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## Shortened pre-clerkship medical school curriculum associated with reduced student performance on surgery clerkship shelf exam

Jesse K. Kelley<sup>a</sup>, Niki Matusko<sup>b</sup>, Jonathan Finks<sup>a, b, c</sup>, Karla Robinson<sup>a, b, c</sup>, Rishindra M. Reddy<sup>a, b, c, \*</sup><sup>a</sup> University of Michigan Medical School, Ann Arbor, MI, USA<sup>b</sup> Department of Surgery, Michigan Medicine, Ann Arbor, MI, USA<sup>c</sup> Surgery Clerkship, University of Michigan, Ann Arbor, MI, USA

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## ABSTRACT

**Background:** Many U.S. medical schools are modifying their curricula with limited understanding of the impact on students' clinical knowledge.**Methods:** The surgical rotations and Surgery Shelf Exam score reports of 1514 students at a single medical school over nine academic years (2010–2018), which included a four-year transition period to a condensed pre-clerkship curriculum. Subject-specific results were compared by rotation type using Mann-Whitney tests. Regression analysis was used to assess the relationship between scores and time.**Results:** Data from 1514 students were included. Shelf scores decreased each year of the transition curriculum compared to the reference year (2014–2015). However, clinical exposure to specific rotations resulted in better scores in related shelf subjects. For example, students who rotated on Vascular Surgery achieved statistically better scores on the related subject than their colleagues (3.62 vs. 3.44;  $p = 0.0014$ ).**Conclusions:** The transition curriculum was associated with a lower performance on the surgical shelf exam when compared to the traditional curriculum, regardless of when surgery was taken during their clerkship year.

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## Introduction

Medical schools have been struggling with developing new strategies to best educate their students in an era of exponential growth of research and medical knowledge.<sup>1</sup> Many have shifted their curricula to help students become life-long learners,<sup>2–5</sup> and have begun to minimize some of the traditional hallmarks of a physician's education, like anatomy and histology.<sup>6,7</sup> They are also working to minimize the burnout that has plagued the medical field over the recent years.<sup>8</sup> The impact these large medical education reforms of the past decade have had is still being evaluated.

Many medical schools are condensing their traditional two-year pre-clerkship curriculum, thus getting students onto the wards earlier in their training, either at the start or at the mid point of their 2nd year of medical school.<sup>9</sup> In 2017–2018, the Association of

American Medical Colleges (AAMC) sent out a survey to medical schools in the United States to better understand the curriculum changes taking place. According to their resulting curriculum report, 68 of the 147 medical schools that responded to the survey said that the length of the pre-clerkship curriculum has been shortened within the past three years or that there are plans for it to be shortened in the near future.<sup>9</sup> Many have cited an improvement in USMLE Step 1 scores with the abbreviated curriculum,<sup>10,11</sup> but little has been published on the impact on students as they progress through their clerkships. With the recent changes to USMLE Step 1 and its score being reported in the future as pass/fail, performance on the clerkships and their respective shelf exam may carry more weight in applicant screening for residency than in previous years.

Our medical school has completed a transition to a shorter pre-clerkship curriculum, with drastically less time on subjects like anatomy, but with modifications to the core clinical curriculum to integrate more basic science in an effort to make up for some of the removed materials. The primary aim of this study was to analyze student performance on the National Board of Medical Examiners

\* Corresponding author. Chair- University of Michigan-Comprehensive Robotic Surgery Program, University of Michigan, Thoracic Surgery, TC2120/5344, 1500 East Medical Center Drive, MI 48109, Ann Arbor, MI, USA.

E-mail address: [redryrm@med.umich.edu](mailto:redryrm@med.umich.edu) (R.M. Reddy).

(NBME) Surgery Shelf Exam during a period of change in the length of the pre-clerkship curriculum. We hypothesized that students in the condensed curriculum would perform worse on the Surgery Shelf Exam compared to their colleagues in the traditional curriculum. As the core clerkship curriculum has been modified to include more basic science to “make up” for lost lectures in the prior curriculum, we hypothesized that students who took their surgery clerkship and Surgery Shelf Exam in the second half of their clerkship year would “catch up” and achieve shelf scores similar to their colleagues of the traditional pre-clerkship curriculum. In addition, we wanted to see if exposure to specific rotations would affect students' performance on related areas of the Shelf exam.

## Material and methods

A database containing Surgery Shelf Exam scores, specific surgery clerkship rotations, and timing of the clerkship from a single U.S allopathic medical school was created to analyze exam performance. Data from 1514 students who rotated between 2010 and 2018 (nine academic years) were included. The years 2010–2014 represent the period of the traditional two-year (22 months) pre-clerkship curriculum followed by an 8-week Surgery Clerkship (7-weeks of core surgery and 1-week subspecialty surgery). The years 2015–2018 represent the transition period toward a condensed 14-months of pre-clerkship education (20 months, 19 months, 18 months, and 16 months) with a 6-week Surgery Clerkship (6-weeks of core surgery).

Each student in all nine academic years rotated on two different surgical services during their clerkship, one of which must be a core general surgery rotation (Veterans Affairs, Acute Care Surgery, Colorectal Surgery/Surgical Oncology, Hepatobiliary, Minimally Invasive/Endocrine Surgery, and Pediatric Surgery) with significant abdominal and gastrointestinal surgery exposure. The second rotation could be either another core rotation, or a sub-specialty (Thoracic, Abdominal Transplant, Plastics, Urology, and Vascular). Some students rotated on two core surgery rotations whereas others rotated on only one.

All rotations were classified into subcategories based on corresponding surgery shelf subcategories (if applicable). For example, vascular surgery corresponded to cardiovascular surgery questions (Table 1). Shelf exam subcategory scores were reported using a “performance bar” that gives the range of the student's performance, but not an exact score. These results were assigned a score 1–5 with respect to the location of the student's performance bar relative to the average performance line by two independent coders. A score of 3 was assigned to subcategories that had a performance bar centered on the “Average Performance” line. A performance bar shifted toward “Lower Performance” but still touching the “Average Performance” line was assigned a score of 2, and a performance bar shifted toward “Higher Performance” but

still touching the “Average Performance” line was assigned a score of 4. A performance bar shifted toward “Lower Performance” and not touching the “Average Performance” line was assigned a score of 1, and a performance bar shifted toward “Higher Performance” and not touching the “Average Performance” line was assigned a score of 5. Fig. 1 provides a sample shelf report with the corresponding scores. A random sample of 200 entries that were assigned numeric codes were analyzed using the kappa statistic as outlined in Altman<sup>12</sup> to check for inter-rater reliability and for sufficient agreement between the two raters and ratings before progressing on to coding all available data.

Linear regression analysis was used to assess the relationship between shelf scores and time with 2014–2015 specified as the comparison year. The effect of exposure to various rotations on overall and specific subject area scores was assessed using Mann-Whitney tests. All analyses were conducted in STATA15<sup>13</sup> and significance was set at  $p < 0.05$ . The study was deemed to be exempted by our institutional IRB (HUM 00093346).

## Results

The scores and rotations from 1514 students were included in the analysis. Table 2 compares the total number of students per surgical service in the transition years (2015–2018) to the traditional years (2010–2014). Prior to the transition to a condensed pre-clerkship curriculum, the average shelf score for each academic year was relatively stable. Shelf scores decreased significantly for each year of the transition curriculum compared to the reference year (2014–2015). Specifically, scores for 2015–2016 decreased significantly by 2.23 compared to the reference year (77.14 vs. 79.37;  $p = 0.014$ ) while scores for 2016–2017 decreased by 3.57–75.80 ( $p < 0.001$ ) and scores for 2017–2018 decreased by 5.22–74.15 ( $p < 0.001$ ). There were no significant differences between the reference year and the three years prior (2013–2014, 2012–2013, 2011–2012).

(Fig. 2). Students in the transition curriculum who were on the surgery clerkship and took their surgery shelf during the second half of their core clerkship year performed better on the shelf than those in the first half of the year but still lagged behind students in the traditional curriculum from the corresponding part of the clerkship year (76.7 vs. 80.3,  $p < 0.001$ ) (Fig. 3).

In analyzing student performance on the shelf and its subcategories with regard to their surgical rotations, the group of students who rotated on two core services did not achieve a statistically better average shelf exam score than the group of students who rotated on only one core service (77.6 vs 77.0,  $p = 0.197$ ). In addition, students who rotated on the Thoracic Surgery service and Acute Care Surgery service trended toward better scores than their counterparts on the respiratory (3.55 vs. 3.42,  $p = 0.077$ ) and emergency (3.59 vs. 3.44,  $p = 0.062$ ) subcategories, respectively, although the differences

**Table 1**  
Surgery rotation and corresponding Surgery Shelf subcategory.

Surgery Rotation	Corresponding Surgery Shelf Subcategory
General Surgery Service	Gastrointestinal
Endocrine/Minimally Invasive Surgery Service	Gastrointestinal
Colorectal Surgery Service/Surgical Oncology	Gastrointestinal
Acute Care Surgery Service	Gastrointestinal, Emergency
Veterans Affairs General Surgery Service (General Surgery and Vascular service)	Gastrointestinal, Cardiovascular
Vascular Surgery Service	Cardiovascular
Thoracic Surgery Service	Respiratory
Transplant Surgery Service	No corresponding shelf subcategory
Pediatric Surgery Service	No corresponding shelf subcategory
Urology Surgery Service	No corresponding shelf subcategory
Plastic Surgery Service	No corresponding shelf subcategory

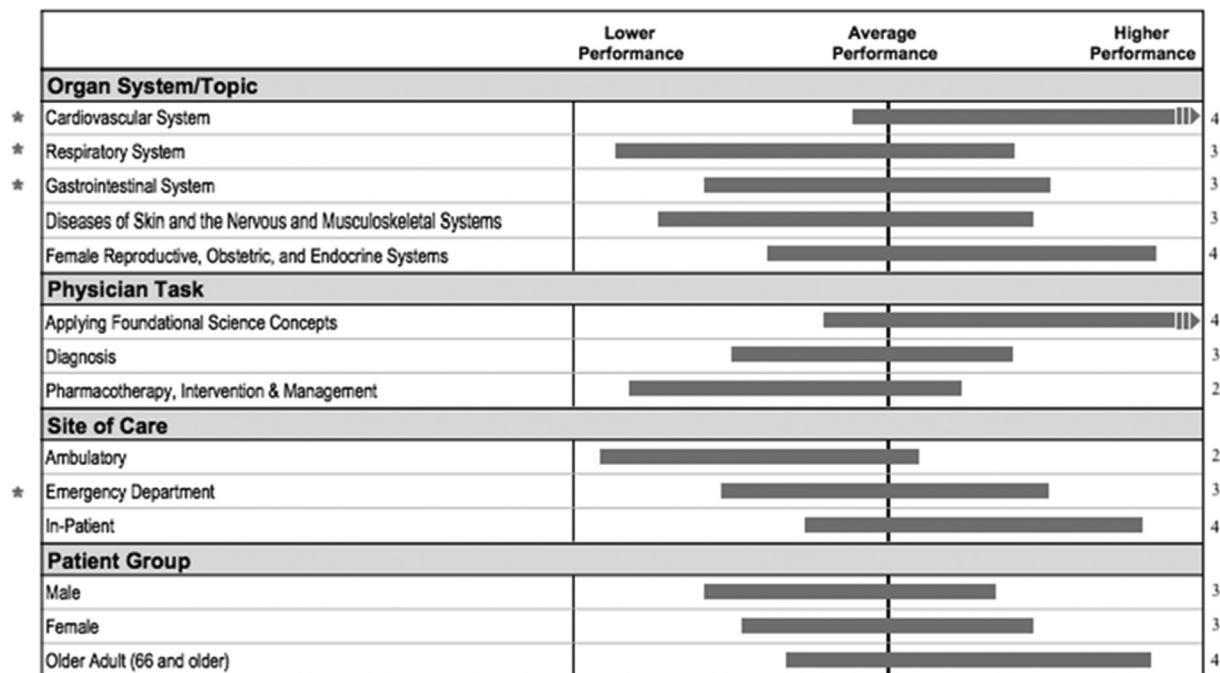


Fig. 1. Sample shelf report. An asterisk to the left of the visual identifies shelf subjects analyzed in this study. Assigned scores for each subject can be found on the right of the visual.

did not reach significance. Students who rotated on the vascular service achieved statistically significant better scores on the cardiovascular subcategory compared to those who did not (3.62 vs. 3.44;  $p = 0.001$ ) (Fig. 4). Students who rotated on gastrointestinal services did not appear to do better on the gastrointestinal subject when compared to their colleagues who did not rotate on one of the gastrointestinal services (3.55 vs. 3.47,  $p = 0.434$ ).

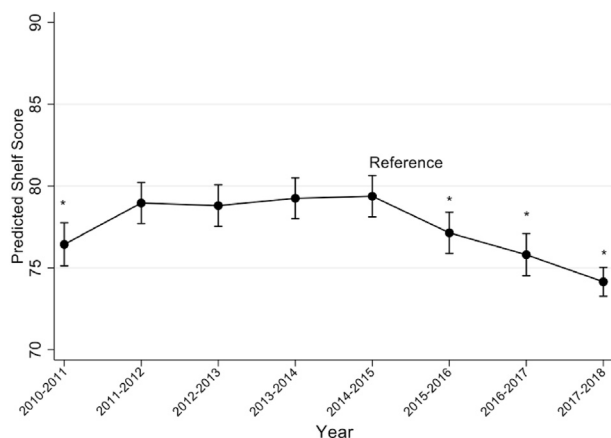
## Discussion and conclusions

After reviewing the surgery shelf exams from a single institution during a transition from a traditional two-year pre-clerkship curriculum to a condensed one-year pre-clerkship curriculum, it appears that students going through the condensed pre-clerkship curriculum achieve significantly lower surgery shelf scores than their colleagues who had the traditional pre-clerkship curriculum. In addition, it appears that exposure to certain surgery services may influence student performance on respective subject-specific questions on the surgery shelf exam, especially for students who rotate on vascular surgery.

This is one of the only studies that has studied student performance in the clerkships with respect to the length of the pre-clerkship curriculum. Several studies that have researched student performance on the USMLE Step 1 with respect to timing of USMLE Step 1 (before vs. after clerkships) and have found that students performed significantly better on USMLE Step 1 if it was scheduled after their clerkships.<sup>10,11</sup> This generalized finding is why many medical schools condensed their pre-clerkship curriculum and had students rotate on their clerkships prior to taking the USMLE Step 1.<sup>11</sup> While exceptional performance in all aspects of evaluation is highly valued, there was extra emphasis placed on performance on the USMLE Step 1, largely because many residency programs screen applicants for away rotations, as well as prospective residents by looking at their USMLE Step 1 score.<sup>14,15</sup> USMLE Step 2 CK is also a screening tool used by program directors for screening prospective residents, albeit not as powerful as Step 1.<sup>15</sup> For surgery programs specifically, performance on the ABSITE is positively correlated with performance on USMLE Step 1 and 2 CK.<sup>16</sup> With the recent change in USMLE Step 1 scoring to be reported as solely pass/fail, residency programs may place more

Table 2  
Number of clerkship students who rotated on each surgery service.

	Curriculum		
	Total	Traditional	Transitional
Total Clerkship Students	1514	834	680
Total Clerkship Rotations	3028	1668	1360
Endocrine/Minimally Invasive/General Surgery Service	722	451	271
Colorectal Surgery Service	367	204	163
Acute Care Surgery Service	405	218	187
Veterans Affairs General Surgery Service	284	165	119
Vascular Surgery Service	263	161	102
Thoracic Surgery Service	271	154	117
Transplant Surgery Service	290	163	127
Pediatric Surgery Service	261	150	111
Urology Surgery Service	86	0	86
Plastic Surgery Service	75	0	75
Services not recorded	4	2	2



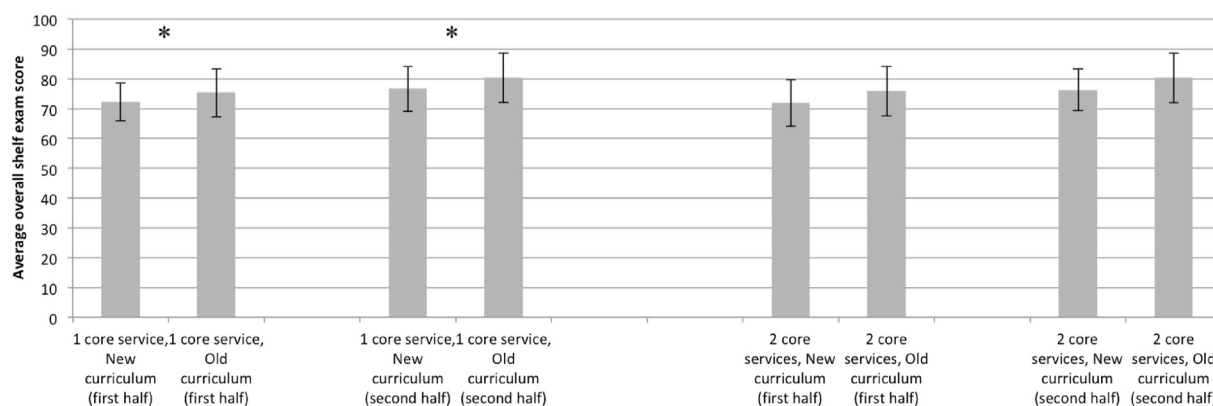
**Fig. 2.** Mean shelf exam scores prior to and during transition curriculum. \* signifies significance ( $p < 0.05$ ). Error bars represent 95% confidence intervals.

emphasis on shelf scores as a way to screen prospective residents. As such, this calls into question the value of a condensed pre-clerkship curriculum, as it may lead to worse performance on shelf exams.

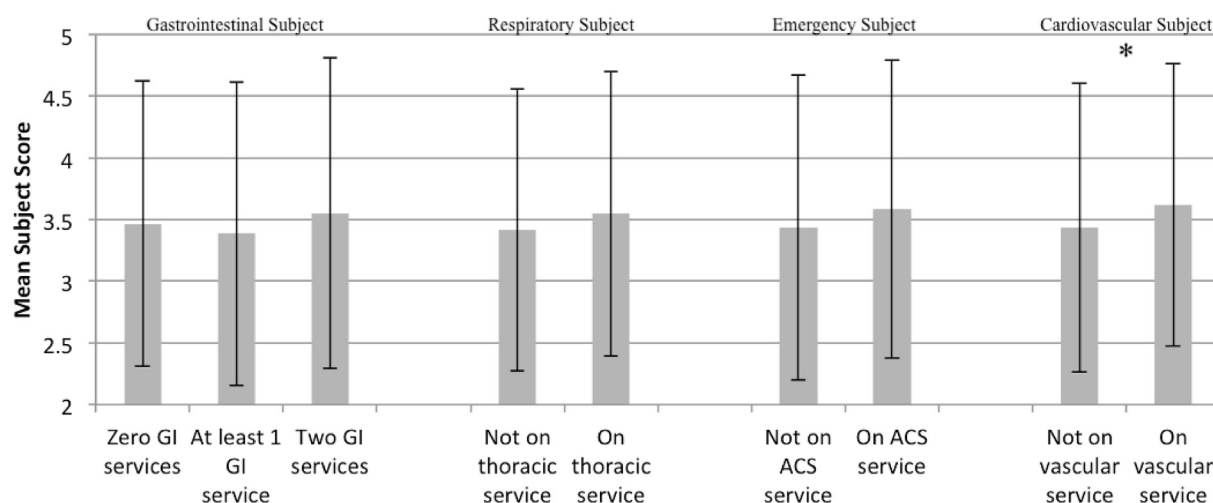
A question that students often have is whether or not the specific surgery service that they rotate on has an impact on their

performance and grade. A recent study found that there is no statistically significant difference in performance on the surgery shelf exam between students who rotated on general surgery services and students who rotated on subspecialty services.<sup>17</sup> Our study suggests that the type of subspecialty rotation may affect the subcategory score on the shelf, especially for vascular surgery as this was the only service associated with a significant difference in performance on related shelf subject. Students who rotated on Thoracic Surgery and Acute Care Surgery services showed trends toward better performance on respiratory- and emergency-specific questions than students who did not rotate on those services, respectively. Since analyzing this data, our clerkship has increased the quantity of vascular surgery didactics delivered during the core clerkship so that all surgery students, regardless of the surgery service they are on, have similar exposure to vascular surgery topics.

As part of our curriculum change included more basic science correlation to clinical medicine in an effort to make up for lost lessons, we thought that we would see an increase in shelf exam scores by the end of the clinical year, even in students in the transition period. This was not seen. Students in the transition curriculum who were on the surgery clerkship and took their surgery shelf during the second half of their core clerkship year did not achieve overall shelf scores similar to their colleagues who were in the traditional curriculum. This may be attributable to the small sample size of students who were in the transitional curriculum



**Fig. 3.** Performance on shelf exam with respect to relative timing of shelf exam in clerkship year. \* signifies significance ( $p < 0.05$ ). Error bars are determined by standard deviation.



**Fig. 4.** Mean shelf subcategory scores with respect to surgery service. \* signifies significance ( $p < 0.05$ ). Error bars are determined by standard deviation.

and took their Surgery Shelf Exam in the second half of the core clerkship year.

There are several limitations to this study. One such limitation is that student performance on the surgery shelf may be dependent on the timing of the surgery clerkship in the student's clerkship schedule. We controlled for this by breaking the clerkship year into halves and comparing the two. Another limitation is that this study only focuses on data from the surgery clerkship, which in its own right is unique and different from all other clerkships. It is possible that by chance it is only performance on the surgery shelf exam that is negatively impacted by a condensed pre-clerkship curriculum. The length of the surgery clerkship was also modified from the traditional curriculum, shortening from 8 weeks to 6 weeks, although the actual reduction in exposure to core surgery was only 1 week. There are other potential changes that may have occurred, including changes in admissions criteria resulting in students less interested in surgery. While this is possible, there were no clear changes during this study in admissions criteria or medical school leadership to suggest a change in philosophy. Further studies from other clerkships would provide more insight.

Based on the findings of this study, it is important that clerkship directors across all clerkships evaluate student performance on their shelf exam and modify clerkship curriculum where necessary. By modifying the type and quantity of didactics offered, clerkship directors may be able to improve any deficiencies that exist. Finally, further studies evaluating student performance on non-surgery shelf exams with respect to length of pre-clerkship curriculum would provide additional data for further curriculum changes in the setting of a new pass/fail USMLE Step 1.

## Disclosures

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## Declaration of competing interest

None.

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