), presented ($\beta = 2.42$, $p = 0.047$), and documented ($\beta = 2.70$, $p = 0.036$) by students. On average, preceptor RVU/session increased by 42% (mean 5.6 ± 1.2 , $p < 0.0001$) when a student was present in clinic compared to sessions without students. In addition, preceptor invoices increased by 35% (mean 2.7 ± 0.6 , $p < 0.0001$) and charges by 39% (mean $\$929 \pm \210 , $p < 0.0001$) when a student was present in clinic. **Conclusions:** This observational study suggests a mutual benefit to preceptor clinical productivity and student-perceived educational value when students have active responsibilities in neurology clinics. Despite concerns that students slow down preceptors in clinic, these results suggest that preceptors may have an overall boost in productivity, potentially by performing billable work while students independently see patients. *Neurol Clin Pract* 2017;7:474-482



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According to the 2012 Neurology Clerkship Director Work Group of the American Academy of Neurology, 80% of all neurology clerkship rotations include an ambulatory clinic component.¹ This same survey revealed that over half of preceptors are not compensated for their clinic teaching time, despite evidence that the presence of a medical student in clinic adds 32 minutes to a preceptor's clinic session.^{1,2} Neurologists are also reporting high burnout rates and low professional satisfaction.³⁻⁵ These have been in part linked with increased regulatory expectations, including the implementation of electronic medical records (EMRs).³⁻⁷ Whereas students may have previously assisted with clinic notes in the paper documentation era, students now cannot document in EMRs in over 50% of academic medical centers.⁸⁻¹⁰ As a result of these pressures, it is progressively more difficult to find preceptors willing to teach students in ambulatory clinics.^{8,11,12}

Few studies have explored the influence that medical students have on preceptor clinical and financial productivity in clinic settings.¹³ Fewer studies have investigated variables that define an optimal educational experience in ambulatory neurology clinics.^{10,14} The objectives for this study were (1) to evaluate the ambulatory clinic responsibilities that neurology clerkship students perceive as having the highest educational value; and (2) to evaluate the association between a student's presence and level of responsibility and a preceptor's clinical and financial productivity during a clinic session.

METHODS

Overview

This project was designed as a collaboration among 4 medical students, 3 medical educators, and 1 financial administrator. This observational study incorporated neurology preceptors and medical students in the neurology core clerkship at Johns Hopkins University from 2014 to 2015.

Standard protocol approvals, registrations, and patient consents

The Johns Hopkins University institutional review board (IRB) reviewed and approved this study.

Student perception of effective learning experience

Neurology clerkship (2nd–4th year) students participated in the study. Clerkship students spent 1 week in subspecialty and general neurology clinics during the 4-week clerkship. Students voluntarily chose which clinics to attend from a clerkship-provided list of neurology clinics with instructions to contact preceptors prior to attending clinic.

After completing the clerkship, all students were asked to voluntarily complete a one-time, 11-question electronic survey (figure e-1 at Neurology.org/cp) for each physician preceptor the student worked with in clinic for at least one half-day clinic session. The primary goal of the survey was to gather feedback on which student roles (active involvement vs passive shadowing) and patient care responsibilities were most valuable to the student educational experience. For student responsibilities, students recorded the number of patients they independently interviewed, presented to the preceptor, and documented during the clinic session. The student survey was developed initially as a quality improvement initiative, and evaluated for face validity within a pilot group. To limit response and recall bias: (1) students submitted surveys online to preserve anonymity; (2) no student demographic information was collected to ensure that students felt they could confidentially evaluate preceptors; (3) the survey had no effect on grades and was not available to clerkship directors during the clerkship; (4) surveys were collected immediately after completing the clerkship, with up to 3 email reminders.

For comparison, clinical preceptors were divided into 2 groups based on student survey results: the most effective vs less effective teachers. The most effective teaching preceptors (9 preceptors; n = 106 clinic visit surveys) were identified by selecting the preceptors

Supplemental Data

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with the highest mean score of effective learning experience on student surveys. Most effective teaching preceptors provided effective learning experiences in over 90% of student-evaluated clinic sessions (96/106 clinic sessions). The remaining preceptors comprised the group of less effective teachers (53 preceptors; $n = 185$ clinic sessions), and provided effective learning experiences in 66% of student-evaluated clinic sessions (122/185 clinic sessions). Preceptors from both groups were subsequently surveyed to provide recommendations on ways to improve student learning and clinic workflow with students in clinic.

Preceptor productivity

Preceptor productivity was assessed using metrics collected by department financial analysts ($n = 43$ preceptors). The 43 preceptors are a relative subset of the 62 preceptors previously noted in student surveys (figure e-2). Clerkship attendance records were retrospectively used to identify dates that students were present or not present in each preceptor's clinic for 3 months (June, August, October) in the 2014–2015 academic year. Attendance was not recorded and thus not available for the remainder of the year.

Relative value units (RVU) were used to measure clinical productivity.¹⁵ RVU consisted of all RVU generated by the preceptor during their clinic session, including procedures (e.g., EEG, EMG/nerve conduction studies), to be most representative of day-to-day clinic activity. Procedure-specific clinics were excluded since students do not attend those clinics. The primary outcome was the mean difference between RVU generated per clinic session for a preceptor when a student was present vs not present in clinic. Secondary outcomes, measured similarly, included (1) mean difference in invoices generated per session and (2) mean difference in charges generated per session. Invoices were defined as statements of medical charges issued by preceptors during a half-day clinic session. Since each patient generally receives one invoice per visit, the number of invoices serves as a measure of the number of patients for whom preceptors performed billable work for during a clinical session. Charges were defined as the amount of money the preceptor billed for medical services provided during the half-day clinic session. Importantly, these productivity measures included charges and invoices submitted during the designated clinical session for patients who were physically present as well as for patients who were not present (e.g., notes completed, EEG interpretations). This was to capture the potential opportunity for preceptors to complete other clinical work concurrently while a student interacts with live patients.

Statistical approach

STATA version 13.0 was used for all analyses. To analyze Likert items, responses were converted to binary outcomes with scores of 4/5 as yes and 1/2/3 as no. First, we determined the student responsibilities associated with effective learning experiences. General estimating equations with simple logistic regression models were used to account for within-student correlation from one student evaluating multiple clinics. Two student surveys were discarded due to missing data. For each student responsibility, the odds were calculated that a preceptor's clinic session was rated as an effective (Likert 4/5) vs ineffective (Likert 1/2/3) learning experience. The odds ratio (OR) represents the increase in the odds that a student has an effective learning experience for each one-unit increase in student responsibility (e.g., each additional patient interviewed by a student), after adjusting for the total number of patients seen by the student. A similar method was used to analyze secondary outcomes. Simple logistic regression was prioritized over multiple logistic regression because of concerns that student responsibilities were collinear. For example, a student could not present a patient encounter if he or she had not also interviewed the patient. In addition, demographics and student responsibilities were compared between the most effective and less effective teaching preceptor groups using Pearson χ^2 and 2-sided, 2-sample t tests.

Table 1 Odds ratio (OR) of student learning outcomes based on student clinic responsibilities^a

Predictors (n = 291)	Effective learning experience			Engagement in clinic			Recommend to other students		
	OR (SE)	95% CI	p Value	OR (SE)	95% CI	p Value	OR (SE)	95% CI	p Value
Interviews by student	1.89 (0.2) ^b	1.51-2.38	<0.001	2.93 (0.5)	2.15-3.99	<0.001	2.77 (0.6)	1.81-4.26	<0.001
Presentations by student	1.86 (0.2)	1.44-2.39	<0.001	3.72 (0.8)	2.40-5.75	<0.001	4.63 (1.8)	2.20-9.74	<0.001
Documentation by student	2.00 (0.3)	1.42-2.81	<0.001	3.36 (0.9)	2.00-5.65	<0.001	3.56 (1.5)	1.56-8.17	0.003

Abbreviation: CI = confidence interval.

^aGeneralized estimating equation with simple logistic regression models, adjusted for total number of patients seen by students in clinic (n = 291 clinic sessions for 67 students).

^bInterpretation example: The odds that a student has an effective learning experience in clinic increases by 1.89 times for each additional patient interviewed by the student, after adjusting for the total number of patients seen by the student in clinic.

Next, we evaluated the association between the presence of a medical student and the preceptors' clinical and financial productivity. Clinical metrics (e.g., mean RVU/session) were calculated for each preceptor on dates that a student was present in his or her clinic, and on dates without students. Clinical metrics were compared with and without students for each preceptor independently so that preceptors served as their own controls. Two-sided, paired *t* tests were used to evaluate the mean difference in preceptor productivity based on the students' presence in clinic. In addition, we examined whether specific student responsibilities in clinic were associated with preceptor productivity. Each preceptor for whom we had both productivity and student survey data was included (n = 38). For each preceptor, we calculated the mean number of student-performed interviews, presentations, documented encounters, and effective learning experiences via student survey data. Simple linear regressions were used to assess the expected mean change in RVU/clinic associated with increases in student clinical responsibilities. Two-sided, 2-sample *t* tests were performed to assess baseline differences in productivity outcomes comparing most effective (n = 8) vs less effective (n = 35) teaching preceptors. This was designed as exploratory a priori since groups were not powered to detect significant differences.

RESULTS

Student perception of effective learning experience

A total of 67 students completed the student survey (65% response rate). Students evaluated 291 total clinic sessions with 62 individual preceptors. There was no significant difference in demographics between preceptors deemed by students to be the most effective vs less effective teaching preceptors (table e-1).

The number of patient interviews, presentations, and documented encounters by students were each significantly associated with students' effective learning experience, engagement in clinic, and recommendation of clinic to peers (table 1). For each patient encounter documented by a student, the odds were twice as high that the student perceived the clinic to be an effective learning experience (OR 2.0, 95% confidence interval [CI] 1.4–2.8). In further analyses, there was no particular cutoff for the number of student interviews, presentations, or documentation necessary for preceptors to provide an effective learning experience.

In addition, we compared student responsibilities in clinics of the most effective vs less effective teachers (table 2). The most effective preceptors enabled students to interview over twice as many patients (2.94 ± 0.2 vs 1.25 ± 0.1 , $p < 0.0001$) and present 3 times as many

Table 2 Comparison of student responsibilities in clinics of most vs less effective teaching preceptors^a

Variable	Most effective teachers (n = 106)	Less effective teachers (n = 185)	Difference	95% CI	p Value
No. of patients seen	5.46 (0.2)	5.56 (0.2)	-0.09 (0.3)	-0.75 to 0.56	0.77
No. of interviews	2.94 (0.2)	1.25 (0.1)	1.69 (0.2)	1.27 to 2.12	<0.0001
No. of presentations	2.75 (0.2)	0.79 (0.1)	1.97 (0.2)	1.59 to 2.34	<0.0001
No. of documents	2.30 (0.2)	0.21 (0.1)	2.10 (0.1)	1.80 to 2.39	<0.0001

Abbreviation: CI = confidence interval.

Values are mean (SE).

^aTwo-sided t tests were used to assess differences in student responsibilities between clinics of most effective (n = 106 clinic sessions for 9 preceptors) vs less effective teaching preceptors (n = 185 clinic sessions for 53 preceptors).

patients (2.75 ± 0.2 vs 0.79 ± 0.1 , $p < 0.0001$). Students documented approximately 2 patient visits on average in clinics with the most effective preceptors, but rarely documented in clinics of less effective preceptors (2.30 ± 0.2 vs 0.21 ± 0.1 , $p < 0.0001$).

Preceptor productivity

We reviewed productivity metrics for 43 preceptors, totaling 891 clinic sessions without a student present (mean 20.7 per preceptor) and 115 sessions with a student present (mean 2.7 per preceptor). Preceptor productivity significantly improved for each metric when a student was present in clinic (table 3). Among preceptors, 74% (n = 32) generated more RVU/session when a student was in clinic. The mean number of RVU/session was 42% higher for preceptors when a student was present in clinic compared to the same preceptor's average with no student (mean increase 5.6 ± 1.2 , 95% CI 3.1–8.1). Similarly, the mean number of invoices generated by preceptors was 35% higher (mean increase 2.7 ± 0.6 , 95% CI 1.5–3.9) and charges generated were 39% higher (mean increase $\$929 \pm \210 , 95% CI $\$505$ – $1,353$) per session when a student attended clinic. Surveyed preceptors (n = 30; 48% response rate) made 2 main recommendations to improve teaching and clinic workflow with students. First, 37% of preceptors (n = 11) suggested improving students' ability to document in the EMR. Second, 33% of preceptors (n = 10) suggested having more examination rooms when students are in clinic.

Next, we evaluated whether student responsibilities in clinic were associated with preceptor clinical productivity. Notably, the mean number of preceptor RVU/session significantly increased in relation to the number of student interviews ($\beta = 2.6$, 95% CI 0.3–5.0), presentations ($\beta = 2.4$, 95% CI 0.4–4.8), and documented encounters ($\beta = 2.7$, 95% CI 0.2–5.2) (table 4). In exploratory analyses due to power limitations, most effective teaching preceptors had twice the increase in RVU/session when a student was present in

Table 3 Comparison of preceptor clinical productivity based on student presence in clinic^a

Outcomes (n = 43)	With student	Without student	Difference	95% CI	p Value
No. RVU/session	19.0 (1.5)	13.4 (1.1)	5.60 (1.2)	3.12–8.09	<0.001
No. invoices/session	10.3 (0.86)	7.68 (0.79)	2.65 (0.59)	1.45–3.85	<0.001
Charges/session, \$	3,309 (280)	2,380 (220)	929 (210)	505–1,353	<0.001

Abbreviations: CI = confidence interval; RVU = relative value units.

Values are mean (SE).

^aTwo-sided, paired t tests were used to assess differences in clinical productivity measures for physician preceptors with and without a student in clinic (n = 43 preceptors).

To maximize productivity and student learning, an extra clinical room appears to be an important resource to realizing this mutual benefit.

clinic, but this was not different from less effective preceptors (9.53 ± 3.4 vs 4.71 ± 1.28 , $p = 0.13$). Similarly, results show the most effective preceptors had greater increases in invoices (4.55 ± 1.7 vs 2.21 ± 0.6 , $p = 0.13$) and charges ($\$1,440 \pm \590 vs $\$812 \pm \220 , $p = 0.25$) generated, but this was not significantly different from less effective preceptors.

DISCUSSION

This study shows that actively involving medical students in clinic may be associated with both student perceptions of a more valuable educational experience and greater preceptor clinical and financial productivity. Consistent with medical education literature in other specialties, this study found that students who adopted more responsibility in ambulatory clinic perceived the experience to be more educationally enriching.^{16–18} In addition, the results of this study suggest an association between specific student clinic responsibilities (e.g., documenting) and perceived learning within a neurology clerkship. Allowing students to become actively involved in patient evaluations enables students to practice and get feedback on interviewing, documentation, and presentation skills from preceptors. Developing these skills is critical for a successful transition to residency, as outlined in the recently emphasized Entrustable Professional Activities.^{19–21}

For preceptors, this study suggests that the presence of students and the provision of clinical responsibilities are associated with preceptors generating more RVU, invoices, and charges in clinic. This may be because when a student is utilized in a value-added role in clinic, such as EMR documentation, the preceptor may simultaneously see another patient or accomplish other work (e.g., complete prior notes or procedure interpretations). This aligns with surveyed preceptors' recommendations that access to additional clinic rooms is an important component to hosting medical students. This is also supported by our analysis showing the presence of a student was associated with an increase in both generated invoices and charges, thus indicating that

Table 4 Effect of student responsibilities in clinic on preceptor clinical productivity^a

Predictors (n = 38 preceptors)	Change in RVU/session		
	β (SE)	95% CI	p Value
No. of interviews	2.64 (1.1) ^b	0.34–4.95	0.026
No. of presentations	2.42 (1.2)	0.38–4.79	0.047
No. of documents	2.70 (1.2)	0.18–5.22	0.036
Effective learning experience (yes/no)	5.49 (2.7)	0.01–11.0	0.050

Abbreviations: CI = confidence interval; RVU = relative value units.

Values are means.

^a Simple linear regression models, adjusted for mean number of patients seen by students in clinic.

^b Interpretation example: There is an expected mean increase of 2.64 RVU/clinic session for preceptors for each additional patient interviewed by a student in clinic, after adjusting for the total number of patients seen by students in clinic.

Effectively involving students and providing them with responsibilities such as documenting may reduce the clerical burden for preceptors.

preceptors are able to perform billable work related to seeing more patients, rather than simply bill for more time per patient visit. To maximize productivity and student learning, an extra clinical room appears to be an important resource to realizing this mutual benefit.

The results of this study imply that preceptors in neurology clinics can provide a rewarding teaching experience to students and stay financially productive at the same time. A recent study of emergency medicine preceptors correlates higher clinical productivity with higher resident teaching scores.²² Prior studies suggest that involving students in clinic has no adverse effects on patient outcomes or satisfaction.^{23–25} While students may add as much as 32 minutes to clinic sessions,² having students present either improves or has no effect on staff, student, and preceptor satisfaction.^{23,24} This suggests that even when the clinic time is extended, the stakeholders may consider it to be valuably spent. These arguments can be used to recruit preceptors to continue to teach to medical students.

Leaders in medical education have recently called for the creation of guidelines for students to document in EMRs.²⁶ This is largely in response to recent clinical trends limiting student documentation in EMRs due to billing and theoretical legal liability concerns.^{8,10,12} This is concerning to medical school deans who feel that limiting student documentation will negatively affect student education, preparation for internship, and involvement with clinical teams and patients.¹² In addition, this may be contributing to the sentiment among graduating neurology residents who feel ill-prepared for the business side of medicine at graduation.²⁷ Our study suggests that allowing students to document may create the 2-fold benefit of enhancing student learning and improving preceptor productivity. For preceptors, this aligns with prior studies that have shown that enabling students to document can save an estimated 3.3 minutes per patient.²⁸ For students, documentation enables them to reflect on the clinical experience, practice clinical reasoning, and assume increased ownership in patient care.^{8,12,19} It will be important for academic institutions and national organizations to develop guidelines that allow for early exposure, training, and engagement in EMRs to better integrate medical students to EMRs.^{9,26}

For preceptors, incorporating medical students utilizing this type of student engagement model may help generate greater professional intrinsic satisfaction and promotional recognition as faculty educators. In addition, effectively involving students and providing them with responsibilities such as documenting may reduce the clerical burden for preceptors. Making work more meaningful and improving efficiency may be 2 paths to help address the high burnout levels among neurologists.^{4,5,7}

A limitation of this study is that it reflects the experience of a single neurology clerkship in one medical system. While not fully representative, the principles and experiences translate to other sites and clerkships since the clinic workflow involving students will be relatively similar. Another limitation is the percentage of missing data, since 35% of students did not complete the survey despite multiple contacts, and we do not know how their input may have affected the results. As an IRB-approved study, student participation in survey completion was strictly voluntary. In this light, the 65% response rate reflects a relatively high response rate based on published rates for voluntary organizational surveys.²⁹ Furthermore, we only had access to productivity data for a 3-month period since there were no attendance records for the remainder of the year. The 3-month sample is representative of the academic year because there were no changes in course structure, student expectations, or student aptitude throughout the academic year. Next, the student survey was not statistically validated, and the results may be biased by measurement error. Future studies are planned to incorporate a validated survey conducted in various

specialties in order to reduce the potential for these aforementioned limitations and to capture a larger and more diverse group of learners and preceptors. Finally, our study did not record whether students documented in the EMR or outside of it. We are actively working within our institution to create a uniform policy regarding student documentation in EMRs.

These conclusions have 2 important biases to disclose. First, we did not evaluate whether students influenced patient satisfaction, experience, or outcomes. This leaves out the input of a critical stakeholder. Notably, ambulatory clinic studies conducted by other specialties have indicated that students have no negative effect on patient-related outcomes.^{23–25} Second, 2 of the article authors were included within the most effective group based on student evaluations of their clinics. While they did not contribute to the data collection/analysis, being aware of the project may have biased their metrics. However, the results remain consistent when excluding these 2 preceptors. Nevertheless, we are unsure how our findings may have changed if less effective teachers had more input in the data interpretations and conclusions.

Student-perceived learning in neurology is enhanced when students are given the opportunity to take on more active roles in clinic. In addition to the intrinsic rewards of teaching, preceptors also appear to preserve their clinical and financial productivity when students are present and given active clinical roles. This is presumably by completing work related to patients physically present or not present (e.g., completing notes and interpreting procedures) while the student is actively seeing patients. In addition, medical school policies on student documentation in EMRs should be further developed to allow students to document patient encounters. This project was inspired and executed from a collaborative team of medical students, educators, and administrators. Efforts like these provide invaluable opportunities for students and educators to gain insight regarding each other's perspective on professional roles.

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AUTHOR CONTRIBUTIONS

J. Tanner: study concept and design, acquisition of data, data analysis, interpretation of data, drafting and revising manuscript. K. Rao: study concept and design, acquisition of data, interpretation of data, drafting and revising manuscript. R. Salas: study supervision, study concept and design, interpretation of data, revising manuscript. R. Strowd: interpretation of data, critical revision of manuscript intellectual content. A. Nguyen: study concept and design, acquisition of data. A. Kornbluh: study concept and design, acquisition of data. E. Mead-Brewer: acquisition of data, data analysis, interpretation of data. C. Gamaldo: study supervision, study concept and design, interpretation of data, revising manuscript.

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