A Third-Year Medical School Ophthalmology Curriculum for a Longitudinal Integrated Clerkship Model

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Abstract

Background Longitudinal Integrated Clerkships (LICs) are innovative educational models that allow medical student continuity with patients, preceptors, colleagues, and health care systems. Given their benefits, the number of LICs continues to increase. We share a pilot model for an ophthalmology LIC curriculum at the University of Colorado School of Medicine targeted for students to see patients through transitions of care.

Methods A needs assessment was performed including literature search, interviews with expert faculty, and a precurricular student questionnaire. Based on our findings, we developed a pilot two-part curriculum consisting of an introductory lecture and a half-day clinical experience designed to integrate patient eye care into the LIC model. At the end of the year, students completed a questionnaire assessing attitude, confidence, and knowledge. Precourse data were collected from students in the academic year (AY) 2018/2019 to aid with the needs assessment. Postcourse data were collected after completion of the curriculum from students in AY 2019/2020. Data from questionnaire were intended to improve our curricular experience.

Results Our curriculum was piloted between the 2019 and 2020 AY. The completion rate of our curriculum was 100%. The questionnaire response rate was 90% in pre- and postcurricular groups ($n = 15/17$ and $n = 9/10$, respectively). Hundred percent of students from both groups responded that it is "very important"/"important" for all physicians to be able to identify when ophthalmology referral is indicated. After the intervention, there were significant differences in the rate of students responding that they were "confident" diagnosing acute angle-closure glaucoma (36 vs. 78%, $p = 0.04$), treating a chemical burn (20 vs 67%, $p = 0.02$), and diagnosing viral conjunctivitis (27 vs. 67%); 90% of students reported increased confidence in longitudinal care of patients in the eye clinic.

Keywords
- medical education
- ophthalmology
- Longitudinal Integrated Clerkship
- ophthalmic education
- ophthalmology training
- ophthalmology curriculum

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Conclusions Medical students believe in the importance of ophthalmic education regardless of their specialty of choice. We present a pilot model to introduce ophthalmology within an LIC model. Future studies with a larger sample are needed to determine the impact of this model in terms of knowledge acquisition and relationship between curriculum and ophthalmology interest among students. Our curriculum can be adapted to other underrepresented specialties in the medical school curriculum and is easily exportable to other LICs.

Ophthalmic conditions compose 2% of all primary care patient visits and approximately 1.5% of all emergency department visits.[1,2,3] As such, medical students need to learn how to recognize and treat some common eye conditions and triage visually threatening emergencies requiring prompt referral to an ophthalmologist. Although a higher number of ophthalmic education hours has been associated with greater confidence in the treatment of ophthalmological conditions, medical school education in ophthalmology has been in decline.[4,5] While 68% of medical schools required a formal ophthalmology rotation in 2000, only 18% required one by 2013.[6] In terms of ophthalmology education, 78.9% of medical schools only required preclinical coursework that averaged 12.5 hours but ranged from 1.5 to 50 hours.[7] The decreasing number of hours spent learning ophthalmology in medical school is concerning in a context in which most residents who will become primary care providers do not feel prepared to manage eye conditions.[5] A survey of primary care residency program directors found that nearly 90% felt that less than half of their entering residents met the minimum ophthalmic competencies outlined by the Association of University Professors of Ophthalmology (AUPO).[8] Furthermore, 33.33 and 13.6% of internal medicine and pediatric program directors, respectively, did not believe their graduates met the AUPO standards.[8] A lack of ophthalmology exposure may lead to students being unable to fully understand the importance of eye conditions in the overall health of patients and could also lead to students discounting ophthalmology as a career.[9] In addition, a recent study which included 49 U.S. AAMC-affiliated medical schools reported a significant association between students matching in an ophthalmology residency program and factors such as ophthalmology content in the medical school curriculum.[10]

While these statistics are not encouraging, innovations have been ongoing in medical education to better train future physicians. One such approach is the Longitudinal Integrated Clerkship (LIC) model. The premise of this innovation is to provide comprehensive clinical training by integrating the traditionally separate specialty clerkships into an integrated experience. A student develops and follows a panel of patients that is representative of each specialty (i.e., adult, pediatric, obstetric, and psychiatric) through primary care and emergency room visits as well as hospitalizations. Students are also scheduled regularly with a preceptor from each specialty. Faculty preceptors from all specialties work closely with students to identify patients suitable for longitudinal care and can also assist in facilitating follow-up appointments when the LIC student will be present. In addition, students are trained with tools to track upcoming appointments and contact scheduling departments through the electronic medical record. Moreover, the LIC schedule allows students for flexibility to attend panel patient visits and rearrange clinical time to accommodate patient visits. A sample monthly schedule of the LIC can be seen in ►**Fig. 1**. Our LIC lasted the entirety of the core clinical year of medical school and included all core clerkships except for neurology.[11]

It has been demonstrated that the LIC model leads to positive outcomes for not only medical students but also patients and faculty preceptors.[12,13,14,15] Some of the demonstrated benefits of patients cared for by LIC students include improved patient experience, mitigation of perceived health system failures, and subjective improvement in health outcomes.[13] Faculty preceptors involved in the LIC model have also shown greater satisfaction from teaching as well as improved mentoring skills when compared with traditional rotation-based clerkships.[12] Additionally, student benefits include lower rates of burnout, increased engagement, and greater understanding of the intricacies of our health care system among many other benefits.[16]

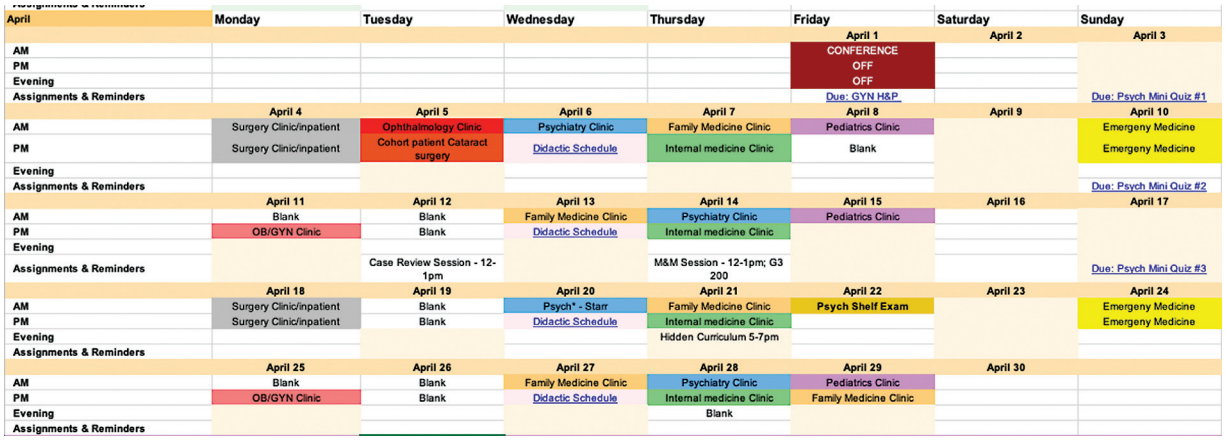
Given the above benefits, the number of U.S. medical schools offering LICs has increased from 29 in 2010 to 50 in 2021.[17,18,19] While the incorporation of core specialties tends to be relatively seamless, the inclusion of the surgical subspecialties can be more challenging. There is very limited literature on how programs include surgical subspecialties, including ophthalmology. The LIC program at the University of California San Francisco, Parnassus Integrated Student Clinical Experiences included four sessions each in ophthalmology, otolaryngology, urology, and orthopedics such that a total number of hours for subspecialty teaching were 7, 14.5, 4.5, and 27, respectively.[20]

We present a model of an ophthalmology curriculum compatible with the LIC model piloted at the University of Colorado School of Medicine. To our knowledge, this is the first published example of the formal integration of ophthalmology in an LIC model.

Methods

Needs Assessment

We performed a needs assessment which included a literature search of core ophthalmology topics required in the



April	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
					April 1	April 2	April 3
AM					CONFERENCE		
PM					OFF		
Evening					OFF		
Assignments & Reminders					Due: GYN H&P		Due: Psych Mini Quiz #1
	April 4	April 5	April 6	April 7	April 8	April 9	April 10
AM	Surgery Clinic/inpatient	Ophthalmology Clinic	Psychiatry Clinic	Family Medicine Clinic	Pediatrics Clinic		Emergeny Medicine
PM	Surgery Clinic/inpatient	Cohort patient Cataract surgery	Didactic Schedule	Internal medicine Clinic	Blank		Emergeny Medicine
Evening							
Assignments & Reminders							Due: Psych Mini Quiz #2
	April 11	April 12	April 13	April 14	April 15	April 16	April 17
AM	Blank	Blank	Family Medicine Clinic	Psychiatry Clinic	Pediatrics Clinic		
PM	OB/GYN Clinic	Blank	Didactic Schedule	Internal medicine Clinic			
Evening							
Assignments & Reminders		Case Review Session - 12-1pm		M&M Session - 12-1pm; G3 200			Due: Psych Mini Quiz #3
	April 18	April 19	April 20	April 21	April 22	April 23	April 24
AM	Surgery Clinic/inpatient	Blank	Psych* - Starr	Family Medicine Clinic	Psych Shelf Exam		Emergeny Medicine
PM	Surgery Clinic/inpatient	Blank	Didactic Schedule	Internal medicine Clinic			Emergeny Medicine
Evening				Hidden Curriculum 5-7pm			
Assignments & Reminders							
	April 25	April 26	April 27	April 28	April 29	April 30	
AM	Blank	Blank	Family Medicine Clinic	Psychiatry Clinic	Pediatrics Clinic		
PM	OB/GYN Clinic	Blank	Didactic Schedule	Internal medicine Clinic	Family Medicine Clinic		
Evening				Blank			
Assignments & Reminders							

Fig. 1 Sample schedule depicting the integrated clinical experiences working one-on-one with faculty preceptors in core specialties. As denoted by "blank spaces," students are given ample unstructured time for independent learning, follow-up with cohort patients, and professional development. April 5th shows an example of a student with a scheduled clinical ophthalmology experience in the morning followed by the opportunity to follow a cohort patient undergoing cataract surgery in the afternoon. Students also participate in weekly small group didactic and workshop series focusing on core clinical topics where our 2-hour introductory lecture was delivered.

medical school curriculum, tested ophthalmology concepts in the United States Medical Licensing Examination, and interviews with expert faculty from different fields including family medicine, emergency medicine, internal medicine, and general surgery. Lastly, we developed a precurricular student questionnaire. The questionnaire consisted of Likert-scale general assessment questions as well as confidence questions related to attitudes and knowledge. Likert-scale questions were answered using the following 5-point Likert scale: 1 = not important at all, 2 = a little important, 3 = moderately important, 4 = important, and 5 = very important. Items on the survey were developed based on expert opinion and literature review. Validation of the questionnaire was performed by initial review by an expert committee from different fields (ophthalmology, internal medicine, family medicine, and emergency medicine). Medical students not involved in the curriculum piloted the survey and participated in cognitive interviews providing feedback on the clarity and relevance of items. A review of the requirements of the appropriate field of knowledge including academic requirements of accrediting agencies such as the Accreditation Council for Graduate Medical Education and AUPO, as well as discipline-specific competencies, was performed. A pilot test of the questionnaire was given to third-year medical students not included in the evaluation to evaluate for internal consistency and test reliability. Data collected allowed for an assessment of possible curricular gaps before the development of our curriculum. The goal of the needs assessment was to identify gaps in ophthalmic knowledge among third-year LIC medical students and to assess the student comfort level in identifying common eye conditions and ocular emergencies. Responses to the questionnaire informed quality improvement efforts aimed at modification of the curriculum.

Curriculum Design

Based on the needs assessment, we developed a multimodal two-part curriculum targeted to address the curricular goals and learning objectives detailed in ►**Table 1**. The content was modeled to emphasize AUPO-recommended competency standards for medical school graduates.[8] The curriculum consisted of a 2-hour introductory lecture and a half-day clinical experience designed to integrate patient eye care into the LIC model. The 2-hour session was presented in a slide presentation format with the purpose to focus attention on the learning objectives. Short case vignettes were presented throughout the slideshow to encourage participation and engage students. To structure the half-day clinical experience, students were provided a document detailing learning goal, expectations, and a quiz to be filled out before the clinical experience (supplemental section). The students were encouraged to have a resident or attending physician review the document prior to submission. Throughout the clinical experience, students were encouraged to identify patients to add to their LIC patient panel.

Table 1 List of curriculum goals and learning objectives

Curriculum goals
To feel more comfortable performing a basic eye exam
To properly identify common eye conditions and be able to treat or triage these disorders
To expose students to the field of ophthalmology
To identify potential longitudinal patients that could be followed in other clinics
Learning objectives
Review the anatomy of the eye and visual system
Learn how to perform a basic eye exam
Evaluate a patient with a red or painful eye
Recognize when it is necessary to urgently refer a patient to ophthalmology
Recognize the importance of ophthalmological exams in different systemic conditions

Table 2 Student participation

	Classes 2017–2018 Precurricular cohort	Classes 2019–2020 Postcurricular cohort
Participants	17	10
Participants who completed the course	17	17
Participants who completed the questionnaire	15	9
Questionnaire response rate	90% (15/17)	90% (9/10)

Measures and Outcomes

Two cohorts of third-year medical students completed a questionnaire before and after the development of the ophthalmology curriculum. Precourse baseline data were collected from the Denver Health (DH)-LIC cohorts from the academic years (AY) 2017/2019 ($n = 17$). This first cohort completed the DH-LIC program but did not have a dedicated ophthalmology curriculum presented. Postcourse data were collected from DH-LIC students in AY 2019/2020 ($n = 10$) at the same time interval after completion of the DH-LIC program, but with the inclusion of the ophthalmology curriculum, to evaluate course impact and success. Comparison between groups was performed with chi-square and Fisher's exact tests.

Results

All participating students completed our ophthalmology curriculum. The response rate was 90% in precurricular and postcurricular groups ($n = 15/17$ and $n = 9/10$, respectively) ►**Table 2**. Out of the 24 respondents from the pre- and postintervention groups, 9 students reported interest in internal medicine (38%), 4 in family medicine (17%), 3 in psychiatry (13%), 2 in general surgery (8%), and 1 each in orthopedics, neurology, and obstetrics/gynecology (13% combined). A total of three students selected interest in other specialties not specified in our questionnaire (13%). No students selected interest in ophthalmology as a specialty of choice.

Likert-Scale Questions

When asked about the importance for all physicians (regardless of their specialty) to be able to properly identify ophthalmic emergencies, students scored a mean of 4.5 on the 5-point Likert scale score (4.6 in the precurricular group and 4.2 on the postcurricular group). On the same scale, students indicated a score of 3.8 when asked about the importance for all physicians (regardless of their specialty) to be able to properly work up a patient with a chief complaint of "red eye" (3.9 and 3.7, respectively, in pre- and postcurricular groups). Lastly, students gave a score of 4.6 when asked about the importance for all physicians to be able to properly identify when it is indicated to refer patients to ophthalmology (4.7 and 4.6 in pre- and postcurricular groups, respectively). Hundred percent of students from both groups regarded it as "very important" or "important" for all physicians to be able to identify when it is indicated to refer patients to ophthalmology (►**Fig. 2**).

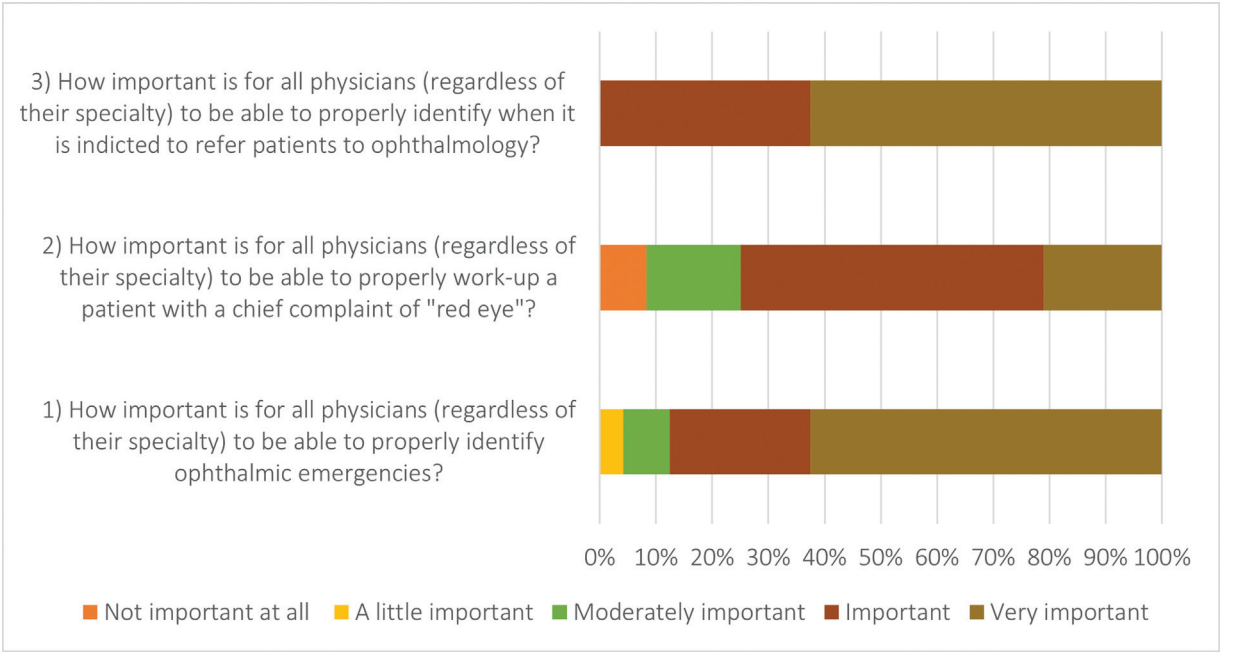


Fig. 2 Individual Likert-scale questions assessing student perceived the importance of ophthalmology training in medical school in students not exposed to our curriculum (precurriculum) and students exposed to our curriculum (postcurriculum).

Fig. 3 Confidence scale questions. Percent students who choose "not confident, somewhat confident, and completely confident" for each of the questions in students exposed and not exposed to our ophthalmology curriculum. Comparison between groups was performed with chi-square and Fisher's exact tests. *Statistically significant *p*-value.

Confidence Questions

We found a significant difference in the rate of students who responded that they were "confident" diagnosing acute angle-closure glaucoma (AACG) when comparing students who experienced our ophthalmology curriculum with students who did not experience our curriculum (78 vs. 33% respectively, $p = 0.04$). A significant difference was also seen when comparing confidence in treating a patient with a chemical burn with 20% of precurriculum students reporting being somewhat confident compared with 67% in the postcurriculum group ($p = 0.02$). No students reported feeling completely confident in both questions above (►**Fig. 3**). After the completion of the curriculum, 90% of students felt more confident to follow patients longitudinally at the eye clinic. Hundred percent of students recommended the lecture for their incoming peers the following AY. Sixty-eight percent recommended the clinical session the following year.

Knowledge-Based Questions

Twenty-seven percent of precurriculum students versus sixty-seven percent of students subjected to our curriculum correctly identified viral conjunctivitis and provided appropriate treatment ($p = 0.054$). In addition, students exposed to our curriculum were more likely to identify AACG in a clinical vignette (40 vs. 89%, $p = 0.02$). In total, 46 and 78% of students appropriately provided referral after recognizing AACG in precurriculum and postcurriculum groups, respectively ($p = 0.13$). As detailed in ►**Fig. 4**, 27% of precurriculum students versus 33% of postcurriculum students correctly identified episcleritis. Thirty-three percent of students in both groups correctly identified keratitis.

Constructive Feedback

Students suggested introducing the ophthalmology curriculum and lecture portion earlier in the AY to have more time to follow patients in the clinic. In addition, students were interested in additional ophthalmology-specific physical exam sessions including practicing with the slit lamp and obtaining intraocular pressures. Other suggestions included more required shifts, more structure to the clinical portion of the curriculum, and proper education of ophthalmology residents and faculty about the LIC program to be more aware of the role of medical students while in the clinic.

Discussion

Despite the importance of ophthalmology education for medical students, its presence in medical education has drastically decreased over the past half-century.[7] We followed the proposals suggested by Albert and Bartley as well as Succar et al to improve ophthalmic education in medical schools by creating an outcome-based educational tool focusing on teaching content identified via our needs assessment.[21,22] There are key learning points from our LIC ophthalmology curriculum. First, our survey confirmed that medical students have gaps in their ophthalmology knowledge and believe that it is important to receive ophthalmology training in medical school regardless of their specialties of choice. Second, we demonstrated that our curriculum has the potential to increase ophthalmology knowledge, given that students exposed to our curriculum felt more confident diagnosing and treating some eye conditions and demonstrated improvement based on knowledge questions compared with students who did not receive dedicated curriculum. Lastly, our ophthalmology curriculum provides

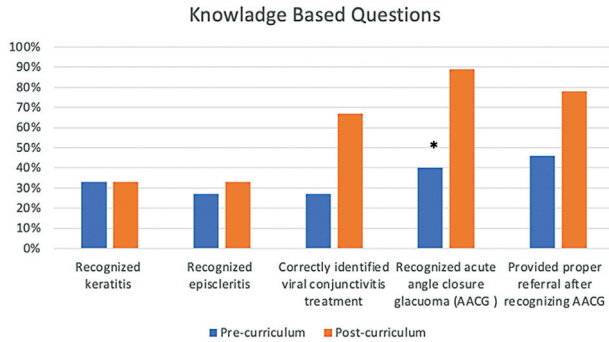


Fig. 4 Knowledge-based questions. Percent of students who correctly identify diagnosis on multiple-choice question format in students exposed and not exposed to our ophthalmology curriculum. Comparison between groups was performed with chi-square and Fisher's exact tests. *Statistically significant *p*-value

a platform where students can follow eye conditions longitudinally throughout their clinical year.

As medical education evolves rapidly, finding innovative and effective ways of teaching ophthalmology is crucial. Moreover, given the many documented benefits of LICs, the number of medical schools implementing this clerkship educational model continues to grow.[12,23] Still, to our knowledge, no educational intervention seeking to teach basic ophthalmology in the LIC model has been published. The findings in this article have limited generalizability, as we only compared two cohorts at one point in time, and our findings are limited to a single medical school. Furthermore, we cannot quantify how much each part of the curriculum (didactic vs. clinical) contributed to the progress of learners. We did not assess the durability of knowledge acquisition beyond the end of the curriculum; understanding if students carry increased skill and knowledge forward in their careers is of great importance. Further research is necessary to assess the overall ophthalmology knowledge of learners and how this factual knowledge translates into clinical practice.

Logistical challenges are also a limitation in incorporating ophthalmology into an LIC. Although we had the benefit of trialing this initiative at one hospital with a preexisting LIC, this implementation may be more difficult for medical schools that are still transitioning from a traditional clerkship model to an LIC. In addition, many institutions (ours included) utilize multiple clinical sites for clerkships. Differences in ophthalmic clinic scheduling, clinic availability, and clerkship leadership between sites may limit implementation, or at least pose further obstacles. For example, unlike for larger ambulatory specialties (such as adult primary care) which may have several clinics available for LIC students within any single clinical institution, there is likely to be only one ophthalmology clinic—this may pose inherent limitations on the number of LIC students that can rotate through ophthalmology at any given time. Nevertheless, aspects of this curriculum can be easily exportable to LIC programs in a variety of clinical settings and adapted to other underrepresented specialties in the medical school curriculum. Educators may also consider the replacement of the slide presentation during the didactic portion with one using active learning techniques, such as flipped classrooms or online modules, as viable alternatives.[22,24,25] The combination of a didactic session coupled with experiential specialty clinic learning where lessons can be directly applied to patient care can be used as a framework for curricular interventions in other medical schools aiming at achieving similar goals. Based on the feedback received from students, we plan to continue to make changes to improve the students' experience and better fill the gaps in ophthalmic knowledge. Some of the modifications implemented include the addition of the didactic experience earlier in the year and the addition of a "logger" of common ophthalmic emergencies required to be discussed with a resident or attending physician during their clinical encounters. Having the introduction to ophthalmology earlier in the AY will allow students more time to identify longitudinal cohort patients, thereby providing more opportunities to see patients in clinics or in the OR settings.

In conclusion, we share a novel ophthalmology curriculum integrated in an LIC model. These curricular experiences can be adapted to other institutions, helping to address the knowledge gaps in medical students regardless of their chosen specialty, ultimately translating into improved patient care. Finally, we argue that our clinical experience allows medical students to interact with residents and faculty within ophthalmology, providing an opportunity for exposure to this underrepresented field in medical education and to foster mentorship in the field.

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None.

Conflict of Interest
None declared.

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