Internal Medicine Clerkship Characteristics Associated With Enhanced Student Examination Performance

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Abstract

Purpose

To determine which internal medicine (IM) clerkship characteristics are associated with better student examination performance.

Method

The authors collected data from 17 U.S. medical schools (1,817 students) regarding characteristics of their IM clerkships, including structural characteristics, pedagogical approaches, patient contact, and clinical teacher characteristics. Outcomes of interest were postclerkship National Board of Medical Examiners (NBME) subject examination score, United States Medical Licensing Examination (USMLE) 2 score, and change in score from USMLE 1 to 2. To examine how associations of various clerkship characteristics and examination performance may differ for students of different prior achievement, the authors categorized students into those who scored in the top ¼ of the cohort on USMLE 1 and the bottom ¼. The authors conducted analyses at both the school and the individual student levels.

Results

In school-level analyses (using a reduced four-variable model), independent variables associated with higher NBME subject examination score were more small-group hours/week and use of community-based preceptors. Greater score increase from USMLE 1 to 2 was associated with students caring for more patients/day. Several variables were associated with enhanced student examination performance at the student level. The most consistent finding was that more patients cared for per day was associated with higher examination performance. More structured learning activities were associated with higher examination scores for students with lower baseline USMLE 1 achievement.

Conclusion

Certain clerkship characteristics are associated with better student examination performance, the most salient being caring for more patients per day.

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Surprisingly, the academic medicine community knows little of how the characteristics of clinical clerkships influence student learning.[1] For example, one would surmise that students on longer clinical clerkships in a particular discipline would learn more about that discipline, but results of studies of clerkship length and examination performance have been mixed,[1–8] and—even in the positive studies—explain only 1% to 2% of the variance in examination scores.[4,5] Clerkship directors often decide on a pedagogical approach (lectures, small-group discussion, computer-based instruction), but little is known about which approaches are most effective for student learning in clinical clerkships. Some studies assume lectures are necessary to deliver curriculum and enhance learning; these show that style of lecture delivery (Web-based, telemedicine, PowerPoint) makes no difference in student learning outcomes.[9–12] To our knowledge, Oregon Health Sciences University conducted the only study comparing student learning in a clerkship with and without a core lecture series; in this 1980s study, National Board of Medical Examiners (NBME) subject examination scores in medicine were about a half a standard deviation higher after the implementation of a 50-hour lecture series that was delivered across a 12-week clerkship compared with the scores of students who experienced no lecture series.[13] Two other studies suggested the importance of lectures. Their results showed that students who fail to attend lectures or complete case study assignments do not perform as well on NBME subject examinations,[14,15] although one wonders whether habitual student absence reflects inherent student characteristics, which explain the lower examination scores more than the content missed from lecture. Finally, small-group discussions as a means of curriculum delivery typically engage students more than lecture formats, but they are not associated with enhanced student learning as measured by scores on written examinations.[16] In summary, some sort of structured curriculum (such as a core lecture series) seems to be important for student learning, but only two studies from the 1980s have documented this[13,17]; the literature has not supported the superiority of

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one pedagogical approach over another.

One could posit that student learning is most affected and most engrained by learning from patient encounters, but the evidence for this supposition is also sparse. For example, the volume of patients a student encounters has not been associated with enhanced student learning, at least as measured by examination scores.[8,18–21] Site of patient encounters could be influential. For example, encountering patients in ambulatory settings would seem ideal for student learning, given that the broader array of common clinical conditions experienced in the outpatient setting is much more representative of usual clinical practice than that experienced in quaternary care academic medical centers.[1] Nevertheless, the evidence that students learn more in ambulatory settings than in inpatient settings is sparse. An occasional single-site study shows a positive correlation,[22] but most studies fail to show such an advantage.[1,8,23] Longitudinal ambulatory rotations and experiences seem compelling, allowing for continuity of care, continuity of curriculum, and continuity of supervision.[24] Yet, again, the literature does not support the conclusion that these experiences enhance student learning, and some studies actually suggest an association with decrements in selected examination performances.[25–27] In contrast to the inconclusive evidence about the influence of location or type of clinical rotation on student learning, several studies have documented the benefits of excellent clinical teaching in enhancing student examination performance.[28–33] Excellent resident teaching may be even more critical to enhanced student learning.[31,32]

One could conclude from these studies that the length of clerkships, pedagogical approaches to undergraduate medical education, the type of clerkship sites, and the type and number of patients encountered are all irrelevant to student learning. In other words, just send students out to work with the better teachers and learning will occur. Such a conclusion would be premature because these studies have many limitations. For one, the vast majority of them are single-institution, raising questions of generalizability.[2–3,6–22,26–33] In addition, many of these studies, even those that include multiple institutions (such as those from NBME data sets[4–5,8]), generally focus on just one structural variable,[2–3,6–19,21,22,26–33] such as length of clerkship, percentage of ambulatory time, number of lectures, or number of patients seen; these studies do not consider how these variables all interact in various ways to affect learning. For example, the results of one rare study that, to a degree, did consider this interplay, showed that volume of clinical experiences alone did not predict the attainment of student "competence" on clerkship examinations, but the *interaction* of quality clinical supervision with patient volume was influential.[20] Finally, these studies do not take into account differences in students. For example, one could posit that high-achieving students may benefit less from formal didactic exercises or formal teaching rounds, suggesting that a one-curricular-approach-fits-all strategy is a fallacy. The purpose, therefore, of this project was to determine which IM clerkship characteristics were associated with better student examination performance, across multiple institutions, considering a multitude of clerkship characteristics. We hypothesized that various clerkship structural features, pedagogical approaches, teacher characteristics, and patient contact would be associated with differences in student examination performance, and that these variables would differ for students of high and low past examination achievement.

Method

Participants were a convenience sample of clerkship directors well known to the principal investigator (PI; C.G.) from interactions at the Clerkship Directors of Internal Medicine national meetings. The PI selected the schools to achieve diversity of both geography and school characteristics (large, medium, small; private or not) and to broadly represent the 126 U.S. IM clerkships. NBME exam and United States Medical Licensing Examination (USMLE) exam results for these schools were similar to national averages. The clerkship directors, all coinvestigators, participated in the study design including achieving funding for the project, refining the questions, and attaining IRB approval from their institutions. An important criterion to participate was the use of the NBME subject examination in medicine as a clerkship final examination. Of 19 clerkship directors solicited (including the PI), 2 were unable to participate because they did not use the NBME subject examination in their program.

Our conceptual framework suggested that several clerkship characteristics could influence student learning:

(1) structural characteristics,

(2) pedagogical approaches,

(3) patient contact, and

(4) clinical teacher characteristics.

On the basis of this framework, in the spring of 2003 the PI conducted a semistructured, 30-minute telephone interview of participating clerkship directors regarding characteristics of their clerkships.

Table 1 shows the characteristics we examined. We knew some characteristics (length of clerkship, % ambulatory time) with absolute certainly. Some data (e.g., the average number of patients on a student's ward service) represent our best estimate, based on our knowledge of the teaching services and sites on our clerkships. In addition, some of these characteristics (e.g., presence of hospitalists, whether a faculty member is a generalist or not, and faculty members' average months of attending per year and length of inpatient attending rotations) were included in the study data set because we hypothesized that these characteristics could potentially be associated with student learning, although at the time of this study no literature existed on these variables' influence. In addition, we could conceptualize some variables in different ways (such as *weeks* of ambulatory time versus *percentage* of ambulatory time; *total* hours of lecture or small-group time versus *hours per week*), so we performed separate analyses, operationalizing these variables in these different ways, and the results were similar.

Each site coinvestigator provided data regarding examination scores from individual students who rotated on their third-year IM clerkship in academic year 2002–2003 (each student in the data set remained anonymous). Examination scores included those on the NBME subject examination in medicine, USMLE 1, and USMLE 2.

Our primary analysis used multiple linear regression approaches from the general

Table 1

Descriptive Data for Characteristics of Internal Medicine (IM) Clerkships, as Measured by Structural Characteristics, Pedagogical Approaches, Level of Patient Contact, and Inpatient Attending Characteristics for the 17 Medical Schools Participating in a Survey, Academic Year 2002–2003

Clerkship characteristic	Mean of 17 IM clerkships
Structural characteristics	
Length of clerkship in weeks (SD); range	9.6 (2.3); 5–12
% ambulatory time (SD); range	19.0 (18.0); 0–50
% time on general medicine services versus specialty (SD); range	82.6 (25.4); 25–100
Pedagogical approaches	
Lecture frequency in number per week (SD); range	3.0 (1.9); 0–5
% with lecture series*	82.3
% with small-group conferences*	76.5
Small-group hours in number per week (SD); range	2.1 (2.2); 0–7
% with computer-based instruction*	23.5
Patient contact	
Average number of patients a student follows per day (SD); range	3.4 (0.9); 2.5–5.5
Average patient census per day per team (SD); range	12.6 (3.3); 8–20
Average admissions per call night per team (SD); range	7.0 (2.4); 3–12
Inpatient attending characteristics	
% any use of community-based faculty on the inpatient services*	58.8
% with any students on hospitalist services*	40.0
% ward attendings who are general internists (SD); range	82.6 (25.4); 25–100
Average number of months per attending per year (SD); range	4.5 (3.0); 1.5–9
Average length of attending rotation in weeks (SD); range	3.5 (0.9); 2–4
Average hours of rounds with attending per day (SD); range	1.9 (0.7); 1–3
% use separate teaching attending*†	41.1

* These percentages represent those answering "yes" to a yes/no dichotomous question.
† A separate teaching attending is a faculty designated to meet with the students and/or residents for teaching rounds each week, not the attending of record for patient care.

linear model. Unit of analysis presented a challenge. On the one hand, many of our clerkship characteristics (e.g., length of clerkship, average number of patients for whom a student cares) represent data on a school level, so the most conservative analysis entailed the school as unit of analysis. On the other hand, for our investigation into how clerkship characteristics affect students of different prior academic achievement, the individual student seemed the more appropriate unit of analysis, and we performed these student-level analyses as well. One outcome of interest was the score on the NBME subject examination in medicine. We used each school's mean NBME subject examination score as the value in school-level analyses, and individual NBME subject examination scores in the student-level analyses. Independent variables included all the clerkship characteristics listed in Table 1. Each variable produced a true two-tailed hypothesis in that we could posit the influence of each variable in a positive or negative fashion. For example, we could hypothesize that students would learn more from being involved in the care of more patients. On the other hand, caring for too many patients could compromise reading time and, therefore, compromise learning. For school-level analyses, the small number of degrees of freedom ($n = 17$) prohibited using all clerkship characteristics in analyses and limited the power of the analyses. To compensate in different analyses, we included one variable from each of the four categories of our conceptual model as an independent variable, based on those variables that exhibited the best distribution across our 17 schools (the structural characteristic of length of clerkship; the pedagogical approach of numbers of small-group hours per week; the patient-contact variable of average number of patients per day for whom a student cares; and whether the attending faculty in the inpatient setting was community based or not). We used SAS statistical software (Copyright 2009 SAS Institute Inc., Cary, North Carolina).

As stated above, some evidence suggests that aspects of an IM clerkship—specifically, exposure to the "best" clinical teachers—can have sustained beneficial effects, as suggested by higher USMLE 2 scores.[29,30] To analyze the effect of teaching on USMLE 2 scores, we used mean USMLE 2 score from each school for the school-level analyses. For the student-level analyses, we used the individual student's score. In addition, we studied a third outcome of interest: the change in score from USMLE 1 to USMLE 2. We used the individual student's change score in the student-level analyses. Change score by school is less useful because, within a school, mean student scores on USMLE 1 and 2 are very similar. Instead, we chose to focus on the percentage of students within a school who had significant changes from their USMLE 1 to USMLE 2 scores. We defined "significant" change as a difference of at least ½ standard deviation on the test, which amounted to a change in score of 10 points or more.

In addition, a primary purpose of our study was to investigate how clerkship structural variables associated with enhanced student learning might differ for students of higher versus lower prior academic achievement. We could account for prior academic achievement by using students' USMLE 1 scores as a control variable, as indeed, many studies have suggested that USMLE 1 score does account for much of the variance in USMLE 2 scores (62% of the variance in one study).[5] However, for our study, we were interested in what aspects of clinical clerkships explained student examination performance *over and above* Step 1 scores. In addition, in our initial examination of the distribution of the study data, we found that the use of the USMLE 1 score violated assumptions in that it was not equally linear across the range of the two prime dependent variables, USMLE score and NBME subject examination. Thus, correcting for the score for either school- or individual student-level analyses would not be appropriate. In addition,

given that regression to the mean occurs for many students on licensing and other examinations, for the purposes of student-level analyses we categorized students into two distinct groups that would be unlikely to have much overlap: those in the top ¼ of USMLE 1 scores (those who earned a score of 233 or higher) and those with the bottom ¼ of USMLE 1 scores (those who earned a score of less than 200), analyzing these groups separately. This approach allowed us

(1) to control for level of performance on USMLE 1,

(2) to avoid the problem of covariance assumptions that we encountered with normal use of USMLE 1 as a regression control covariate, and

(3) to correct for much of the problem of regression to the mean.

In addition, this approach makes conceptual sense because high and low scorers on USMLE 1 are likely to differ in multiple characteristics (background, motivation, preparation, expectations) that are not really linear dimensions. In essence, both statistically and conceptually, we believed that high and low scorers represented two different types of students and that such an analytic framework would best represent the data.

Balancing Type I and Type II errors is always a dilemma for studies that have multiple predictor and outcome variables. We tried to mitigate these errors by reducing the number of absolute comparisons; however, we believe that the only real confirmation must come from replication, and, in this type of study, Type II errors are the major concern. Another approach we used to balance Type I and II errors was an analytic style that tried to determine how robust each finding was. We did this by examining the statistically significant findings for potentially spurious relationships (correlations with other factors) and by using regression influence statistics to determine whether statistical outliers were overly influencing the findings.

Results

We received data regarding 1,817 students from 17 different medical schools. Sixteen of the schools provided data about all of their students. One school's IRB required prospective written informed consent from students for the use of their examination scores, and subsequently fewer than 50% of students signed such a consent. However, results were similar with or without this school's data in the study analysis, so, for purposes of presentation, the findings below include data from all 17 schools.

Mean USMLE 1 score was 216.9 (SD 21.2), mean USMLE 2 score was 216.4 (SD 22.3), and mean NBME subject examination score was 73.8 (SD 7.6). Mean student Step 1 to Step 2 change score was −0.4 (SD 17.1), with a range of −58 to + 75. On a school level, the mean percentage of students who had significant improvements in their Step 1 to Step 2 score was 27.9% (SD 9.0; range 17.1%–50.5%); the mean percentage of students who had significant decrements in their Step 1 to Step 2 score was 27.5% (SD 9.4; range 8.7%–44.9%). For the cohort of students who had scored in the top ¼ on USMLE 1, the mean USMLE 2 score was 237.3 (SD 15.8; range 183–275), and the mean NBME subject examination score was 79.9 (SD 7.1; range 57–97). For the students who scored in the bottom ¼ of USMLE 1, the mean USMLE 2 score was 196.5 (SD 16.3; range 151–242) and the mean NBME subject examination score was 68.2 (SD 5.7; range 51–99). Table 1 summarizes the results from the various clerkship characteristics.

In school-level analyses (N = 17), we used a conceptual model that included the clerkship characteristic of length of clerkship; the pedagogical approach of numbers of small-group hours per week; the patient-contact variable of average number of patients per day for whom a student cared; and whether the attending faculty in the inpatient was community based or not. In this model, independent factors that were associated with higher mean NBME scores included a larger number of small-group hours per week ($F = 4.37$; $P < .05$) and use of community-based preceptors ($F = 4.74$; $P < .05$). The R^2 of the model was 0.44, suggesting that the model explained 44% of the variance in NBME subject examination scores. For mean USMLE 2 score, no variable emerged as significantly associated. However, the percentage of students in the school with significant improvement in their USMLE 1 to USMLE 2 score was associated with a greater number of patients per day on average for whom these third-year students cared ($F = 7.93$; $P < .01$; R^2 0.47). Similarly, the fewer the number of patients the third-year students followed on average was associated with a greater percentage of students with a significant drop in scores from USMLE 1 to 2 ($F = 6.55$; $P < .02$; R^2 0.44).

Table 2 summarizes the findings from the student-level analyses. For students who achieved high USMLE 1 scores, factors that were associated significantly with higher NBME subject examination scores were more patients cared for per day, greater length of rounds with the attending, and any use of computer-based instruction. Higher USMLE 2 scores were associated with longer attending rotations (four weeks versus two weeks) and any use of hospitalists. Greater increase in USMLE 1 to USMLE 2 was associated with more patients cared for per day, any use of hospitalists, and four-week (versus two-week) attending rotations. For students who achieved low USMLE 1 scores, factors that were associated significantly with higher NBME subject examination score were a greater number of small-group hours, any use of computer-based instruction, use of a separate teaching attending, greater ambulatory time, and more clerkship weeks. Higher USMLE 2 scores were associated with more patients cared for per day and a greater number of small-group hours. Greater increase in USMLE 1 to USMLE 2 was associated with more patients cared for per day, four-week (versus two-week) attending rotations, and more admissions to the ward services per call night. R^2 for these models ranged from 0.08 to 0.21.

Discussion

Our study is unique in accounting for a large number of clerkship structural characteristics across multiple institutions. Unlike the high number of negative or equivocal studies done in the past, our findings suggest that many aspects of IM clinical clerkships are associated with enhanced student learning, as measured by performance on NBME-type examinations. Perhaps the most consistent finding is that higher examination performance is associated with students caring for more patients. Even after taking into account other clerkship pedagogical practices, contact

Table 2

Summary of Statistically Significant Associations Between Teaching Variables and Better National Board of Medical Examiners (NBME) Subject Examination Scores, United States Medical Licensing Examination (USMLE) 2 Scores, and USMLE Change Scores for Students Who Scored High (Top) or Low (Bottom) on the USMLE 1 Examination

Students	NBME subject exam	*P* value	USMLE 2	*P* value	Change score USMLE 1 to 2	*P* value
Students who achieved high (>233) scores on the USMLE 1	More patients cared for per day	<.0001	Greater length of attending rounds	<.05	More patients cared for per day	<.01
	Greater length of attending rounds	<.025	Use of hospitalists	<.05	Use of hospitalists	<.025
	Computer-based instruction	<.05	—		4-week versus 2-week attending rotations	<.01
Students who achieved low (<200) scores on the USMLE 1	More small-group hours	<.0001	More patients cared for per day	<.01	More patients cared for per day	<.0001
	Computer-based instruction	<.0001	More small-group hours	<.05	4-week versus 2-week attending rotations	<.001
	Separate teaching attending	<.001	—		More admissions to student's service per call night	<.01
	More ambulatory time	<.01	—		—	
	More clerkship weeks	<.01	—		—	

with patients is the most salient factor for most of our outcomes. This is especially true of outcomes that reflect more engrained learning, such as performance on USMLE 2. In an era in which patient contact is more harried (in busy inpatient and outpatient settings) and in which instructional supplements (e.g., standardized patients, computerized virtual patients) are advocated, contact with patients still remains the factor that is most associated with and appears most influential for student learning.

One should be cautious and not interpret our results to suggest that other clerkship characteristics are unimportant, a form of pedagogical nihilism. Indeed, an interesting finding unique to our study is that the more structured pedagogical approaches (a greater number of small-group hours, computer-based instruction, and formal rounds with a separate teaching attending—not lectures, however) seem to benefit the students who achieve lower scores, especially for the postclerkship subject examination. Studies that fail to show improvements in learning from various educational interventions should take into account the fact that different educational strategies may benefit one group of students more than the others. High-achieving students may learn regardless of a lecture series or small-group sessions; nevertheless, course directors should consider that the lower-achieving students may need that more formal structured curriculum. Future studies should continue this line of investigation, examining how various clerkship teaching strategies affect different types of students.

In addition, one should not use our findings to suggest that third-year medical students should care for huge numbers of patients. Indeed, our clerkship directors generally expected students to follow three to four patients, and the most expected was five to six. We speculate that there is a threshold effect; that is, at some point, too many patients results in an inability to learn from an individual patient, with reading time and reflection time curtailed. In addition, we do not have data on exactly how many patients individual students followed, just how many patients they were expected to follow. We surmise that in clerkships where students are expected to care for more patients, they probably do, and our student census numbers are comparable to what students themselves report (mean number of patients 3.2, SD 1.1 in one large multisite study).[34] Nevertheless, future research should consider actual numbers of patients per student, taking into account other clerkship structural variables and such factors as patient acuity and complexity, not just raw numbers.

Our study has several limitations. For one, many of our measures were quite crude. For example, we specified neither the degree of computer-based instruction nor what, exactly, having community-based faculty on the wards entails; we simply categorized each of these (and some other measures) as yes or no. In addition, measuring precisely such variables as the number of patients an individual student followed or the exact rounding characteristics of each individual student's attending was beyond the scope of this study (besides the challenges of measuring these variables, accounting for such factors as the complexity of students' patients or the quality of time teaching versus rounding is extremely difficult; these are daunting, but perhaps ripe, areas for future study). The crudeness of some of our measures added error variance to our analyses, and it would have been a great concern if we had demonstrated negative findings. Indeed, because of the imprecision of measures, one should be cautious in interpreting as definitive the variables that we found to have no association with examination performance. However, showing statistically significant associations despite this background "noise" in the data set strengthens our confidence in our primary findings. Nevertheless, even though our study does provide some answers to which clerkship

characteristics are or are not especially associated with student learning, these answers are not definitive; rather, our study's answers are most useful for pointing the direction for future research in this area.

A second limitation is that most of our clerkship variables reflect inpatient experiences, with ambulatory experiences merely the percentage of time in clinics. Originally, we aimed to ascertain in more detail the influence of ambulatory characteristics, such as whether faculty were community based or not, the type of practice, the types of patients seen, and so on. However, what became apparent in our semistructured interviews was that course directors had detailed and intimate knowledge of the inpatient services, as those experiences were more uniform for students, with similar hospital and ward teams. However, ambulatory experiences reflected a huge number of permutations involving many different practices and faculty across a wide array of settings, many of them off-site, and clerkship directors knew only cursory details of these rotations. Future work should investigate in more detail the influence of ambulatory clerkship characteristics on student learning. Third, our outcomes are limited to national board-type multiple-choice examinations. Clerkship characteristics may influence many other outcomes such as student attitudes, the development of professionalism, and clinical skills.[35]

Still, despite these limitations, our study has many strengths, including the cross-institution study design, data on a variety of clerkship variables rather than a single characteristic, data on both short-term (NBME subject examination) and long-term (USMLE 2 examinations) learning outcomes, and a focus on students with different prior academic achievement, which captures the notion that clerkship features may have a different influence on different types of students.

A structured curriculum and pedagogical approach is associated with enhanced learning especially for the lower-achieving students, particularly for achievement on end-of-clerkship examinations. A variety of clerkship characteristics are associated with enhanced student learning, but, in the end, the most beneficial aspect of clinical clerkships in terms of student learning is caring for patients.

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