



## Original Research Article

## Impact of general surgery rotation exposure on surgery clerkship performance

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## ABSTRACT

**Background:** Medical students often have variable exposures to general surgery (GS) and subspecialty surgery (SS) during their surgical clerkship. We will evaluate the relationship between clinical exposure to GS and performance on the NBME Subject Examination in Surgery.

**Methods:** Student data was collected retrospectively from 2015 to 2018 at a single academic institution. Students were categorized based on their clinical clerkship exposure to GS. A linear model was used to estimate the mean difference in NBME performance between GS and strictly SS exposed students while controlling for prior standardized examination scores and completion of an internal medicine clerkship prior to surgery.

**Results:** 365 (67%) of 547 students were exposed to a GS rotation prior to their NBME exam. Performance on the NBME exam was comparable between GS versus SS students ( $\mu$ diff = 0.37, 95% CI: -0.73 to 1.48;  $p = .51$ ).

**Conclusions:** Exposure to a GS rotation is not advantageous on the NBME surgery examination. Students who completed the medicine clerkship prior to surgery demonstrated superior performance on the NBME surgery examination.

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## Introduction

Clinical knowledge of medical students is commonly assessed following their required surgery clerkship using the National Board of Medical Examiners (NBME) Clinical Sciences Subject Examination in Surgery (i.e., the NBME surgery exam). Due to volume constraints, surgical clerkship curricula often vary based on exposure to general surgery (GS) and subspecialty (SS) patient care. The effect of these variable exposures on assessment scores is poorly understood. We sought to evaluate if GS exposure improves performance on the NBME surgery exam.

Based on the 2018 AAMC Medical School Graduation Questionnaire with 16,223 respondents, 27.3% of graduates reported plans to pursue a surgical residency (6.1% general surgery or subspecialties).<sup>1</sup>

Clinical knowledge of medical students is commonly assessed following their required surgery clerkship using the NBME surgery exam.<sup>2</sup> According to a survey of clerkship directors, 100% of clerkship directors reported using the NBME exam, and 89% reported requiring students to pass the NBME surgery exam in order to pass the clerkship.<sup>3</sup> Performance on this standardized exam is an important factor in clerkship grading. Institutions vary the weight of the NBME surgery exam in calculating final grades. However, it commonly accounts for at least 33% of the final grade, with 75% of surgery clerkship directors reporting that the NBME score accounts for 21–50% of the final surgery clerkship grade.<sup>3,4</sup> Furthermore, 67% of surgery clerkships reported using NBME surgery exam performance to determine honors in the surgery clerkship.<sup>3</sup> The surgery clerkship grade was also reported by 76% of surgical program directors as important in selecting applicants to interview and rank in the 2018 Match.<sup>5</sup> Exposure to educational content during the required surgery clerkship is variable and is based on institutional, rotation, student, and clinical factors. Consequently, students at large academic institutions may be exposed to different experiences during their surgical rotations which may lead to disparate performance advantages on the NBME surgery exam.

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Anecdotal claims among students argue that NBME surgery exam scores improve after exposure to more general surgery clinical content during the surgical clerkship. For example, because the NBME surgery exam has a reported 20–25% emphasis on gastrointestinal content, students may estimate a testing disadvantage if they spend their clerkship time primarily focusing on Thoracic or Endocrine specific surgery.<sup>2</sup> Although previous investigators have evaluated this potential advantage, there have been significant changes in educational practices since it was last reviewed, and the analysis lacked multivariable adjustment for independent predictors for success on the NBME, such as previous Medical College Admissions Test (MCAT) scores or United States Medical Licensure Examination (USMLE) Step 1 performance.<sup>6</sup> Additionally, because completion of a medicine clerkship prior to a surgery clerkship has been shown to provide an objective performance advantage, this must be accounted for in order to properly compare student population NBME performance.<sup>7</sup> Although we did not observe a downtrend in NBME scores at our institution prior to this study, we wished to evaluate this question to strengthen our counseling of medical students regarding clinical rotations.

The purpose of this study is to identify whether exposure to one or more months of GS provides a performance advantage on the NBME surgery exam after adjusting for USMLE Step 1 score, MCAT score, and prior completion of a medicine clerkship.

## Methods

All third-year medical students enrolled in the 8-week core surgery clerkship from 2015 to 2018 were retrospectively assessed at a single academic medical center. Clerkship structure for each student included assignment to two separate 4-week clinical sites. Students participated in daily clinical activities unique to their assigned site in addition to supplemental curricula prior to a final clinical knowledge assessment using the NBME surgery exam. Clinical sites (assigned by student preference or at random) included: acute care surgery, burn surgery, colorectal surgery, endocrine surgery, minimally invasive surgery, surgical oncology, pediatric surgery, plastic surgery, thoracic surgery, transplant surgery, general surgery at a veterans hospital (Veterans Hospital), general surgery at a rural community hospital (Rural Community Hospital), general surgery at two different urban community hospitals (Urban Hospital 1 and Urban Hospital 2), and vascular surgery. Clinical sites staffed by supervising faculty who practice primarily within the scope of their fellowship training defined SS sites: burn, colorectal, endocrine, minimally invasive, pediatric, plastic, surgical oncology, thoracic, transplant, and vascular surgery. The remaining sites were classified as GS. Students were categorized in a dichotomous fashion based on at least 4-week exposure to a GS site.

### Statistical methods

Univariable general linear models were used to test for an association between NBME performance and exposure to a general surgery site, clerkship order (medicine first vs surgery first), MCAT score, and USMLE Step 1 performance. A follow-up multivariable general linear model was used to estimate the mean difference between students exposed to a general surgery site versus those never exposed to a general surgery site while controlling for clerkship order, MCAT performance, and USMLE Step 1 score. Regarding model assumptions, linearity and normality were assessed using residual and QQ plots, respectively. Outliers were assessed using box-plots. For the multivariable model, the fundamental assumption of homogeneity of regression slopes was assessed by allowing an interaction term between each factor

(general surgery and clerkship order) and each covariate (USMLE and MCAT).

Importantly, a sensitivity analysis was performed which excluded 11 students doubly exposed to a GS rotation. There was no change in model conclusions. All analyses were completed using SAS version 9.4 (Cary, NC).

## Results

Among the 547 students included in this retrospective review, 365 (67%) were exposed to a GS rotation (Table 1). Further, 265 (48%) students completed their surgery rotation before their medicine rotation. Table 2A presents summary statistics by general surgery exposure. Compared to SS students, GS had comparable USMLE Step 1 performance ( $\mu_{\text{diff}} = 0.71$ , 95% CI:  $-2.79$  to  $4.21$ ;  $p = .69$ ) and comparable MCAT performance ( $\mu_{\text{diff}} = 0.21$ , 95% CI:  $-0.34$  to  $0.76$ ;  $p = .45$ ) in this sample of data. Table 2B presents summary statistics by clerkship order (i.e. medicine clerkship first or surgery clerkship first).

Controlling for clerkship order, USMLE Step 1 score, and MCAT score, there was no significant difference in NBME performance between GS students and SS students ( $\mu_{\text{diff}} = 0.37$ , 95% CI:  $-0.73$  to  $1.48$ ;  $p = .51$ ) (Table 3). Conversely, compared to examinees who took medicine first, those who took surgery first scored significantly lower on the NBME exam ( $\mu_{\text{diff}} = -3.11$ , 95% CI:  $-4.15$  to  $-2.07$ ) even after controlling for all other variables in the model ( $p < .001$ ). As expected, after controlling for all other variables in the model increasing MCAT scores were associated with higher NBME performance as were increasing USMLE Step 1 scores. That is, for every one-point increase in MCAT performance NBME scores increased by approximately 0.24 (95% CI: 0.05 to 0.43) points ( $p = .01$ ). Similarly, for every one-point increase in USMLE Step 1 performance, NBME scores increased by approximately 0.30 (95% CI: 0.27 to 0.33) points ( $p < .001$ ).

## Discussion

Since the NBME surgery exam heavily tests topics that are frequently encountered on general surgery services, we hypothesized that students exposed to GS rotations would demonstrate superior performance on the NBME surgery examination over their peers who are solely exposed to SS rotations. However, in this evaluation of 547 medical students, after adjusting for prior test taking and exposure to internal medicine, we found that medical students exposed to general surgery services do not gain a performance advantage on the NBME surgery exam over those who are exposed primarily to subspecialty services.

There a variety of reasons that might explain this result. As previously mentioned, the variance in surgery site assignments and specialty rotation exposures is unavoidable due to volume constraints at large academic centers. Secondly, it is known that students experiencing higher clinical volumes on surgical services demonstrate statistically higher NBME scores, a factor that we were unable to account for in this study.<sup>7</sup> However, at our institution multiple factors are employed to safeguard students against an unfair disadvantage, including didactics and skills activities that supplement clinical exposure. It has been shown that implementation of a structured teaching curriculum improves performance on the NBME examination.<sup>8</sup> At our institution, students are required to attend approximately twenty 60–90-minute didactic lectures over the course of the clerkship, which are taught by surgical faculty to supplement clinical duties. The didactic curriculum comprises approximately 10% of the clerkship experience while departmental morbidity and mortality conferences, grand rounds, and objective structured clinical examination (OSCE) exercises

**Table 1**  
Summary frequencies by surgery clerkship site.

		General Surgery Site					
		No (n = 182)		Yes (n = 365)		Total (N = 547)	
		n	%	n	%	N	%
<b>Acute Care Surgery</b>	<b>No</b>	182	100.0%	251	68.8%	433	79.2%
	<b>Yes</b>	0	0.0%	114	31.2%	114	20.8%
<b>Burn Surgery</b>	<b>No</b>	146	80.2%	309	84.7%	455	83.2%
	<b>Yes</b>	36	19.8%	56	15.3%	92	16.8%
<b>Colorectal Surgery</b>	<b>No</b>	109	59.9%	343	94.0%	452	82.6%
	<b>Yes</b>	73	40.1%	22	6.0%	95	17.4%
<b>Endocrine Surgery</b>	<b>No</b>	163	89.6%	303	83.0%	466	85.2%
	<b>Yes</b>	19	10.4%	62	17.0%	81	14.8%
<b>Minimally Invasive Surgery</b>	<b>No</b>	142	78.0%	358	98.1%	500	91.4%
	<b>Yes</b>	40	22.0%	7	1.9%	47	8.6%
<b>Pediatric Surgery</b>	<b>No</b>	177	97.3%	331	90.7%	508	92.9%
	<b>Yes</b>	5	2.7%	34	9.3%	39	7.1%
<b>Plastic Surgery</b>	<b>No</b>	168	92.3%	298	81.6%	466	85.2%
	<b>Yes</b>	14	7.7%	67	18.4%	81	14.8%
<b>Rural Community Hospital</b>	<b>No</b>	182	100.0%	298	81.6%	480	87.8%
	<b>Yes</b>	0	0.0%	67	18.4%	67	12.2%
<b>Surgical Oncology</b>	<b>No</b>	102	56.0%	358	98.1%	460	84.1%
	<b>Yes</b>	80	44.0%	7	1.9%	87	15.9%
<b>Thoracic Surgery</b>	<b>No</b>	166	91.2%	341	93.4%	507	92.7%
	<b>Yes</b>	16	8.8%	24	6.6%	40	7.3%
<b>Transplant Surgery</b>	<b>No</b>	159	87.4%	348	95.3%	507	92.7%
	<b>Yes</b>	23	12.6%	17	4.7%	40	7.3%
<b>Urban Hospital 1 (General Surgery)</b>	<b>No</b>	182	100.0%	361	98.9%	543	99.3%
	<b>Yes</b>	0	0.0%	4	1.1%	4	0.7%
<b>Urban Hospital 2 (General Surgery)</b>	<b>No</b>	182	100.0%	264	72.3%	446	81.5%
	<b>Yes</b>	0	0.0%	101	27.7%	101	18.5%
<b>Vascular Surgery</b>	<b>No</b>	124	68.1%	307	84.1%	431	78.8%
	<b>Yes</b>	58	31.9%	58	15.9%	116	21.2%
<b>Veterans Hospital (General Surgery)</b>	<b>No</b>	182	100.0%	275	75.3%	457	83.5%
	<b>Yes</b>	0	0.0%	90	24.7%	90	16.5%

account for an additional 5–10% of the clerkship experience. Students are also encouraged to complete WISE-MD online multimedia modules, which offer hands on surgical skill-based learning such as suturing and instrument tying, two handed knot tying, Foley catheter placement, and ultrasound techniques.<sup>9</sup> These modules allow students to participate in an OSCE exercise as well as a high-fidelity virtual hospital team exercise. Online programs, such as WISE-MD (Aquifer, Lebanon, NH), have helped clerkship directors to provide a uniform curriculum to medical students regardless of their site assignment or clinical experience. A variety of similar resources allow for effective undergraduate surgical education to be offered in many specialty settings, without reliance on general surgery exposure.

In this study, we attempted to control for other factors potentially influencing NBME performance in order to investigate if GS exposure offers a performance advantage in the context of modern curricula. When comparing groups exposed to GS and those only exposed to SS care, we found no difference in prior USMLE Step 1 and MCAT exam performance. Consistent with prior investigations, we found that enrollment in the internal medicine clerkship prior to surgery improves performance on the NBME surgery exam.<sup>7,10</sup>

These data are consistent with our analysis, which demonstrates that students who completed the surgery clerkship prior to the medicine clerkship scored approximately 3 points lower on the NBME surgery exam, after adjusting for prior standardized test performance. This is thought to be because internal medicine concepts provide a fundamental basis for medical knowledge in all medical specialties, and many topics emphasized during the medicine clerkships are revisited during the NBME surgery exam.

Given that there is subjective bias in clinical evaluations that contribute to final grade calculations, the NBME surgery exam is an especially important objective measurement of competence. Furthermore, it has been shown that performance on this exam can influence students' decisions to pursue a surgical specialty.<sup>7</sup> Thus, we suggest that students interested in pursuing a career in general surgery should not be concerned that their surgical specialty assignment will impact their performance on the NBME surgery exam, or that peers with more GS exposure will have an unfair advantage.

Although we defined our SS group to include colorectal surgery, minimally invasive surgery, and surgical oncology, we did consider that these surgical specialties may offer significant exposure to

**Table 2A**  
Summary statistics by general surgery exposure.

	General Surgery Exposure								
	No			Yes			Total		
	n	Mean	SD	n	Mean	SD	N	Mean	SD
<b>NBME Exam Score</b>	181	73.04	8.66	365	73.86	8.76	546	73.59	8.73
<b>MCAT Score</b>	180	31.75	3.11	363	31.96	3.06	543	31.89	3.08
<b>USMLE Step 1 Score</b>	182	230.64	19.75	365	231.35	19.58	547	231.12	19.62

**Table 2B**  
Summary statistics by clerkship order.

	Clerkship Order								
	Medicine First			Surgery First			Total		
	n	Mean	SD	n	Mean	SD	N	Mean	SD
<b>NBME Exam Score</b>	277	74.87	8.67	265	72.28	8.62	542	73.60	8.73
<b>MCAT Score</b>	277	31.77	2.82	264	32.05	3.32	541	31.90	3.07
<b>USMLE Step 1 Score</b>	278	230.43	19.67	265	232.22	19.17	543	231.30	19.43

**Table 3**  
NBME score as a function of student characteristics.

	Valid N	Unadjusted		Adjusted	
		$\beta$ (95% CI)	<i>p</i>	$\beta$ (95% CI)	<i>p</i>
<b>General Surgery Exposure:</b> Yes vs No	546	0.82 (−0.74 to 2.38)	.30	0.37 (−0.73 to 1.48)	.51
<b>First Clerkship:</b> Surgery vs Medicine	542	−2.59 (−4.05 to −1.13)	.001	−3.11 (−4.15 to −2.07)	<.001
<b>MCAT score</b> (per 1-point increase)	542	1.06 (0.84–1.29)	<.001	0.24 (0.05–0.43)	.01
<b>USMLE Step 1 score</b> (per 1-point increase)	546	0.31 (0.28–0.33)	<.001	0.30 (0.27–0.33)	<.001

**Note:** Valid N = The number of examinees used to compute the unadjusted estimates. Valid N for the adjusted estimates = 540.

general surgery – particularly gastrointestinal pathology. In an attempt to address this concern, we ran a sensitivity analysis using a broader definition of GS including colorectal surgery, minimally invasive surgery, and surgical oncology. However, in our sample, we found no student with only subspecialty exposure using this broader definition, and therefore were unable to test for an effect on NBME performance. We acknowledge that our GS definition and single-center design limit the external validity and/or generalizability of our results. Future studies could evaluate larger samples at other institutions to identify students with no exposure to general surgery, including colorectal surgery, minimally invasive surgery, and surgical oncology services. Additionally, we are unable to evaluate differences in self-study patterns and alternative curricular resources utilized by students, which can of course affect NBME performance.<sup>11</sup>

## Conclusions

After adjusting for prior standardized test performance and clerkship order, medical students exposed to GS rotations did not demonstrate a performance advantage on the NBME surgery exam over those exposed to primarily SS care. However, enrollment in an internal medicine clerkship prior to surgery is associated with improved performance on the NBME surgery exam.

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## Declaration of competing interest

The authors report no conflict of interest in relation to this manuscript.

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