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Predictors of medical student success on the surgery clerkship

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ABSTRACT

Introduction: Predictors of student performance on clerkship rotations are limited. In this study, we aim to identify predictors of success on the surgery clerkship.

Methods: 62 third-year medical students completed an institution-specific clerkship survey. Students were grouped according to clerkship grade of honors (HG) versus high-pass or pass (PG). Statistical analyses were performed using Student's t-test, Pearson's Chi-square/Fisher's exact test, and linear regression analysis. Multivariate logistic regression was performed to identify predictors of achieving an honors on the clerkship.

Results: HG students were more likely to be individual-based learners with higher grit and USMLE Step 1 scores compared with PG students. Moreover, USMLE Step 1 score was associated with quiz, shelf examination, and final clerkship grades, but not clinical evaluations. There were few differences with regard to preferred learning modalities, but overall, medical students favored active learning activities.

Conclusions: We found that higher USMLE Step 1 score, higher grit score, and an individual-based learning style were associated with a higher grade on the surgery clerkship. However, these factors may not fully capture the less objective components of high performance. Additional methods by which educators can measure students' clinical competency are needed.

Introduction

In 1930, Dr. George H. Heuer charged surgical educators "to develop the highest type of surgeons—men fitted to continue the teaching of surgery in medical schools and to assume the leadership in the practice of Surgery."[1] Today, this charge remains a central mission of surgical faculty and residents as they educate the next generation of doctors and mentor those interested in surgery. Included in this directive is identifying students who may excel in surgery and encouraging them to pursue a career in the field.

The task of recruiting talented and interested students to surgery may be accomplished simply by being a positive role model and teacher. Prior work has shown that medical students who worked with residents deemed effective teachers and role models were more likely to pursue a surgical residency.[2–5] However, reliable and objective metrics by which educators can evaluate students on the general surgery clerkship are limited. For example, United States Medical Licensing Examination (USMLE) Step 1 scores have been associated with student success on the surgery clerkship, but most of the reported metrics appear to better correlate with objective outcomes, such as the National Board of Medical Examiners (NBME) Surgery Shelf Exam, and not necessarily clinical performance.[6] For the latter, resident and faculty clinical evaluations play an important role because they can attest to a student's skills and abilities that cannot be captured by a written examination.

While there is data to suggest that personality factors play a role in one's choice of medical specialty,[7,8] there is a paucity of studies evaluating the impact of a medical students' personality traits and work ethic on clerkship performance. Various personality inventories (e.g. learning styles, grit, burnout), widely used in other fields, have emerged in the medical education literature, and researchers are beginning to explore the impact of these factors on surgery resident performance. However, this work has yet to be done among medical students. Identifying predictors is important not only for surgical educators, but also medical schools, to be able to identify potentially at-risk students who may require additional resources or assistance. Therefore, we set out to identify predictors of medical student success on the surgery clerkship at our institution.

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Materials and methods

All third-year medical students are required to complete the surgery clerkship at our institution. This eight-week rotation is divided into four weeks on a general surgery service and four weeks on a subspecialty service. During the rotation, students participate in weekly lectures, which provide material for two quizzes. At the end of the rotation, students take the NBME Surgery Shelf Examination, or "shelf exam." The final clerkship grade is comprised as follows: 50% clinical evaluations (25% per 4-week rotation), 25% NBME exam score, 10% quiz average, and 15% for required course activities (i.e. specific patient encounters and online learning modules). Final numeric grades are then converted to "Honors" (90%+), "High Pass" (85–89%), or "Pass" (61–84%).

All third-year medical students on the surgery clerkship during the 2016–2017 academic year were invited to complete a set of surgery clerkship surveys. These included a pre- and post-clerkship survey designed specifically for this study, as well as the Kolb Learning Style Inventory[9] and the 12-item Grit Scale.[10] Surveys were administered using an online survey tool (www.surveymonkey.com). Participation in the study was voluntary, and all data was analyzed at the end of the academic year after student clerkship grades were assigned. Only students who completed the pre- and post-clerkship surveys were included in this analysis.

In brief, the pre-clerkship survey consisted of 23 questions and was used to collect demographic information, as well to assess student expectations about the upcoming rotation and interest in surgery. The post-clerkship survey consisted of 26 questions and evaluated student perceptions regarding their experience and preferred methods of learning on the rotation. Questions were formatted as a combination of multiple choice, Yes/No, and five-point Likert scale. The Kolb Learning Style Inventory 3.1 (LSI) (HaysGroup, Boston, MA) was administered to assess the learning styles of students. The LSI assesses how an individual perceives and interacts with new information (i.e. individual-based versus team-based) and then processes and solidifies that information (i.e. through action versus observation) to create knowledge. Further details on this inventory and its use in surgical education can be found in our group's prior publications.[11–14] The 12-item Grit Scale measures an individual's grit, defined as one's perseverance and passion for long-term goals, with a scale ranging from 1 (low) to 5 (high).

Continuous data are represented as mean and standard deviation (SD) and categorical data as frequency and percentage. Categorical survey response data are reported as the percent responding "Yes." Answer choices involving a five-point Likert scale were converted to a binary of "Yes" (strongly agree, agree) or "No" (strongly disagree, disagree, neutral). Comparisons were performed using Student's t-test for continuous data and Pearson's Chi-square test (or Fischer's exact test for rare occurrence) for categorical data. Simple linear regression (SLR) was performed, and R^2 was reported to indicate goodness of fit. Multivariate logistic regression analysis was performed; covariates included were USMLE Step 1 score, grit score, undergraduate major, and learning style. A p-value <0.05 was considered statistically significant. All statistical analyses were performed using JMP Pro Version 12.0 (SAS Institute, Cary, NC). This study was approved by the University of Cincinnati's Institutional Review Board.

Results

During the 2016–2017 academic year, 166 third-year medical students were invited to complete the survey set while on the surgery clerkship. Of those, 97 students (58%) completed the pre-clerkship survey and 79 students (48%) completed the post-clerkship survey. Sixty-two students (37.4%) completed both the pre- and post-clerkship surveys, and only these respondents were included in this study. The demographics and clerkship performance of this group are shown in Table 1.

To explore factors associated with high performance on the surgery clerkship, we compared students who earned an "Honors" (Honors Group, HG) with the students who earned either a "Pass" or "High Pass" (Pass Group, PG) (Table 2). There were no differences in gender, race, age, undergraduate major or research experience between the groups (all $p > 0.05$). However, HG students had significantly higher USMLE Step 1 scores (249.6 ± 11.7 vs 239.0 ± 14.2, $p = 0.006$) and higher grit scores (3.76 ± 0.47 vs 3.42 ± 0.59, $p = 0.030$) compared to PG students. Moreover, HG students were more likely to be individual-based learners (75.0% vs 45.7%, $p = 0.039$) compared to PG students.

Next, since higher USMLE Step 1 score, higher grit score, and an individual-based learning style were observed among HG students, we explored each factor's potential association with clerkship performance. On SLR there was a positive correlation between USMLE Step 1 score and average quiz score ($p < 0.001$), shelf exam score ($p = 0.001$), and overall final clerkship grade ($p = 0.003$), but not average clinical evaluation scores ($p = 0.097$) (Fig. 1). There was no linear association, however, between grit and average quiz score ($p = 0.432$), shelf exam score ($p = 0.379$), average clinical evaluation scores ($p = 0.197$), or overall final clerkship grade ($p = 0.102$). Furthermore, learning styles did not correlate with any of the individual components of clerkship performance (data not shown). On multivariate logistic regression analysis, USMLE Step 1 score (OR = 1.08, 95% CI 1.02–1.14, $p = 0.01$) and grit score (OR = 4.18, 95% CI 1.10–15.80, $p = 0.04$) remained independent predictors of achieving an honors grade.

Finally, we examined whether a student's preferred learning modality impacted performance. We evaluated perceptions between the HG and PG with regard to various learning environments and learning activities. A higher proportion of HG students found the operating room to have a positive impact on their learning compared to PG students (87.5% vs 60.9%, $p = 0.037$); however,

Table 1
Surgery clerkship student demographics.

Student Information	*n (%)*
Total	62 (100%)
Gender (female)	25 (40.3%)
Race (Caucasian)	43 (69.4%)
Age	
<26	50 (80.6%)
27-29	7 (11.3%)
30+	5 (8.1%)
Undergraduate major	
Biological sciences	42 (67.7%)
Physical sciences	8 (12.9%)
Social sciences	4 (6.5%)
Humanities	8 (12.9%)
Prior research	49 (79.0%)
Current research	30 (48.4%)
Learning style (processing)	
Action learners	20 (32.3%)
Observation learners	42 (67.7%)
Learning style (perception)	
Individual learners	33 (53.2%)
Team learners	29 (46.8%)
Surgery clerkship grade	
Honors	16 (25.8%)
High pass	24 (38.7%)
Pass	22 (35.5%)
USMLE Step 1 (mean ± SD)	241.7 ± 14.3
Grit score (mean ± SD)	3.51 ± 0.58

Table 2
Comparison of honors and pass group on the surgery clerkship. *p < 0.05.

Student Information	Honors Group	Pass Group	p
	n (%)	n (%)	
Total	16 (25.8%)	46 (74.2%)	
Gender (female)	8 (50.0%)	17 (37.0%)	0.360
Race (Caucasian)	14 (87.5%)	29 (63.0%)	0.244
Age			0.864
<26	14 (87.5%)	36 (78.3%)	
27-29	1 (6.3%)	6 (13.0%)	
30+	1 (6.3%)	4 (8.7%)	
Undergraduate major			0.698
Biological sciences	11 (68.8%)	31 (67.4%)	
Physical sciences	3 (18.8%)	5 (10.9%)	
Social sciences	0 (0%)	4 (8.7%)	
Humanities	2 (12.5%)	6 (13.0%)	
Prior research	11 (68.8%)	38 (82.6%)	0.241
Current research	9 (56.3%)	21 (45.7%)	0.465
Learning style (processing)			0.471
Action learners	4 (25.0%)	16 (34.8%)	
Observation learners	12 (75.0%)	32 (65.2%)	
Learning style (perception)			0.043*
Individual learners	12 (75.0%)	21 (45.7%)	
Team learners	4 (25.0%)	25 (54.4%)	
USMLE Step 1 (mean ± SD)	249.6 ± 11.7	239.0 ± 14.2	0.006*
Grit score (mean ± SD)	3.76 ± 0.47	3.42 ± 0.59	0.030*

there was no difference among the other learning environments (Fig. 2). With regard to learning activities, a student's preference did not differentiate HG from PG students (Fig. 3). When comparing the average rate of positive (yes) responses among all medical students for each learning activity, students appear to prefer active rather than passive activities (76.1% vs 61.7%, p = 0.032).

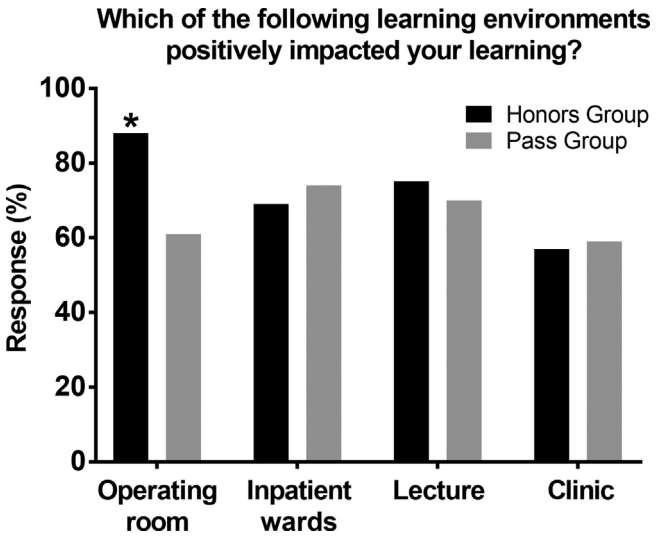

Fig. 2. HG students were more likely to report that the operating room benefitted their learning during the clerkship, but there were no differences for the other learning environments. *p < 0.05.

Discussion

In this study, we examined the performance of third-year medical students on the surgery clerkship at our institution to identify factors associated with high performance. We found that students who achieved an "Honors" had higher USMLE Step 1

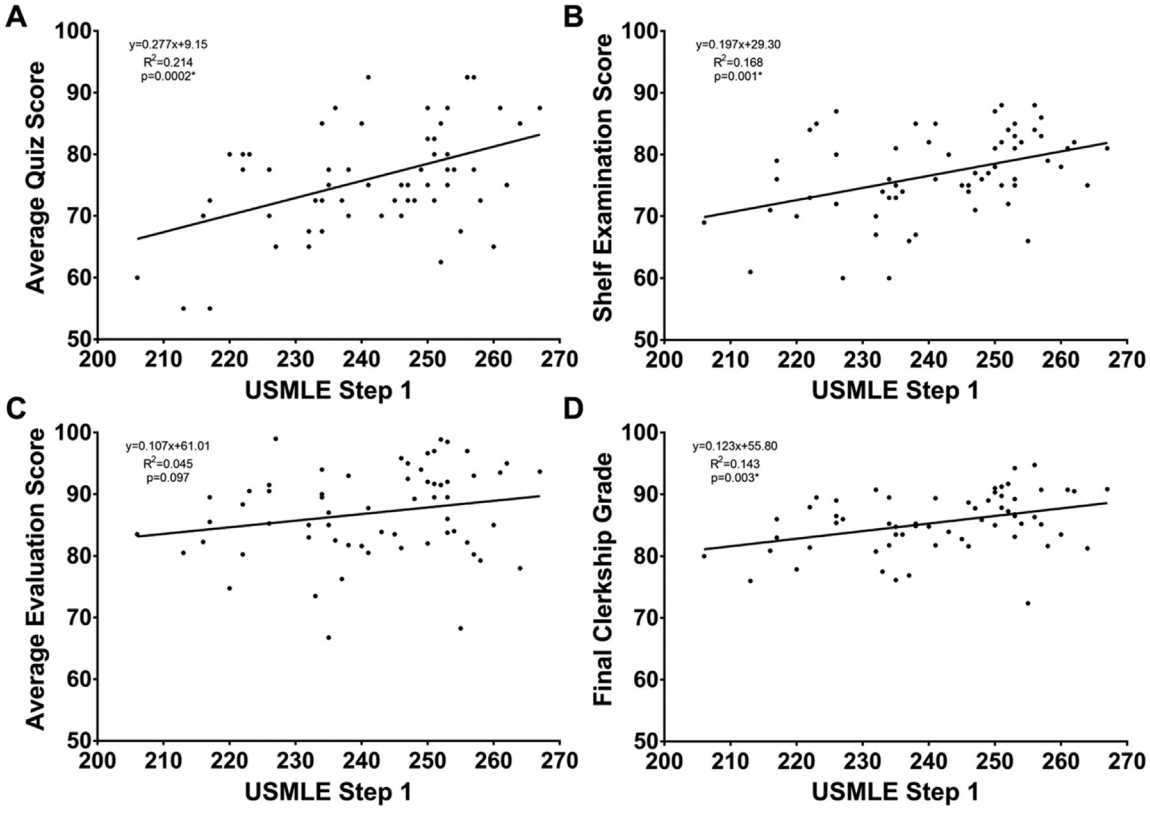

Fig. 1. USMLE Step 1 score is associated with surgery clerkship performance. There was a positive correlation between USMLE Step 1 score and average quiz score (p < 0.001) (**A**), shelf exam score (p = 0.001) (**B**), and overall final clerkship grade (p = 0.003) (**D**), but not average clinical evaluation score (p = 0.097) (**C**). *p < 0.05.

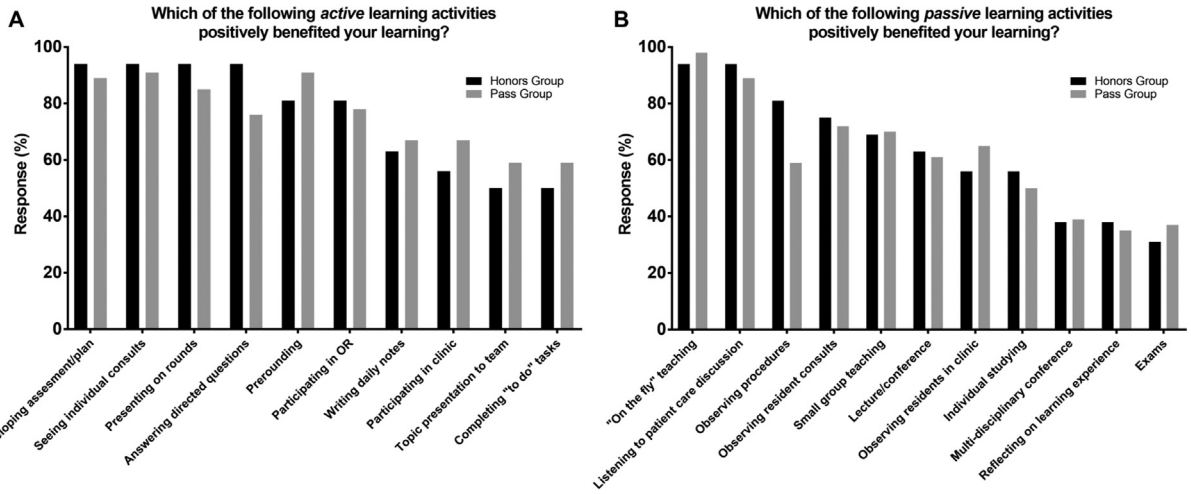

Fig. 3. Students' preferred learning modality does not play a major role in clerkship performance as there was no difference between HG and PG students in terms of preference for active (**A**) vs passive (**B**) learning activities.

scores, higher grit score, and were more likely to be individual-based learners compared to students who earned a "High Pass" or "Pass." Furthermore, USMLE Step 1 scores, but not grit or learning style, were predictive of objective performance items in the clerkship grade (i.e. quiz score and shelf exam), as well as the overall total clerkship grade, but not clinical evaluations by residents and faculty. Finally, we found that a student's preferred learning modality did not differentiate HG students from PG students, but overall, medical students favor active learning activities to passive learning activities.

Consistent with our findings, other groups have shown that student performance on USMLE Step 1 correlates with NBME Surgery Shelf Exam scores.[15,16] This comes as no surprise as it likely identifies students who have mastered the demands of higher education and standardized test taking, but this metric may not capture one's true clinical knowledge or bedside skills. Moreover, the impact of high medical school test scores on future success in surgery residency is unclear. Although there is data supporting a correlation between USMLE Step 1 scores with American Board of Surgery In-Training Examination (ABSITE) performance and first-time board pass rates,[17] USMLE Step 2 scores may better predict ABSITE performance and first-time board pass rates.[18,19] In our study, despite observing that one's USMLE Step 1 score did not correlate with clinical evaluation score (which comprises 50% of the final grade), USMLE Step 1 score still correlated with the final clerkship grade on both SLR and multivariate analysis. Therefore, we propose that USMLE Step 1 score may help identify students who may be at risk on the rotation; however, this parameter should not be used in isolation because it may not adequately assess the beside skills required in daily practice, including professionalism, interpersonal communication, and complex problem solving.[20]

Grit is a psychological term that describes one's perseverance and passion for long-term goals. To our knowledge, little is known about grit among medical students, although it is becoming increasingly studied in the surgical education community. The duration of training, long work hours, and emotional and physical stresses of surgical residency undoubtedly require grit. Grit has been shown to have a positive correlation with psychological wellbeing and a negative correlation with attrition among surgical residents.[21–23] Furthermore, higher levels of training among surgeons have been correlated with higher grit scores.[24] Our findings indicate that, compared to USMLE Step 1 score, grit has an even higher association with performance on the surgery clerkship.

If grit positively predicts surgical residency completion and performance, then identifying "grittier" medical students may help surgical educators usher in future generations of surgical trainees who are likely to excel. One study evaluating hiring practices of novice teachers assigned a scoring system for grit based on involvement and leadership in previous work and college activities; the authors found that this grit score predicted teaching performance and classroom retention.[25] As such, the use of grit within the selection process for undergraduate and graduate medical education has been proposed.[26] A potential application may be to include grit in the residency selection process. Letters of recommendation could also comment on students' perseverance while on service. Together, a clerkship grade of honors, letters of recommendation, and dedication to previous service and employment may help program directors select those students most likely to succeed in general surgery residency.

Unlike grit, learning styles have been more thoroughly studied among medical students.[6,7,27,28] Although learning styles may be overly simplistic or rigid, they allow educators a framework for grouping and characterizing learners to best tailor teaching methods. Previous studies from our own institution have demonstrated a significant difference between the predominant learning style of surgical residents and that of medical students,[11–14] which is consistent with independent studies from other institutions.[6,29,30] These findings have strong implications, as contrasting learning styles within the student-teacher relationship may negatively impact learning.[28]

Ultimately, the impact of learning styles on outcomes and performance must be evaluated if they are to have a genuine influence on medical education. For example, Lynch et al. observed higher USMLE Step 1 scores among individual-based learners; however, there was no difference between learning style and clinical performance.[6] Similarly, we found that HG students were more likely to be individual-based learners with higher USMLE Step 1 scores. This is interesting given prior data from our institution that, since the implementation of duty hours, surgery residents are more likely to be team-based learners.[13] This discrepancy may be due to our surgery clerkship grading scheme in which 35% of the final grade is determined by the shelf exam and quizzes, favoring the individual-based learner. In other words, student grades may not reflect the team-based, multidisciplinary care activities of the surgical service, but rather, the more objective, rote knowledge that is routinely asked of students by clinicians or on tests.

Learning styles also describe how individuals process and solidify new information—either by action or observation. Whereas we have found that action-based learners do better in general surgery residency,[12] we did not observe a difference in action-based versus observation-based learning styles between HG and PG students. Although HG students were more likely than PG students to report that the operating room positively impacted learning, there was no influence on clinical evaluations to suggest this translated to superior clinical performance. Moreover, the HG group's favorable impression of the operating room may be confounded by their higher grit, as high performers are likely more adaptive to the conditions of the operating room and better able to maximize learning in such an environment. Finally, we found that regardless of final grade, medical students more frequently preferred active learning activities compared to passive learning activities. Given that active involvement and operative experiences are associated with increased interest and higher match rates into general surgery, surgical educators should make every effort to increase active learning activities and operating room exposure when designing and implementing third-year surgical clerkship curriculum.[31,32]

While our findings provide insight into which students may perform highly on the surgery clerkship, these predictors must take into account that "performance" is defined as a "good grade." While we believe this is not unique to our institution, as most programs use a combination of evaluations, final exam, and in-house assessments to grade students, it raises the question of how to define performance and competency among students. In our study, there was no difference in clinical evaluation scores between students whose USMLE scores were above versus below the mean (data not shown), suggesting that higher test performance does not translate to better clinical evaluations. This is consistent with a study by Farrell et al. that demonstrated that objective measures may not capture the more subjective elements and tacit knowledge we desire our students to learn.[20] To address this, we also studied student performance using only the clinical evaluation, defining HG as the top 25th percentile and the PG as the bottom 75th percentile of evaluation scores, but no predictors were noted (data not shown). Therefore, one may question why our surgery clerkship grading system, and likely other clerkships for that matter, favors to students with individual-based learning styles who excel on standardized assessments. With emerging data on the importance of non-technical skills for surgeons, identifying these skills in students is even more important today.[33]

In an ideal system, resident and faculty member evaluations would objectively judge the performance and competency of medical students. Obtaining high quality, accurate evaluations is extremely important because they speak to the students' interpersonal skills and applied knowledge, which are not identified by a standardized exam and often serve as the basis for letters of recommendation. In practice, however, quality evaluations are difficult because of the inherent subjectivity of the process. Goldstein et al. found that despite high interrater reliability between attending surgeons and residents, there was no convergent validity to suggest these evaluations reflected students' actual knowledge.[34] Ultimately, these issues highlight the need to further identify methods of measuring competency.

Moving forward, a promising strategy for reforming medical student clinical assessments may be the use of Entrustable Professional Activities (EPAs). EPAs translate competencies into clear and observable activities that can be monitored in various work settings, which may better identify students who have achieved mastery of and independence in the foundations of medical and surgical care.[35,36] EPAs can be further divided into Observable Practice Activities (OPAs), which encompass even more detailed behaviors and activities of daily practice. The Association of American Medical Colleges (AAMC) already offers a list of 13 EPAs expected of all graduating medical students, and surgical clerkship directors could enhance this list by outlining their own EPAs to facilitate expectation setting and the evaluation process.[37] Some downsides of the EPA/OPA system is they make the evaluation process so granular that it becomes cumbersome for educators. In addition, it is unclear how different activities should be weighed and tracked over time.[38] On the surgery clerkship, it is unknown to what extent EPAs/OPAs should focus on the needs of future interns entering general surgery programs versus more broad based activities.

There are several limitations to this study. First, it is a single institution's experience and therefore may not be generalizable to all medical students. Second, the cohort size is limited and may lack sufficient power to capture subtle differences that could better explain student performance. Third, the data is based on participants' self-reporting and is therefore subject to recall bias. However, our inclusion of validated assessments and objective data mitigates these concerns. Finally, there are inherent limitations to the Kolb model, which assumes that individuals approach learning tasks in a characteristic and automated fashion. Although the Kolb LSI has been used extensively in education research, the model has been criticized for its lack of applicability and failure to emphasize reflection, cultural based learning differences, and the relationship of learning processes to knowledge.[29] Kolb LSI detractors also question the test's reliability and validity, and the literature is mixed regarding the inventory's test-retest reliability, which complicates interpretation of this data.[39]

Conclusion

We found that students who achieved an honors grade on the surgery clerkship had higher USMLE Step 1 scores, higher grit scores, and were more likely to be individual-based learners. However, it remains difficult to predict which students will excel in clinical performance on the surgery rotation. As a result, it is important that residents and faculty make a concerted effort during the rotation to carefully observe students in order to provide quality evaluations that speak to their true skillset and knowledge.

Disclosures

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