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Following Incorporation of Eyesi
Indirect Simulators into the Optometric
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Report

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Sept. 11-13, 2017

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Student Performance and Perceptions Following Incorporation of Eyesi Indirect Simulators into the Optometric Curriculum

Heather A. Anderson OD, PhD, FAAO, Amber Gaume Giannoni OD, FAAO, and David A. Berntsen OD, PhD, FAAO | Optometric Education: Volume 42 Number 2 (Winter-Spring 2017)

Background

Virtual reality patient simulators are an appealing tool in education programs for medical professionals. Simulators provide an opportunity for increased training in risk-free environments, which may result in better patient outcomes as trainees transition from the laboratory to actual clinical care. With respect to surgical simulators utilized in ophthalmological training, virtual patient simulators have been well-accepted by trainees,¹ have been demonstrated to provide improvements in surgical outcomes in the operating room,²⁻⁴ and have even been validated for the assessment of clinical competencies for surgical certification.⁵

In addition to ophthalmological surgical simulators, non-surgical, retinal diagnostic simulators are now available in a virtual reality platform to train eyecare practitioners.⁶ The Eyesi Indirect and Eyesi Direct systems (VRmagic, Mannheim, Germany) utilize augmented virtual reality, which incorporates virtual views of the patient face and fundus blended with actual views of the surrounding environment, such as the examiner's hand, to create a realistic examiner experience for binocular indirect ophthalmoscopy (BIO) and direct ophthalmoscopy (DO). The system hardware includes a touchscreen user interface and either a headband-mounted stereo display with two handheld fundus lenses (Eyesi Indirect) or a handheld direct ophthalmoscope display (Eyesi Direct). A model patient face interacts with the examination equipment to render fundus images (**Image 1**). Both the indirect and direct ophthalmoscope platforms include a software curriculum that trains the mechanics of retinal examination, recognition of normal anatomic findings, and understanding of an extensive library of pathological findings rendered from fundus photographs of actual clinical patients. In addition to disease detection and recognition, the software aids in the development of the diagnostic process by incorporating common diagnostic tests, such as visual fields and OCT scans, and furthers the understanding of patient management through a variety of clinical questions that are built into each case scenario.



Image 1. A University of Houston College of Optometry student using the Eyesi Indirect simulator (VRmagic, Mannheim, Germany). Pictured are the touchscreen user interface, headband-mounted stereo display, handheld fundus lens and model patient face. Note that the student examiner views the patient images through the stereo display, while the touchscreen user interface simultaneously displays views for the on-looker.

[Click to enlarge](#)

In the fall semester of 2014, the University of Houston College of Optometry (UHCO) became the first optometric institution in the United States to equip a clinical skills simulation lab for the training of both retinal examination and diagnosis with the Eyesi Indirect and Direct simulators. While the potential for improvements in student preparedness through simulation training is evident from previous studies of surgical simulators, published reports of the translation of student clinician skills from simulated to live patients for retinal diagnostic techniques are limited.⁷

This study seeks to provide a retrospective report of student performance on a pre-clinic, live-patient BIO skills assessment in the years prior to and during the implementation of the clinical skills simulation lab. In addition, anonymous feedback from surveys of faculty and current and incoming students is summarized to detail perceptions of the effect of implementing a clinical skills simulation lab in the UHCO curriculum on student performance.

Methods

This study was approved by the Committee for the Protection of Human Subjects at the University of Houston and was

classified as exempt from informed consent due to the educational nature of the research. For this retrospective analysis, data were compiled from the UHCO second-year students' BIO skills assessments (described below) for fall semesters 2011, 2012 and 2013 (pre-implementation of simulation technology) and compared to second-year students' scores during fall semester 2014 (post-implementation of simulation technology). Student training methods for BIO examination at UHCO are described below for both pre- and post-implementation of simulation technology.

Traditional BIO instruction

Historically, students at UHCO are first introduced to BIO examination in the spring of their first year during the Clinic Practicum II Lab. Model eyes are utilized to develop an understanding of the mechanics of obtaining views and documenting abnormalities. In addition, students complete one lab session during which they examine classmates with dilated pupils as a cursory introduction to performing BIO on a live patient. All evaluations of BIO examination skills are conducted on model eyes during the first year.

In the fall semester of the second year, students receive BIO training in the Clinic Practicum III Lab, which consists of five instructor-led lab sessions during which students practice examining dilated classmates for up to one hour at a time. In addition, students may attend weekly two-hour 'open-lab' sessions throughout the semester to practice any basic clinical skills they desire, including BIO on classmates with dilated pupils. These extra sessions are not instructor-led; thus, documentation regarding who attended or how many hours were devoted to BIO during these open-lab sessions is not available.

Incorporation of simulation training

In the summer of 2014, five Eyesi Indirect and five Eyesi Direct platforms were installed at UHCO as part of the new clinical skills simulation lab (simlab) for retinal examination and diagnosis. The Eyesi platforms include a sequential courseware designed to educate students in: 1) obtaining fundus views and documenting findings (geometric shapes), 2) recognizing normal anatomical structures in the retina, 3) recognizing and managing common retinal pathologies, and 4) recognizing and managing pathology from advanced clinical cases. For the purposes of this study, only the students' basic understanding of obtaining systematic views of the retina with BIO after completion of Eyesi Indirect Tier A (device handling and documentation) is assessed. This study does not investigate the clinical training benefits of the Eyesi Direct platform or the pathology portions of the software on either platform.

At the beginning of the 2014 fall semester, all enrolled second-year optometry students ($n = 100$) were assigned individual simlab accounts and received two hours of hands-on training from representatives of VRmagic to orient them to the proper use of the equipment. Students were then required to complete and earn passing scores on all cases in Tier A: Examination Skills of the software (version 1.4). At the time of assignment, Tier A consisted of nine subsections: A1 Device Handling (easy), A2 Device Handling (medium), A3 Device Handling (difficult), A4 Device Handling (small pupil), A5 Retina Screening, A6 Retina Documentation (easy), A7 Retina Documentation (medium), A8 Retina Documentation (difficult), A9 Retina Documentation (small pupil). For all subsections, the task included examination of the virtual patient's fundus with the user having to 'detect' geometric shapes by obtaining a stable view with a virtual cross-hair positioned on top of the shape, or view, remember, and document observed geometric shapes by placing the appropriate shape with proper size, orientation and location on a touchscreen fundus map. The difficulty of cases increased with the inclusion of more shapes of smaller size and more peripheral retinal location. On subsection A5: Retina Screening, users were scored based on whether a thorough evaluation of the entire fundus was completed. Criteria for passing each case were set by the manufacturer. In total, 57 unique cases were included in the assignment.

Each student user's performance scores, date of completion and time spent per case were stored locally on the simulator in use and then synchronized across all simulators each time the student logged out of the software via a web-based cloud system created by the manufacturer. The creation of the web-based cloud system allowed students to continue completion of their assignment on any available simulator throughout the semester. The data presented in this manuscript were extracted from the instructor web portal, which allows access to all synchronized data. A network cable failure early in the fall semester resulted in the loss of some data regarding time spent by users, which is acknowledged in the results, but student completion status was not lost (i.e., students did not have to repeat completed assignments).

Students were given the simulation assignment the first week of class in August 2014 as part of the course requirements for their Clinic Practicum III Lab and were required to complete the assignment by Dec. 4, 2014. Simlab access was restricted to students who were enrolled in the associated course and was available 24 hours a day, 7 days a week via swipe card. A student representative was assigned by the coursemaster to create an online scheduler for the weekday hours between 9 a.m. and 6 p.m., with each student being assigned three separate 1.5-hour blocks of time in the simlab over the course of the semester. However, all students had the option to come in on their own time on evenings or weekends to finish the assignment sooner.

Although the assignment was not due until December, students were strongly encouraged to complete it earlier with the expectation that it would likely assist in their preparation for the clinical skills exams administered in November. In addition to the new simulation assignment, in the fall of 2014, second-year students completed the same traditional BIO laboratory instruction that had been given in previous years and had the same opportunities for open-lab practice sessions as in past years.

BIO skills assessment

Student BIO skills were evaluated in a skills assessment administered in the Clinic Practicum III Lab during the weeks of November 17 and December 1. The timing of test administration and the content of the exam were the same as previously administered in the fall semesters of 2011, 2012 and 2013. The live patient exam was graded by one of the four instructors assigned to each lab section (four lab sections total with some overlap in instructors). The assessment had well-defined criteria (**Appendix 1**) and was scored as a percentage of points earned out of 26 total points. While there were numerous instructors participating in grading over the years, it should be noted that one of the authors of this manuscript (AG) was the coursemaster for the lab and graded approximately 25% of the student class each year, and a second author of this manuscript (DB) was an instructor in one lab section and graded approximately 6% of the student class each year.

We hypothesized that test scores would not differ in the years prior to implementation of the simlab, but would improve with the addition of simulation training in 2014. Given that test scores were not normally distributed (all years were skewed towards high performance), we used the non-parametric Kruskal-Wallis test (the non-parametric equivalent of a one-way ANOVA) to compare test scores first for the years prior to implementation of simulation (2011-2013), and then for all years, including the year of simlab implementation (2011-2014). The percentage of perfect scores for each year was compared using chi-squared tests.

Assessment of perceptions: second-year student survey

On Nov. 7, 2014, an online survey link was sent to the second-year student class by the Clinic Practicum III Lab coursemaster, soliciting anonymous feedback regarding the new simlab. In the text of the e-mail, students were asked to complete the survey if they had finished at least half of the simulation assignment as of the date the survey was distributed. The survey consisted of three questions with five response options (strongly agree, agree, neutral, disagree, strongly disagree):

1. Working through the BIO simlab curriculum has increased my understanding of how to systematically examine the retina and document my findings
2. The opportunity to use the simlab has been an overall positive experience and a benefit to my optometric education
3. Working through the BIO simlab curriculum has improved my ability to obtain BIO retinal views on actual student patients

Second-year clinic faculty survey

At the end of February 2015 (two months after the transition of second-year students to patient care in the University Eye Institute at UHCO), faculty who were clinical attending doctors in second-year clinic and had been for at least the past three years were sent an invitation by the Clinic Practicum III Lab coursemaster to complete an anonymous online survey to provide feedback about student performance and preparedness for second-year clinic. No mention was made in the survey invitation about the recent incorporation of simulation technology and/or its evaluation. Faculty responded to a series of questions, including two questions relevant to simulation technology:

1. When thinking about your current OPT II students in the FPS (Family Practice Service) clinic, how do their BIO skills compare to prior OPT II students you've had AT THIS POINT IN THE SEMESTER? (better, the same, worse)
2. When thinking about your current OPT II students in the FPS (Family Practice Service), how comfortable are they in performing BIO on patients compared to prior OPT II students you've had AT THIS POINT IN THE SEMESTER? (more comfortable, the same, less comfortable)

Incoming student survey

In February 2015, students who had already accepted admission to UHCO as part of the class of 2019 were invited to complete an online survey about their decision to attend UHCO. The survey was distributed via e-mail by a staff member in the Office of Optometry Relations. Students responded to a series of questions, including two questions relevant to simulation technology:

1. What factors played into your decision to attend UHCO? (select as many as are applicable: UHCO's facilities, UHCO's Vision Source Surgery Center, Procedures Lab with video slit lamps, Clinical Skills Simulation Lab, College Location, Faculty Expertise, Interview Day Experience, or Other)

2. How much did the clinical skills simulation lab influence your decision? (a lot, some, a little, none)

Responses to the three surveys were summarized by percentages of respondents in order to obtain information regarding perceptions of the simlab. No formal analysis was conducted on survey data.

Results

Simulation completion times

Student completion times for the components of Tier A in the Eyesi Indirect courseware are summarized in **Table 1**. Although all 100 students completed the entire simulation assignment, network connectivity issues early in the deployment of the technology resulted in loss of storage of completion time data for some students. Therefore, total completion times for all individual students are unavailable. Based on the median completion times for each tier from the available data, the total median completion time for Tiers A1-A9 was approximately 8.5 hours. However, completion times varied widely across students, as can be seen in the minimum and maximum columns in **Table 1**.

Student performance

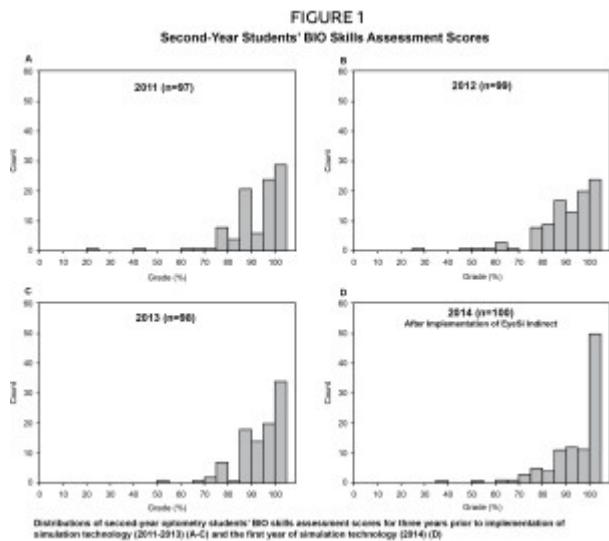


Figure 1: [Click to enlarge](#)

Inspection of student completion dates for the simulation assignment demonstrated that 88% of the class in fall 2014 completed the entire assignment (Tiers A1-A9) by the time of their BIO skills assessment. The remaining 12% had completed, on average, 78% of the assignment by the time of their skills assessment (completion ranged from Tier A5 to A8 for these 12 students). Class performance on the fall semester second-year BIO skills

TABLE 1
Student Completion Times for Tiers A1-A9 of the Eyesi Indirect Courseware

Student	Minimum Completion Time	Maximum Completion Time
22	0:16:35	1:07:59
38	0:12:59	1:56:11
62	0:33:35	3:38:53
78	0:56:56	3:07:51
81	0:58:10	1:29:52
86	0:11:55	1:42:37
92	0:30:05	3:32:31
96	0:46:00	8:12:19
97	0:15:13	3:24:58

ns is the number of students for whom data were available (see 1 minutes:seconds)

Table 1: [Click to enlarge](#)

TABLE 2
BIO Skills Assessment Perfect Scores Before and During Simlab Implementation

	Median	% of Students Earning a Perfect Score
	96	30
	93	24
	96	35
	98	50

ns is the number of students for whom data were available (see 1 minutes:seconds)

Table 2: [Click to enlarge](#)

assessment
was not
normally
distributed
and
consistently
skewed
towards high
performance
(Table 1,
Figure 1),
creating a
potential
ceiling effect
for detection
of
improvements
in test
scores
following the
introduction
of simulation
technology.
Even in light
of this
constraint,
the
distribution
of test
scores when
comparing
years 2011-
2014 were
significantly
different
(Kruskal-Wallis, $p =$
0.032) vs. a
comparison
of years
2011-2013
(before
simlab
implementation), which
did not
significantly
differ
(Kruskal-Wallis, $p =$
0.153),
supporting
our
hypothesis
that
performance
was stable
for the years

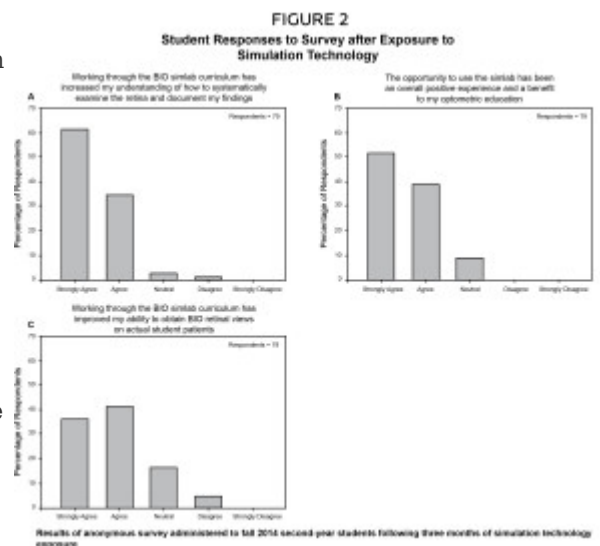
prior to simulation, but improved with the addition of simulation training in 2014. Additionally, the number of perfect scores (100%) earned in the year 2014 was significantly greater than in the three years prior (χ^2 , $p = 0.001$), whereas no difference in the number of perfect scores was observed across the three years prior to simulation technology (χ^2 , $p = 0.274$) (Table 2).

Student perceptions

Student responses to an anonymous web-based survey distributed to the 100 second-year students during the fall 2014 semester are shown in **Figure 2**. Students were asked to complete the survey if they had finished at least half of the simulation assignment as of the date the survey was distributed (Nov. 7, 2014). Web portal information indicates that 93 students had completed at least Tiers A1-A5 by that date, and thus if only those students responded, the response rate for the survey was 88%. Of those responding, more than 90% agreed or strongly agreed that the simlab curriculum had increased their understanding of performing BIO (**Figure 2A**) and that it was a positive overall experience (**Figure 2B**). More than three-fourths of the respondents agreed or strongly agreed that the simlab curriculum had improved their ability to obtain views on student patients (**Figure 2C**).

Faculty perceptions

Sixteen faculty responded to the survey about student performance in the second-year clinic during spring 2015. Of the 16 respondents, 71% [Figure 2: Click to enlarge](#)



felt students were better prepared on basic BIO examination skills when first entering clinic in 2015 than in past years. Also, 100% felt that students were more comfortable performing BIO on patients in 2015 than in past years.

Incoming student perceptions

Sixty-one students responded to the survey of incoming students regarding their decision to attend UHCO. When asked to select as many factors as applicable that influenced their decision to choose UHCO, 80% of respondents indicated that the clinical skills simulation lab was a factor. Regarding the magnitude of the influence of the simlab on their decision to attend UHCO, 22% rated its influence as a lot, 51% some, 20% a little, and 4% none.

Discussion

This study provides evidence that incorporation of simulation training with the Eyesi Indirect positively influenced the performance of students in the second-year class on their lab BIO skills assessment, as indicated by improved test scores. The study also indicates that incorporation of the simulation training positively influenced their performance in the clinic when seeing patients for the first time, as reported anonymously by second-year clinical faculty. The creation of a clinical skills simulation lab was also viewed positively by students currently utilizing the lab as well as by incoming students who had yet to utilize the technology.

BIO is often a challenging technique to master mechanically, as well as mentally, due to the need to comprehend the image reversal created by the fundus lens. That being said, BIO is a technique that was previously being taught with high success at UHCO, as evidenced by the test scores in **Figure 1**. Despite a potential ceiling effect of already strong scores limiting the room for improvement, students in fall 2014 still performed statistically better than students in preceding years. The authors acknowledge that having a second year of test scores from 2015 to demonstrate a continued stronger performance with incorporation of simulation would be compelling; however, these data are unavailable due to changes in both the timing of simulation assignments in the curriculum and resultant changes to the BIO skills assessment, as follows. In the spring of 2014, due to a desire to reduce the simlab load for future second-year students, the first-year students were assigned portions of Tier A to complete during March and April (A1, A2, A6, A7). This change in curriculum meant that students entered the second-year curriculum with greater exposure to BIO than the second-year students reported in this study. Early in the fall semester of 2015, the Clinic Practicum III coursemaster recognized that the new second-year students were much better prepared for BIO examination than in years past, and deemed the traditional BIO skills assessment (reported in this study) as 'too easy'. As a result, the assessment was altered to include full views in nine peripheral locations to better challenge and further assess students' ability to perform BIO, leaving us unable to compare performance between fall 2014 and 2015.

Incorporation of simulation technology in the fall of 2014 resulted in a median simulation usage time of 8.5 hours, which was in addition to the traditional instructor-led practice time of approximately 5 hours. With a class of 100 students, that increase would represent an additional 850 hours of participation from dilated patients if it were conducted on classmates rather than the simulators. Not only did the incorporation of simulation technology offer more practice time for students without the concern of fatiguing their classmates, it redirected the emphasis of BIO education away from a set number of hours of instruction per student to a set endpoint of competency, irrespective of the time it took to reach that goal. By standardizing the endpoint and requiring all students to pass and complete Tier A of the simulation courseware, students were able to work at their own pace instead of achieving the best outcome they could with a fixed set of hours. This shift in educational strategy may be attested to by the fact that more students in the fall of 2014 attained perfect scores on their skills assessment.

While this study offers encouraging findings in support of simulation technology, it is not without its limitations. First, because this study was a retrospective evaluation across years rather than a randomized study of simulation versus non-simulation training, the training experiences of students could have varied from year to year. This possibility is limited, however, given that the same instructor served as coursemaster across all four years tested. In addition, student performance on the BIO skills assessment did not differ significantly across 2011-2013, suggesting that student instruction was likely uniform for the years prior to implementation of simulation.

A second limitation is the fact that two authors of this paper served as instructors scoring the BIO skills assessments each year. The potential for bias toward an improvement with simulation training exists given that the authors led the initiative to implement the simlab. However, the grading criteria of the BIO skills assessment were well-defined with binary outcomes rather than a subjective scoring scale (**Appendix 1**), and the majority of the skills assessments were scored by instructors who had no connection to the simlab, which would limit the potential for bias.

Lastly, the results of this study are limited to a discussion of the potential benefits of completion of Tier A in the Eyesi Indirect

courseware. Tier A is designed to train basic examination skills (obtaining views and documenting findings) and does not address the anatomical structures of the retina or pathological findings. Further studies are needed to evaluate the potential training benefits of completion of the other portions of the courseware and its impact on clinical performance or standardized license examinations.

Conclusions

The incorporation of simulation technology into the BIO training curriculum at the University of Houston College of Optometry had a positive impact on the preparedness of second-year students to systematically obtain views of the retina of live patients in both the classroom and the clinic.

Disclosure

The authors of this manuscript have no conflicts of interest related to the Eyesi Indirect simulator.

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APPENDIX A

BIO SKILLS ASSESSMENT		
Name: _____		Lab Day: M T W Th
Grader: _____		
SET-UP: 1. Adjusted BIO and properly prepared the patient?..... • Must be supine with adequate room to obtain ALL necessary views for a FULL BIO exam. 2. Explained the purpose of the test?.....	Y N Y N	CLEAN LENS? YES NO
MID-PERIPHERAL VIEW #1: FACULTY CHOICE: 3. Stood in correct place to obtain requested view?..... 4. Directed patient's gaze correctly?..... 5. Obtained a clear/stable (3 sec) MID-PERIPHERAL view? (i.e. optic nerve or macula not visible) (2 POINTS) 6. Filled condensing lens (<80% full)? (2 POINTS) 7. Demonstrated appropriate hand placement on face and adequately controlled pt's lids/eyelashes (if applicable)?... 8. Correctly identified mid-peripheral landmark (or correctly indicated which landmark should be expected)?.....	Y N Y N Y N Y N Y N Y N	
MID-PERIPHERAL VIEW #2: FACULTY CHOICE: 9. Stood in correct place to obtain requested view?..... 10. Directed patient's gaze correctly?..... 11. Obtained a clear/stable (3 sec) MID-PERIPHERAL view? (i.e. optic nerve or macula not visible) (2 POINTS) 12. Filled condensing lens (<80% full)? (2 POINTS) 13. Demonstrated appropriate hand placement on face and adequately controlled pt's lids/eyelashes (if applicable)?... 14. Correctly identified mid-peripheral landmark (or correctly indicated which landmark should be expected)?.....	Y N Y N Y N Y N Y N Y N	
POSTERIOR POLE VIEW: FACULTY CHOICE: 15. Directed patient's gaze correctly?..... 16. Obtained a clear/stable view (3 sec)? (i.e. ONH and macula must both be fully visible) (2 POINTS) 17. Filled condensing lens (>90% full)? (2 POINTS) 18. Demonstrated appropriate hand placement on face and adequately controlled pt's lids/eyelashes (if applicable)?	Y N Y N Y N Y N	
POSTERIOR POLE VIEW: FACULTY CHOICE: 19. Gave proper patient instructions throughout procedure? 20. Performance points: <div style="display: flex; justify-content: space-around; width: 100%;"> 0 Below Expected 1 Expected </div>	Y N	

Cerebral Venous Sinus Thrombosis Signaled by Bilateral Optic Disc Edema and Unilateral Pre-retinal Hemorrhage: a Teaching Case Report

Mayra Rullán, OD, FAAO, Eva Wu, OD, and Jose M. De Jesus, OD, MD, MA, FAAO | Optometric Education: Volume 42 Number 2 (Winter-Spring 2017)

Background

Cerebral venous sinus thrombosis (CVST) is a rare, life-threatening condition. It has no age predilection and its presentation may be acute, sub-acute or chronic.¹ Variability in the clinical manifestation of this disease often leads to the misdiagnosis of other neurological conditions such as idiopathic intracranial hypertension (IIH).² Notwithstanding, a significant portion of patients with this condition present with optic nerve head swelling associated with headaches, dizziness and focal neurological deficits.³ Magnetic resonance venography (MRV) is the most efficient test for the diagnosis of cerebral venous sinus abnormalities. Thus, it has become the gold standard for confirming the diagnosis of CVST.^{4,5}

This case report focuses on the proper approach to diagnosing, treating and managing CVST. A thorough review of the clinical aspects of CVST is presented to facilitate the understanding of the course of action taken to treat this patient. In addition, anatomy and physiology concepts of the central nervous system are integrated in the discussion to cultivate critical thinking. For third- and fourth-year students and optometry residents, the case report can reinforce clinical competence in neuro-ophthalmic care. In addition, first- and second-year students may acquire a better understanding of how to incorporate basic science concepts into their clinical training.

Student Discussion Guide

Case description

A 22-year-old Hispanic male was referred urgently by a primary care physician concerning pain in the superior temporal side of his right eye that started eight days earlier. The pain was described as severe, sharp in quality and accompanied by photophobia. A few days after the onset of pain, the patient visited an ophthalmologist. The ophthalmologist diagnosed sinusitis, ordered a sinus X-ray and prescribed oral antibiotics. Per the patient, the result of the sinus X-ray was unremarkable. One day prior to visiting our clinic, the patient noted an acute drop in visual acuity in the right eye associated with the development of a “red central shadow.” No other visual symptoms were noted.



Figure 1A. Initial optometric examination revealed a pre-retinal hemorrhage OD.
[Click to enlarge](#)

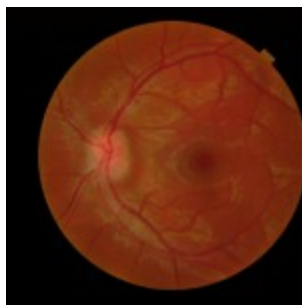


Figure 1B. Initial optometric examination revealed papilledema OU.
[Click to enlarge](#)

Medical history reported was positive for bronchial asthma and sinusitis. The patient had been taking a 50-mg tablet of tramadol hydrochloride daily for pain until one day prior to visiting our clinic. He had no allergies to medications. Family history was positive for diabetes mellitus and hypertension. Social history revealed occasional alcohol consumption.

Entering unaided visual acuity in the right eye was decreased without improvement through pinhole (**Table 1**). Dilated fundus examination showed stage 3 (Frisen Scale) papilledema in both eyes along with a pre-retinal hemorrhage in the right eye (**Figure 1A and 1B**). Differential diagnosis of papilledema based on initial presentation included intracranial mass and cerebral/subarachnoid hemorrhage. The patient was immediately referred to the emergency

TABLE 1
Initial Examination Findings at Optometry Clinic

	OD	OS
Visual acuity	20/70 NLPH	20/25 NLPH
Reflexes	Equal, round, and reactive to light without afferent pupillary defect	
Visual fields	Smooth, accurate, full and extensive	
Slitlamp	12/14	13/14
Card	Normal, open angles	Normal, open angles
Intraocular pressure	12 mmHg	13 mmHg
Retina	Papilledema (Frisen stage 3) along with pre-retinal hemorrhage	Papilledema (Frisen stage 3)
Visual field	Generalized diffuse loss	Enlargement to and incomplete defect inferiorly

improvement through pinhole

Table 1: [Click to enlarge](#)

warfarin was kept at 5 mg per day.

Six-month follow-up visit at eye clinic

At this visit, the patient reported dramatic improvement in vision and no symptoms. Treatment with oral acetazolamide had been discontinued but he was still taking 5 mg of warfarin daily. Vision examination showed 20/20 best-corrected visual acuity in both eyes (**Table 6**). Dilated fundus examination showed significant reduction of optic nerve head edema in both eyes and complete resolution of the pre-retinal hemorrhage in the right eye (**Figure 3A and 3B**).

TABLE 6
6 Months Follow-Up Examination at Optometry Clinic

Unaided visual acuities	20/80+ PH 20/20	20/100+ PH 20/20
Pupils	Equal, round, and reactive to light without afferent pupillary defect	
Motility	Smooth, accurate, full and extensive	
Blood pressure	123/83 (right arm, sitting) @ 2:15 p.m.	
Refraction	Plano -4.75 x015 20/20	+1.00 -6.75 x 170 20/20
Applanation tonometry	11 mmHg	12 mmHg
Fundus	OD, OS (Image 3)	
24-2 Humphrey Visual Field	Normal	Normal
OCT ONH and macula	Mild disc elevation; macula normal	Mild disc elevation; macula normal

PH = pinhole
OCT = optical coherence tomography
ONH = optic nerve head

Table 6: [Click to enlarge](#)



Figure 3A. Dilated fundus photography at the six-month follow-up visit at the eye clinic showed complete resolution of the pre-retinal hemorrhage in the right eye. [Click to enlarge](#)



Figure 3B. Dilated fundus photography at the six-month follow-up visit at the eye clinic showed significant reduction of bilateral disc edema. [Click to enlarge](#)

Educator's Guide

Key concepts

1. Critical thinking in diagnosis and clinical approach in primary eye care
2. The pathophysiology of the venous sinus system of the brain, and its impact on the eyes
3. The importance of ensuring that patients understand their current situation and the seriousness of the matter at hand

Learning objectives

1. Learn the importance of optic nerve head evaluation
2. Gain basic knowledge of CVST, including signs, symptoms and basic testing
3. Learn to differentiate life-threatening situations based on patient presentation
4. Have a basic understanding of the types of headaches associated with papilledema and CVST, as well as the differential diagnosis of pain
5. Understand the concept of papilledema vs. pseudopapilledema
6. Gain knowledge on the differential diagnosis of true papilledema
7. Be able to identify the different stages of papilledema according to the Frisen scale
8. Understand the clinical significance of a pre-retinal hemorrhage in the presence of papilledema
9. Gain expertise in patient education and management when urgent care is required

Discussion questions

1. Basic knowledge and concepts related to the case:
 - a. Describe the anatomy of the venous sinus system of the brain and its correlation with the optic nerve head anatomy
 - b. Describe the flow pathway of the cerebrospinal fluid and its impact on increased intracranial pressure
 - c. Discuss the different stages of papilledema according to the Frisen scale
 - d. Describe CVST and include risk factors
 - e. What is the pathophysiology of CVST?
 - f. What is the pathophysiology of the headache associated with CVST?
 - g. What indicates poor prognosis in CVST cases?
2. Differential diagnosis:

- a. What are the likely diagnoses and differentials based on a patient's presenting signs, symptoms and chief complaint?
- b. What is the differential diagnosis of headaches based on the description of the headache and associated symptoms?
- c. Determine the differential diagnosis based on the patient's retinal findings
- d. Mention the differential diagnosis for papilledema
- e. Discuss the differentiating factors between true papilledema and pseudopapilledema

3. Critical-thinking concepts:

- a. What could be the consequences if treatment is delayed?
- b. Should the primary care optometrist follow up with the patient while the patient is under the care of the hospital facility?
- c. Did the optometrist do the right thing by sending the patient to the ER immediately?
- d. How important is it for the optometrist to ensure the patient understands his or her current eye health situation?

Literature Review

CVST is an uncommon condition that has gained recognition in recent years. This is primarily due to advancements in neuro-imaging technology. Although the outcome of the condition is relatively uneventful with proper treatment, it can be life-threatening if it is misdiagnosed or left untreated. It is more common in young adult women between 20 and 35 years of age. Associated risk factors include pregnancy, puerperium and the use of oral contraceptives.⁶ Diagnosis can be challenging because the condition can present with a wide variety of signs and symptoms that are seen in other neuro-ophthalmic disorders such as IIH. Foroozan et al. concluded in their retrospective study that the rate of occurrence of CVST in patients with presumed IIH was 9.4% (10 of 106 patients).⁷ However, more characteristically, patients with CVST present with a recent onset of an unusual headache or stroke-like symptoms without the usual vascular risk factors.⁷

Pathogenesis

The veins of the brain lie within the subarachnoid space and drain into the cerebral venous sinuses.⁸ The venous system is divided into the superficial and the deep venous system. The two structures belonging to the superficial venous system are the sagittal sinus and the more superficial cortical veins.⁸ The transverse sinus, straight sinus, sigmoid sinus, and the deeper cortical veins belong to the deep venous system.⁸ Venous blood from the cerebral sinuses ultimately reaches the heart via the internal jugular vein. An alteration in the normal blood flow, injury to the vascular wall, or hypercoagulability state can cause a venous blood clot.⁸ A venous clot in the brain may lead to a cerebral infarction. Consequently, this can cause a cerebral hemorrhage and/or increase intracranial pressure (IIP) due to the formation of a thrombotic vein occlusion or thrombotic sinus occlusion, respectively.⁹ Increased vascular permeability from a thrombotic vein occlusion results in extravascular fluid leakage along with coalescence of small hemorrhages ultimately producing a cerebral hematoma.⁹ In contrast, IIP is the most common sign seen in thrombotic sinus occlusions.⁹ This occurs when the cerebrospinal fluid (CSF) is not readily absorbed from the cerebral ventricles through the subarachnoid spaces and drained into the venous sinuses.⁹ As a consequence, the retrobulbar aspect of the optic nerve may begin to swell because of the accumulation of CSF in the proximal subarachnoid space. As the swollen nerve fibers pass through the optic foramen and enter the globe they get compressed and engorge, thus provoking decreased axoplasmic flow. Axoplasmic stasis ultimately results in optic disc edema. Retinal hemorrhaging with vitreous spill may also result from IIP.¹⁰ This occurs when the retinal venous vasculature collapses as a result of an increase in venous pressure relative to the retinal arterial pressure.¹¹

Epidemiology, etiology and risk factors

The incidence of CVST in the general population is approximately three to four cases per million and seven cases per million among children of which 50% are younger than three months.⁹ Although it can occur at any of the sinuses, the sagittal sinus and the lateral (transverse) sinuses are the most commonly affected (70-85% incidence).^{1,6} Multiple conditions and risk factors are associated with CVST (**Table 7**). Nonetheless, direct involvement, such as mechanical trauma during surgery or a consequential injury after a lumbar puncture, has been identified as the cause in approximately 85% of patients. Prothrombotic effects associated with the use of oral contraceptives have also been linked to the disease.⁹ Approximately 75% of the adult population with CSVT are females. This statistic has a positive association with the increased prevalence of young adult women using oral contraceptives.¹ Pregnancy and genetic predisposing mutations such as factor V Leiden may also be influencing factors. Cases of CVST in pregnant women during their last trimester and postpartum period have been documented. Moreover, Allroggen et al. concluded in their study that the chances of developing CVST in a genetically predisposed female of childbearing age taking oral contraceptives is much higher than the normal female counterpart.⁶

TABLE 7 Causes of and Risk Factors for CVST	
in prothrombotic conditions	
genetic	
acquired antibodies	
systemic	
drug	
contraceptives	
sex, ethnic, racial/ethnic	
maternal disease: Rhegner's granulomatosis, sarcoidosis, Behcet disease	
biological: leukemia, anemia, thrombocytopenia, HIV	
or neurosurgical procedures, lumbar puncture	
trauma	
bleeding	
cerebral venous sinus thrombosis	
hemorrhagic bowel disease	
cerebral lupus erythematosus	
polycythemia vera	

Table 7: [Click to enlarge](#)

Clinical manifestations

The onset of CVST may be acute (1-3 days), sub-acute (4-14 days) or chronic (more than 14 days).^{1,12} This variability in initial presentation can create a dilemma regarding the appropriate diagnostic approach. Hence, a proper assessment of signs and symptoms is of utmost importance. Headache is the most repeatable clinical manifestation of CVST. It is present in more than 90% of the cases.⁵ In their retrospective study, Wasay et al. found that 68% of the patients with CVST had a headache accompanied by a neurological deficit on initial presentation, while in the remaining 32% of the patients headache was the only symptom.¹² Notwithstanding, headaches in CVST can present in a variety of forms. They may mimic a thunderclap type headache like is seen in patients with a subarachnoid hemorrhage as well as a throbbing headache that may occur during a migraine attack. Therefore, it is imperative to include CVST in the differential diagnosis when headaches accompany a neurological deficit(s) as well as in headaches that may suggest an impending neurological injury.¹³ Localization of headache may also be a good indicator of CVST. A correlation has been seen between localized headaches and thrombosis of the transverse and sigmoid sinuses.¹² In addition, neurological deficit is observed in the majority of patients with CVST. Usual symptoms include local and generalized seizures, hemiparesis, hemiparesis, ataxia and cranial nerve VI palsy.⁵

TABLE 8 Papilledema Grade (Modified Frisén Scale) ¹⁴	
0 – Normal optic disc	Prominence of the retinal nerve fiber layer at the nasal, superior and inferior poles is inverse proportion to disc diameter
1 – Mild edema	C-shaped halo that is outside with a temporal gap, obscures underlying retinal details. Temporal disc margin normal
2 – Low papilledema	Concentric halo, nasal border elevated, no major vessel obscuration
3 – Moderate papilledema	Obscuration of >1 segment of major blood vessels leaving disc, concentric halo, elevation of all borders
4 – Marked papilledema	Total obscuration on the disc of a segment of a major blood vessel on disc. Elevation of whole ONH, some border obscuration, complete halo
5 – Severe papilledema	Obscuration of all vessels on the disc and leaving the disc

Table 8: [Click to enlarge](#)

Ocular manifestations occur in approximately half of the patients with CVST.¹⁴ Papilledema is the most common ocular sign observed. IIP causes axoplasmic stasis leading to accumulation of cellular waste products and subsequent optic nerve edema. Optic nerve head (ONH) elevation due to papilledema, as well other conditions, may be observed on binocular fundus examination. However, accompanying peripapillary signs such as obscuration of retinal vessels, nerve fiber layer hemorrhages and retinal folds (Paton's lines) are characteristic of papilledema (**Table 8**). Extra-retinal hemorrhaging may also be observed in CVST as a result of capillary collapse provoked by increased retinal venous pressure at other layers of the retina. Depending on the layer involved, blood spill can be found adjacent to the vitreous parenchyma (between the posterior vitreous base and the internal limiting membrane (ILM) and/or at the pre-retinal interphase (posterior to the ILM and anterior to the nerve fiber layer).¹⁵

Diagnostic tools

MRI and MRV of the brain are the most sensitive tests for diagnosing CVST.⁴ If CVST is suspected, the initial standard approach is to order an MRI of the brain. A positive test is interpreted by the presence of a hyperintense signal from the thrombosed sinus(es). Following, due to its specificity, an MRV should be obtained to rule out CVST.¹⁶ A confirming positive result will demonstrate an absence of flow in the corresponding thrombosed region.^{17,18} Despite the effectiveness and non-invasive modality of this approach, other anatomical abnormalities such as septation of the venous sinuses can be incorrectly identified as CVST.¹⁹ Thus, a more invasive approach such as a cerebral angiography (CA) may be warranted in cases where the diagnosis of CVST through magnetic resonance is uncertain.

Alternatively, CT scan may be employed to diagnosis CVST if the use of magnetic resonance technology is contraindicated. It will also show a hyperintense signal on the suspected thrombosed area, which should be further confirmed through a computed tomographic venography (CVT). However, this approach is far less sensitive and specific than magnetic resonance technology.²⁰ Hence, CA must be performed if the diagnosis of CVST is doubtful.

Treatment

The management of CVST involves anticoagulation therapy and the reduction of IIP. For the initial anticoagulation treatment, the patient is usually hospitalized, requiring intravenous or subcutaneous administration of low molecular weight heparin. After stabilization, the patient is usually dismissed from the hospital and treated with oral anticoagulants for months to years.⁹ An acute thrombotic event may be treated with intravenous administration of thrombolytic agents within three hours of the initial presentation. Tissue plasminogen activator (TPA) is usually the preferred agent. However, this treatment approach does not necessarily improve the usual outcome. Approximately 30% of patients treated with TPA during an acute stage have a better outcome in comparison to patients not receiving thrombolytic treatment during the same period.²¹ IIP reduction requires in-hospital intravenous administration of acetazolamide. This is followed by oral acetazolamide treatment for weeks to months. In refractory cases, a lumbar puncture and/or a lumboperitoneal shunt is usually performed.¹ In addition, intractable IIP leading to papilledematous optic nerve atrophy may require an optic nerve head fenestration procedure to decrease ONH swelling.²² With appropriate treatment the prognosis of CVST is favorable. Prospective studies reveal that the great majority of patients who are properly treated fully recover.⁹ A poor outcome is usually a result of severe clinical features manifested at the time of initial presentation.^{23,24} These may include extensive thrombopathy, deep sinus involvement and altered levels of consciousness.

Discussion

CVST is a neurological treatable disease that has good prognosis if diagnosed early. In the case presented, the optometrist immediately recognized the significance of neurological signs and symptoms and ensured that the patient received prompt evaluation and treatment, resulting in a good outcome. The patient's presentation of severe unilateral headache in association with bilateral optic nerve swelling, as detected through fundus examination, are what incited the clinician's suspicion of a cranial pathology that needed immediate attention. Aside from CVST, other diagnostic considerations with this type of presentation should include subarachnoid hemorrhage, intracranial aneurysm, cervical artery dissection, stroke, intracranial hemorrhage, reversible cerebral vasoconstriction syndrome, and posterior reversible leukoencephalopathy.²⁵

As in other neuro-ophthalmic conditions, the clinical distinction between papilledema and pseudopapilledema in the presence of an elevated optic disc must be addressed when CVST is suspected. Clinical signs that prompt the suggestion of papilledema in the presence of an elevated optic disc include blurred disc margins, peripapillary nerve fiber layer splinter-type hemorrhages with exudation and peripapillary retinal folds known as Paton's lines. Pseudopapilledema is often seen secondary to optic nerve head drusen, where the nerve looks elevated due to the presence of "buried" hyaline bodies. OCT is an excellent imaging test to help differentiate true disc edema from pseudopapilledema.^{16,26} In pseudopapilledema secondary to optic nerve drusen, OCT will show a lumpy and bumpy internal contour of the optic nerve head, while in papilledema a sideways "lazy V" pattern of the subretinal hyporeflexive space is typically observed.²⁷ Fundus autofluorescence (FAF) imaging and B scan ultrasonography are other diagnostic instruments that can be employed to rule out optic nerve drusen. It is also essential to consider all potential causes of optic nerve head swelling aside from papilledema. Optic nerve head swelling due to other etiologies may include malignant hypertension, diabetic papillitis, anemia, central retinal vein occlusion, neuroretinitis, uveopapillitis, optic neuritis, anterior ischemic optic neuropathy, Leber's optic neuropathy and retrobulbar optic nerve mass, among others. Functional ocular deficits may also occur in CVST. Eso-binocular diplopia may develop due to IIP compression on the abducens nerve. This cranial nerve is the most commonly affected due to its long trajectory through the subarachnoid space. In addition, static automated perimetry as well as Goldmann dynamic perimetry may reveal an enlargement of the blind spot. Ischemic optic nerve head damage seldom occurs, thus afferent pupillary defects and dyschromatopsia are usually absent.

Discerning urgency and prompt referral

It is important for primary eyecare physicians to be receptive to patients' concerns as well as their signs and symptoms and to have the ability to discern the necessity of urgent care. In this case, for example, the patient presented with a severe unilateral headache accompanied by visual disturbances associated with bilateral papilledema and a pre-retinal hemorrhage in the right eye. Initially, this clinical scenario suggested the possibility of IIH; however, the patient did not fit the typical profile for IIH (overweight female of childbearing age).¹⁰ It is important to remember that IIH is a diagnosis of exclusion and does not necessarily require urgent action. Therefore, other conditions that may require prompt management must be ruled out. CVST must be high in the list of differentials when bilateral papilledema presents with retinal hemorrhages.²⁸ In addition, other conditions such as tumors, infections, occlusions and trauma must be excluded. Assurance of reaching the proper personnel is imperative in urgent care management. Therefore, the primary eyecare physician should contact the referring facility to ensure that the patient is attended promptly by the appropriate personnel.

Patient education

Proper patient education is especially vital in urgent care management. The primary eyecare physician must ensure that the

patient acknowledges the status of his/her condition and the subsequent care that may be required. This provides patients with the opportunity to ask concerning questions and helps them to be mentally prepared for the forthcoming process. In addition, it helps to ensure patient compliance with seeking care.

Conclusion

CVST should be included in the differential diagnosis of patients presenting with bilateral disc edema or papilledema and headaches. The great “mimicker” would be IIH, especially if patients are young women. The patient in this case was a young male with headaches, bilateral disc edema and a preretinal hemorrhage in the right eye. A CT scan did not reveal any abnormalities, and the preliminary diagnosis was IIH. Results of the MRI and MRV that were ordered showed the presence of a venous sinus occlusion. CVST can result in permanent vision loss and death if it is not treated promptly. Hence, an urgent approach to the care of these patients can prevent visual function loss and save their lives.

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The SIFD and the Three-Legged Stool

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Background

The Summer Institute for Faculty Development (SIFD) is a biennial workshop hosted by the Association of Schools and Colleges of Optometry (ASCO).¹ It is designed to assist faculty members' transition into the academic culture by increasing their awareness and understanding of the tools and resources available to them. In 2006 the SIFD, aka the Institute, was established as a collaboration including all of the schools and colleges of optometry. It consists of workshops, small group sessions, lectures, panel discussions and mentoring. The Institute's goals as published on the ASCO website¹ are:

- to provide participants with an opportunity to gain the knowledge and skills necessary to enhance their success in an optometric academic environment as career-long, productive faculty members
- to increase retention of faculty in the schools and colleges of optometry

The program is designed for full-time faculty members with more than two years but less than 10 years of academic experience.¹ The Institute is a way to orient and prepare junior faculty for the process of promotion and development, including tenure when applicable. Faculty development and promotion is evaluated at each respective institution by the contributions made locally, nationally and internationally in teaching, scholarship and service. This is often referred to as the "three-legged stool" of optometric academia. In order for the stool to be balanced and not tip over, there must be relatively equal weight distribution to all three legs. This metaphor represents the need for relatively equal contributions in teaching, scholarship and service for a successful career in academia. The Institute dedicates time to discussing resources and tools available to the faculty members and brainstorming ways to enhance their careers by achieving balance in these three areas.

Six SIFD programs have taken place between 2006 and 2015. The Institute began as an annual workshop in 2006 and evolved into a biennial event starting in 2007. To evaluate the outcomes of the program, a survey was sent to those who participated between 2006 and 2013.³ The purpose of this study is to determine whether the Institute's goals were achieved, based on the survey findings. Specifically, do faculty members feel they gained the necessary skills to be a productive faculty member? Secondly, what is the retention rate of SIFD participants in optometric academia based on their mode of practice at the time of the survey?

Methods

The survey (**Appendix A**) was designed to specifically evaluate the Institute's goals and was sent to all 183 participants from five workshops between 2006 and 2013. The survey consisted of 16 questions with text box areas available for added comments. Each participant was sent the survey on Aug. 25, 2015. Those who had not yet responded were sent a reminder e-mail on Sept. 15, 2015. Participants' contact information was updated in October 2015 as was made available by public record. All participants for whom a different e-mail address was found were sent the survey again on Dec. 15, 2015, and a reminder e-mail on Jan. 4, 2016. The survey was not anonymous; however, the individual respondents and the data are not linked in this study. Utilizing a survey as the method of evaluation presents limitations in assessing the entire population. The survey may attract the participants with the strongest opinion, whether positive or negative. For the purpose of this study, our assumption is that those who responded represent the entire population.^{1,2}

The survey evaluates whether the faculty members gained the skills and knowledge necessary to be successful in academia through responses related to:

- accomplishment of short- and long-term goals
- evaluation of mentor relationships
- resources planned to be utilized in career advancement
- new career goals developed at the Institute
- knowledge of new potential barriers to career advancement
- the overall perceived effect of the program on the academic career

In order to evaluate participants' current mode of practice, additional research was conducted. Each participant's National

Provider Identifier number was obtained⁴ and confirmed via phone calls and Internet Google searches during October 2015. Each school and college of optometry website was reviewed to confirm the faculty positions.⁵⁻²⁷ The current mode of practice of all SIFD participants is reported regardless of their participation in the survey.

Results

The survey reached 170 of the 183 SIFD participants, and 76 responded, resulting in a response rate of 44.7%. We were unable to obtain accurate contact information for 13 participants. Prior to participating in the SIFD, 34% of participants had been working in academia greater than two but less than 10 years, within the Institute’s recruiting goal. Those outside the Institute’s recruiting goal represent 66% of the respondents (**Figure 1**). The distribution of feedback received is shown in **Table 1**. Annual response rates ranged from 26% to 52%.

TABLE 2
Participation Year and Long-Term Goals Accomplished

2006	2007	2009	2011
1	3	1	29
2	1	3	6
7	7	3	1
3	1	2	1
13	12	9	1

redeployment

TABLE 1
SIFD Participants’ Survey Responses

2007	2009	2011
33	34	35
29	33	35
12	9	17
36.4%	26.5%	48.6%

redeployment

This study showed that participants were able to gain the skills and tools needed to be successful. Among SIFD participants, 93% reported meeting one or more of their short-term goals, and 82% reported meeting one or more of their long-term goals, as depicted in **Figure 2**. There was no significant association between SIFD year of participation and number of long-term goals accomplished (Chi-Squared = 15.2, p = 0.2, **Table 2**). Several National Institutes of Health grants for research were funded for multi-centered studies that initiated from the goal development workshop.

Table 2. Click to enlarge

The mentoring program was reported as an extremely valuable resource for providing tools and skills as demonstrated in **Figure 3**. Respondents commented on the benefits of maintaining relationships with their mentors. Other resources strongly valued were the connections made with faculty at other institutions, curriculum vitae (CV) evaluation, and test-writing skills. More than half of the participants (59%) developed new career goals as a result of their experience.

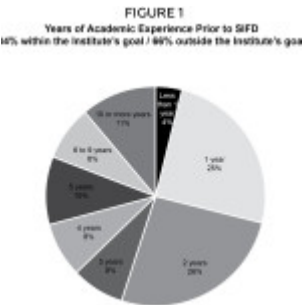


Figure 1. Click to enlarge

Figure 4 shows the respondents acknowledged barriers to career advancement. The most frequently mentioned barriers were too much time devoted to other duties and changed priorities. Participants commented on the challenges of work-life balance and time management. Five respondents felt as if their promotion and advancement were hindered without a PhD. A majority of respondents stated the need for additional mentorship at their respective institutions. The challenges identified at the institution level reportedly led several respondents to gain a better understanding of future expectations.

This study showed that 86% of the 170 SIFD participants surveyed were working in optometric education for a total of six to 10 years at the time of the survey (**Figure 5**). The modes of practice of these 170 SIFD participants were included regardless of their participation in the survey.

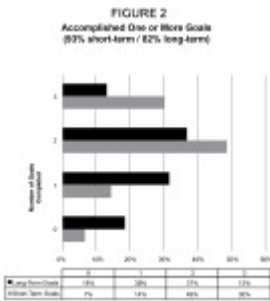


Figure 2. Click to enlarge

Figure 3. Click to enlarge

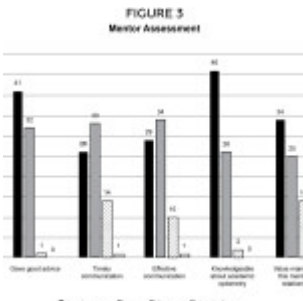


Figure 4. Click to enlarge

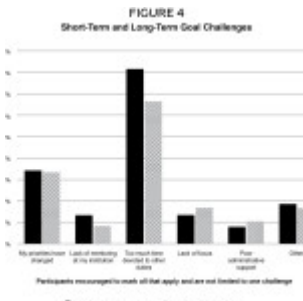


Figure 5. Click to enlarge

Discussion

The SIFD set out with an intention to enhance faculty development throughout the colleges and schools of optometry. This study found multiple aspects of the Institute that support the goal of gaining the knowledge and skills needed to be successful in a career in optometric academia.¹ The information gathered in the following areas was used to assess the Institute’s goals:

- accomplishment of short- and long-term goals

- evaluation of mentor relationships
- resources planned to be utilized in career advancement
- new career goals developed at the Institute
- knowledge of new potential barriers to career advancement
- overall perceived effect of the program on the academic career

During the SIFD workshops, each participant develops three or more short-term and long-term goals. Time is dedicated to developing these goals in the areas of teaching, scholarship and service. Having a balanced career that addresses all three of these factors is crucial for successful promotion and growth as a faculty member. The results of the survey demonstrate that 93% of participants achieved one or more of their short-term goals, while 82% achieved one or more of their long-term goals (**Figure 2**). There was no statistically significant relationship between long-term goals accomplished and year of SIFD participation.

The significant achievements that were reported as a result of goals developed from the Institute are a strong indicator of the success and benefit of the program. Several participants had goals from various areas, including but not limited to:

- leadership responsibilities that include more administrative roles in their institution
- becoming a fellow and diplomate in the American Academy of Optometry
- further education such as obtaining a master's degree in public health or a PhD
- writing a textbook

Those who had not met their short- or long-term goals indicated their time was dedicated to other assigned duties. Participants mentioned they faced many obstacles in striving to accomplish their career goals. However, time limitations stood out as the main factor for the participants. Implementing added focus on time management at future SIFD programs may be beneficial based on the findings of this study. While this study did not prove that accomplishing short- and long-term goals was directly related to retention, lack of time was the main reported obstacle to success in this area. **Figure 4** details the challenges in reaching goals as reported by participants.

The feedback obtained throughout this research positively pointed toward the importance of the connections that were made during the SIFD. The networking opportunity — the connection of junior faculty members with mentors from all of the optometry programs involved — was mentioned as a vital aspect of the program. **Figure 3** shows the majority of participants agreed or strongly agreed with the mentors' ability to:

- provide good advice
- have timely communication
- have effective communication
- demonstrate their knowledge of academic optometry
- be a valuable relationship to maintain

The administrators of the workshops act as mentors to the participants. This mentorship is created to facilitate the relationship between the faculty members at different institutions. Small groups are created with representatives from a variety of programs. This provides the opportunity to discuss goals, tenure and promotion, and more specific questions related to the individual and group. A participant reported that this provided the courage necessary for creating mentors at his/her own institution. Those who were no longer in contact with their mentors reported a benefit from networking with faculty at other Institutes as well.

The participants reported that the SIFD provided tools and strategies for addressing potential barriers to career advancement. One individual reported feeling lost at his/her institution due to a lack of communication related to expectations and development. The SIFD was able to clarify for the participant what is expected of faculty working in optometric education so that he/she could focus on balancing the three-legged stool of teaching, scholarship and service in order to have a complete CV for career advancement. Understanding the balance of the three-legged stool in optometric academia is necessary for a successful career in academia. Each leg of the stool needs to be addressed so the stool can remain upright, i.e., so the faculty member can be successful.

Specific resources from the Institute that have been utilized in career development are test-writing skills and techniques, outcome assessments, and creation of timelines for accomplishments. For example, multiple participants noted that focusing on a timeline to achieve goals and promotion allowed them to explore new areas of academia and find ways to incorporate them into their careers. The public-speaking suggestions and demonstration given were also a valued resource for developing career skills in teaching. Furthermore, the assistance provided in reviewing and strengthening a professional CV was repeatedly mentioned as a beneficial resource.

The overall perceived effect of the program on the academic career was extremely positive. An underlying passion was apparent in all aspects of the research. “I truly don’t think I would be where I am today without this program” was expressed by a participant. This comment, along with many other strong words of support, demonstrated that participants felt the SIFD program was an important part of their career development. The mentorship and connections that were made were identified as the greatest resources participants utilized in assisting them in being a productive faculty member. The SIFD motivated and rekindled their love of teaching and provided ways of being a more effective teacher. It helped establish a perspective on the role of faculty in the larger scheme of academia and optometric education.

Ideas for re-evaluating some SIFD practices also emerged from the study. For example, the majority of participants in the Institute were outside the recruiting goal (to attract participants with more than two but less than 10 years of faculty experience). The majority had between one and two years of experience (**Figure 1**). However, the survey results indicated the participants outside of the recruiting goal valued the program and found it beneficial. This information can be used to assess and possibly adjust the recruiting goal for future SIFD programs.

Several survey respondents suggested a need for consistent follow-up after the program as a way to increase the number of goals achieved and address any new barriers to career development. It was also suggested that participants be regularly updated on currently available resources and tools. The follow-up and updates could come from mentors, SIFD leaders, and/or the home institution. One of the participants reported that taking the survey was a reminder of the goals set and information obtained at the Institute and as such that it indirectly acted as follow-up. The authors suggest creating additional networking and mentorship opportunities by connecting SIFD “graduates” with new participants.

The survey was conducted between September 2015 and January 2016. In May 2016, ASCO launched an online community called ASCOConnect. The SIFD participants have a private community with a discussion forum and an area for posting comments and providing links to files of interest. This forum provides an opportunity for participants to continue collaborating, networking and sharing tools for navigating the culture of optometric academia. The key is to engage participants to maximize the benefits of this online community.

This study also asked the SIFD participants about their opinion of optometry as a profession and academic optometry as a mode of practice. Only 4% reported they would not recommend optometry as a career due to a concern with the debt to income ratio. There was resounding support for recommending a career in optometric academia. “Seeing the growth of students and the impact that you can have on their career is rewarding,” one participant reported. A career in academia was described as fulfilling, rewarding and autonomous with a wide variety of opportunity. It was felt that this career provides the opportunity for “lifelong learning” in a balanced and stable environment.

The retention of faculty members in optometric academia is extremely high in the SIFD participant population, based on their current mode of practice at the time of the survey. **Figure 5** shows the current mode of practice of all participants regardless of their participation in the survey. (The mode of practice of five participants was unable to be identified. They are included in the category labeled “other.”) **Figure 5** shows that 86% are still in academia even if they changed institutions. Those who are no longer in academia have moved on to different areas of optometry, such as private practice and industry. Further research needs to be done to compare the retention rate of non-SIFD participants with the retention rate of SIFD participants to determine whether this is a significant relationship.

Conclusion

This study indicates that the SIFD is a successful program that has reached the goal of providing knowledge and tools for being a productive career-long optometric faculty member while demonstrating retention of SIFD participants in academia based on their mode of practice at the time of the survey. To evaluate whether the Institute increases faculty retention, a follow-up retrospective cohort study to determine statistical significance is needed.

Benefits of this study include the ability to provide quantitative information to help individual schools and colleges of optometry make future decisions regarding their participation in the SIFD. Also, ASCO can use this research to show achievement of the program’s published goals and objectives based on measurable, successful outcomes.

By utilizing the feedback of the participants, organizers of the Institute can make adjustments, advancements or changes to the program that they deem appropriate. The authors suggest consideration of the suggestion for additional program follow-up as it was mentioned throughout the survey feedback. The new online community, ASCOConnect, will provide participants an opportunity for additional follow-up and continued collaboration and networking. Future assessments of the Institute will include this online community resource and are projected to provide a significant benefit to the participants. Re-evaluation of the recruitment goal is recommended as the participants outside of the recruiting goal reported a significant benefit from the experience.

The ability to evaluate participant feedback from multiple schools and colleges of optometry is a significant strength of this study. The weakness of this study was the inability to reach all participants, which resulted in a response rate of 44.7%. There also may be a bias in the research as the study did not reach all participants who are no longer in academia for their feedback.

This study shows a significant positive impact made by the Summer Institute for Faculty Development on enhancing careers in optometric academia. The SIFD is able to help participants understand the need for balancing their professional three-legged stool, which includes teaching, scholarship and service, in order to have a successful career in academia. "The opportunity to be around some really great teachers inspired me to create my own legacy," was one powerful response from a participant. It exemplifies the strong perceived benefit and passion felt for the program. Based on the results of this study, the authors recommend the continued delivery of this program. The next opportunity for participation in the Summer Institute for Faculty Development will be in July 2017. It is the authors' opinion that all optometric faculty would benefit from this program with a specific additional enhancement to those who are new to optometric academia.

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APPENDIX A
2015-2016 SIFD Outcomes Survey

* 1. How many years of academic experience did you have when you participated in the SIFD?

* 2. In which SIFD did you participate?

- ☐ 2006
☐ 2007
☐ 2009
☐ 2011
☐ 2013

* 3. Are you still in academia?

- ☐ Yes
☐ No

* 4. If yes, how many cumulative years of academic experience do you have?

- ☐ <3
☐ 3-5
☐ 6-10
☐ 11-15
☐ >15

* 5. Of your short term goals, how many did you achieve?

- ☐ 0
☐ 1
☐ 2
☐ 3

6. If you didn't achieve one or more of them, can you explain why? (Choose all that apply)

- ☐ My priorities have changed
☐ Lack of mentoring at my institution
☐ Too much time devoted to other duties as assigned
☐ Lack of focus on my part
☐ Poor support for chosen goals by administration
☐ Other (please specify)

* 7. Of your long-term goals, how many have you already achieved?

- ☐ 0
☐ 1
☐ 2
☐ 3

8. If you didn't achieve one or more of them, can you explain why? (Choose all that apply)

- ☐ My priorities have changed
☐ Lack of mentoring at my institution
☐ Too much time devoted to other duties as assigned
☐ Lack of focus on my part
☐ Poor support for chosen goals by administration
☐ Other (please specify)

* 9. Would you recommend optometry as a career?

- ☐ Yes
☐ No

Why? Or Why Not?

10. Please describe how your participation in the SIFD program has specifically affected your career.

11. Please rate your level of agreement with the following aspects of your assigned mentor:

	Strongly Agree	Agree	Disagree	Strongly Disagree
I gain good advice				
communications are timely				
communications are effective				
knowledgeable about academic optometry				
I would value maintaining this mentoring relationship				

12. Are there any new career goals you have developed for yourself as a result of your experience at the Summer Institute?

13. What resources will you plan to use that will help you advance your career as a result of participating in SIFD?

14. What barriers to advancement do you see that you didn't know about before your participation in SIFD?

* 15. Would you recommend a career in academic optometry to an optometrist, research scientist, resident, or current student?

- ☐ Yes
☐ No

Why? Or Why Not?

16. Please describe how you believe your participation in the SIFD program will affect the future of your career.

Competency-based Assessment of Refractive Error Measurement in a Mozambique Optometry School

Kajal Shah PhD, Kovin Naidoo, PhD, OD, Luigi Bilotto, OD, and James Loughman, PhD | Optometric Education: Volume 42 Number 2 (Winter-Spring 2017)

Introduction

The Mozambique Eyecare Project is a higher education partnership between the Dublin Institute of Technology (DIT), the Brien Holden Vision Institute (BHVI), the University of Ulster and Universidade Lúrio (UniLúrio), Nampula, for the development, implementation and evaluation of a model of optometry training at Unilúrio in Mozambique. The four-year optometry program was based on a curriculum developed by BHVI with competencies drawn from the global competency-based model of the World Council of Optometry (WCO) and the Association of Regulatory Boards of Optometry (ARBO). The model allows for objective comparisons of scope of practice between countries. The global competency-based model provides a vertical career ladder for individuals seeking to expand their scope of clinical practice and includes four categories of clinical care. Each category requires a set of competencies that includes the previous category: optical technology, visual function, ocular diagnostic and ocular therapeutic.¹ The minimum required for individuals to call themselves an optometrist is demonstrating competence in dispensing, refracting, prescribing and the detection of disease/abnormality.¹ In Mozambique the exact scope of practice of optometry is not defined, but the curriculum enables at least the ocular diagnostic category to be met.

Competencies are seen as a framework for entry-level abilities in the profession of optometry in most countries. Students have to show by some means of assessment (a specific examination or some form of continuing assessment program) that they are competent in the areas listed.² The definition of competence provided by the General Optical Council (GOC) in the United Kingdom (UK) is: "Competence has been defined as the ability to perform the responsibilities required of professionals to the standards necessary for safe and effective practice. A competency will be a combination of the specification and application of a knowledge or skill within the occupation, to the appropriate standard."³

Literature on methods of assessing clinical competency has existed in medicine for many years; however, little published research exists for optometry.⁴⁻⁷ In the UK, the GOC describes the required competencies in detail, but it does not specify the method of assessment. This is left to the respective training institutions and professional organizations responsible for assessment and certification.⁴

An ideal assessment tool would have to be reliable and valid.⁸ Reliability is a measure of the reproducibility or consistency of a test, and is affected by many factors such as examiner judgments (inter-rater, examiner experience), inter-case (student) reliability, inconsistency of patient performance, and reliability of rating scales.⁶ Validity refers to the ability of the assessment to measure what it is supposed to measure. No valid assessment methods that measure all facets of clinical competence have been designed.⁶ Other factors, including the feasibility of running and resourcing the examination, are also important in a developing country context.⁸

Miller's pyramid conceptualizes the essential facets of assessment of clinical competence.⁷ The base represents the knowledge components of competence: 'knows' (basic facts), 'knows how' (applied knowledge), 'shows how' and 'does'. The base levels are assessed with written tests of clinical knowledge such as multiple-choice questions, short-answer questions, essays and oral examinations. They are still popular in the training of optometry students in the UK and Europe and in the entry-level examinations to the profession in the United States (US).^{9,10} Direct observation of students in clinics, the use of standardized patients (SP) and objective structured clinical examinations (OSCE) are commonly used to test the 'shows how' component.¹⁰⁻¹² The final assessment of pre-registration optometry students in the UK is in the form of an OSCE, wherein students rotate through a series of stations to demonstrate clinical skills applied in a range of contexts.¹¹ However, little literature exists on assessment of exit-level competencies from the optometry program, which is the context in Mozambique, as opposed to entry level into the profession, even though assessment strategies can be similar.

Uncorrected refractive error has been identified as a major cause of visual impairment in Mozambique.¹³ The only providers of refraction services within the national health system in Mozambique are ophthalmic technicians. However, previous assessment of their refraction skills showed they needed upskilling to make them competent at refraction.¹⁴ We did not set out to assess dispensing and contact lens fitting, which are all part of the competency skill set of an optometrist.¹ There were various reasons for this. For dispensing, the spectacle supply system at the university had not been established when the

students graduated; therefore, their exposure to dispensing was restricted. Once the students have graduated and started working within the national health system, their access to contact lenses is limited apart from in the larger central and provincial hospitals. Hence, refractive error measurement was deemed the most important responsibility at present of the Mozambican optometrist. For this paper, refractive error management includes the clinical judgement related to the patient's age, symptoms, accuracy of the subjective or objective refractive result, binocular vision status and disease.¹⁵ Moreover, there is little or no supervision of students once they've graduated. In the absence of alternative refractive care provision, emphasis had to be placed on ensuring they were competent in their refraction routine.

The aim of this study was two-fold: 1) to report on the development of a process for assessing refractive error management competence that is practical to implement and keeps staffing and resourcing costs at sustainable levels within the context of limited academic resources, and 2) to understand the effectiveness of implementation of the process in the context of a low resource environment, in terms of its reliability and validity.

Competence Assessment Development and Implementation

This article describes two components: 1) the development of the competency assessment methods and process, and 2) the implementation of the assessment process. The evaluative elements of this work were conducted according to the tenets of the Declaration of Helsinki and approved by the research ethics committee at the Dublin Institute of Technology.

Assessment Development: Methods

Information was gathered from a literature review of assessment methods in medicine^{6-8,16,17} and high-stakes optometry exams,^{9-11,18} the latter being the only literature available for optometry.

A focus group discussion was conducted with two lecturers from Unilúrio responsible for the clinics of the first cohort of students, and three of the program developers on the basis of their clinical and academic expertise. They were asked to read and sign a consent form by the investigator acting as the facilitator of the focus group. The members of the group, two each from South Africa and Colombia and one from Canada, had an average of 16 years of clinical experience and an average of nine years teaching experience in international undergraduate optometry education, particularly in curriculum design, teaching and developing and conducting assessments.

The investigator informed the participants about the objective of the focus group. The primary intention was to develop the assessment methods for evaluating competencies of the optometry students, concentrating on refraction, before they graduated. Qualitative data based on grounded theory was captured on assessment methods and their evaluation, which would be feasible given the challenges that existed for a new program in a low academic resource context.¹⁹ The participants were asked how best to evaluate the optometry students' refraction competencies as the standard necessary for entry into the profession in Mozambique. The discussion was recorded by the investigator, read, coded, categorized and analyzed thematically. In order to improve the credibility of the data, member checking was used.²⁰ This involved the data being presented to the focus group members to confirm the credibility of the themes and whether the overall account was realistic and accurate.

Assessment Development: Results

The key themes extracted from the focus group, which informed the development of the assessment methods included: 1) exclusion of OSCEs, 2) practice assessment by direct observation, 3) theory exams, and 4) qualitative observations of the competency assessment process.

Exclusion of OSCEs

The existing literature on different assessment procedures suitable for use in medicine^{6-8,16,17} and optometry^{9-11,18} was discussed. The two most commonly cited methods of assessment of clinical competencies, identified from the literature review, are the direct observation of students performing these clinical skills and objective structured clinical examinations (OSCEs). However, there is little published literature on the use of OSCEs in Africa. In a review of the economic feasibility of OSCEs in undergraduate medical studies, only 17 of the 1,075 publications were from Africa.²¹ A study comparing six assessment methods for their ability to assess medical students' performance and their ease of adoption with regard to cost, suitability and safety in South Africa revealed OSCEs to be the most costly.²² Hence, OSCEs and the use of standardized patients were ruled out due to lack of academic resources and examiners.

Recommendations were made on the most suitable methods for competency assessment in Mozambique, taking into account that integrating disease and binocular status with the refractive result is necessary for prescribing a refractive correction.¹⁵

The competencies would be assessed as follows.

Practical assessment by direct observation

This had to be constructed to maximize validity and reliability against the time and cost of running and resourcing the exams. Students undertook an eye examination of two real patients, a presbyope and a pre-presbyope, under observation of two examiners for each patient. Clinical performance was assessed for communication, history and symptoms, vision and visual acuity (with pinhole if necessary), pupil distance, assessment of pupil responses, cover test, ocular motility, near point of convergence, externals, retinoscopy, best sphere, cross cylindrical refraction, binocular balance and near vision, final prescription, ophthalmoscopy, advice, recording, management and time-keeping. (**Appendix A**)

The WCO global competency model would be used as the framework for the assessment, with the assessment method mapped to the elements of competencies and performance criteria and the level of difficulty expected to be mastered by the student specified, to enhance content validity.

Direct ophthalmoscopy and an external exam using a slit lamp were also included because the presence/absence of pathology would indicate the level of best-corrected visual acuity and help in the management of the patient. A pass-fail cut-off score of 75%, as stipulated by the university and backed by literature, was maintained by the participants of the focus group discussion.¹⁰ The skills were weighted according to their importance for safe, effective clinical practice based on the literature and clinical assessment experience of the focus group participants.¹⁰ The weightings and number of checklist items for every skill are reflected in the results in **Table 1** with 100% being the overall score.

The time allowed was 50 minutes. If the examiner considered that the examination was difficult (due to a complex refraction, low vision, pathology, patient being illiterate or unable to communicate in Portuguese), an additional 15 minutes could be allowed. Examiners were to consider the difficulty of the patient in the marking of the student.

Theory exams

To cover the background knowledge required for the competent practice of refraction, two theory exams would be set, short-answer questions and a structured oral exam. Both exams would be double-marked using checklists. The overall pass mark for this was set at 50%, as stipulated by the university, backed by literature,⁵ and agreed upon by the focus group, with each section contributing equal weight.

- short-answer questions (SAQ) (one hour): This consisted of six case slides. Five of the patient cases had a color photograph of an ocular condition, and one comprised a binocular vision scenario in which the patient history and clinical data were presented. The student was examined on recognition (signs and symptoms), judgment (differential diagnosis and extra tests necessary), refraction management and decision-making skills (e.g., referral, low vision appliances) for the five cases with a photograph, and a diagnosis and treatment plan for the binocular vision case. The cases were standardized in terms of content (the elements of competencies and performance criteria assessed) and difficulty for both cohorts, taking into account the depth of coverage of a topic expected in the students' answers and the amount of time required to answer a question to the appropriate standard. Model answers were prepared ranking the importance of the different components using guidance from best practice tools in optometry, and graded using a checklist.^{10,23}
- structured oral exam (half hour): This consisted of an oral exam of three case studies from the students' portfolio: one low vision, one binocular vision and one pathology patient, and the management of their refractive error. A checklist with a set of questions was used to elicit the students' knowledge and rationale in the management of the topic under examination as well as the ability to communicate this knowledge. The checklist included the competencies to be assessed and was adapted from checklists used in optometry registration exams in the UK.²³

For both theory exams, each question/case was first marked independently out of 10 by two examiners and then averaged to give a final score. Students who passed both the theory and the clinical exam were deemed competent to refract.

TABLE 1
Results of Practical Clinical Competency Assessment

Technique / (weighting %)	Mean mark (SD) / total mark		p value	Total number of students demonstrating competency (n=15)	Number of students demonstrating competency	
	Cohort A	Cohort B			Cohort A (n=8)	Cohort B (n=7)
Communication / (4%)	4 (0) / 4	3.6 (0.6) / 4	0.08	15 (100%)	8 (100%)	8 (100%)
History and symptoms / (10%)	8.2 (1.9) / 10	7.5 (2.6) / 10	0.49	14 (93%)	8 (89%)	6 (100%)
Visual/visual acuity with aid Rx / (5%)	4.7 (0.7) / 5	4.6 (0.4) / 5	0.90	15 (100%)	9 (100%)	6 (100%)
Pupillary distance / (2%)	1.3 (1) / 2	2 (0) / 2	0.07	11 (73%)	5 (59%)	6 (100%)
Pupil responses / (2%)	1.8 (0.5) / 2	1.8 (0.6) / 2	0.84	13 (87%)	8 (89%)	5 (83%)
Cover test / (2%)	1.6 (0.6) / 2	1.8 (0.6) / 2	0.22	10 (67%)	6 (89%)	4 (87%)
Ocular motility / (2%)	1.8 (0.5) / 2	2 (0) / 2	0.24	14 (93%)	8 (89%)	6 (100%)
Near point of convergence / (2%)	1.2 (1) / 2	1.7 (0.6) / 2	0.14	9 (60%)	4 (44%)	5 (83%)
External exam / (5%)	4.2 (0.6) / 5	3 (2) / 5	0.19	10 (67%)	7 (79%)	3 (50%)
Retinoscopy / (10%)	6.6 (3) / 10	5.5 (3.6) / 10	0.30	9 (60%)	6 (87%)	3 (50%)
Sphere / (10%)	4.9 (2.6) / 10	5.8 (2.9) / 10	0.33	8 (60%)	3 (33%)	3 (50%)
Cross-cylinder / (10%)	2.6 (2.4) / 10	3.9 (2.8) / 10	0.17	4 (27%)	1 (11%)	3 (50%)
Binocular balance and near visual acuity / (10%)	1.2 (0.6) / 4	2.3 (1.3) / 4	0.02*	4 (27%)	1 (11%)	3 (50%)
Final prescription and auxiliary tests / (4%)	2.6 (1.6) / 4	2.4 (1.6) / 4	0.52	7 (27%)	4 (44%)	3 (50%)
Advice to patient / (4%)	2.4 (1) / 4	2.1 (1.6) / 4	0.88	5 (33%)	2 (22%)	3 (50%)
Ophthalmoscopy / (10%)	5.8 (2) / 10	4.7 (3.3) / 10	0.45	8 (60%)	3 (33%)	3 (50%)
Recording / (4%)	2.8 (0.9) / 4	2.2 (1.2) / 4	0.12	11 (73%)	7 (79%)	4 (87%)
Management and time keeping / (10%)	4.9 (2.6) / 10	4.4 (2) / 10	0.68	4 (27%)	1 (11%)	3 (50%)
Total score (100%)	62.6 (13.8)	61.7 (20.8)		4 (27%)	1 (11%)	3 (50%)

* Mann-Whitney U test
SD = standard deviation

Table 1: [Click to enlarge](#)

Qualitative observations of the competency assessment process

Qualitative observations of the competency assessment process were made by the examiners. These were used to provide information, regarding the results, to the university and the faculty. This would help identify factors affecting student performance that the quantitative assessment results would not provide. Feedback would be provided to the faculty enabling them to develop an understanding of the results from the clinical assessments of the optometry students. Faculty would have the opportunity to learn from this and improve teaching as a consequence.

Overall, the methodology should be appropriate to provide an assessment of optometry students' refraction knowledge, skills, behaviors, attitudes and values, undertaken in a clinical context of a complete eye examination. This would be a low-stakes assessment with the students' performance not affecting their overall university end-of-year result. Before the clinical assessments were carried out, all the students had a portfolio that documented their refraction competencies including retinoscopy, spherocylindrical refraction and binocular balance tests. The students were eligible for the final examination when they had: a) been signed off on the relevant competencies in their portfolio, and b) successfully completed multiple-choice questions in the five courses (clinical optometry, low vision, binocular vision, optometry and clinical medicine and occupational optometry) in their seventh (penultimate) semester.

Assessment Implementation: Methods

Subjects

All 15 students (nine from the first intake, cohort A in 2012, and six from the second, cohort B in 2013) who had progressed to the final semester in their fourth year were invited to participate in the study. The students read and signed a consent form for their inclusion in the study, and confidentiality of the results was maintained throughout.

Equipment

The research equipment used in the study comprised:

- visual acuity chart (3-meter phoropter chart with duochrome and cross-cylinder targets)
- streak retinoscope
- trial lens set and frames / phoropter
- cross cylinders $\pm 0.25\text{D}$ and $\pm 0.50\text{D}$
- $\pm 0.25\text{DS}$ and $\pm 0.50\text{DS}$ flippers
- torchlight
- cover stick
- slit lamp
- ophthalmoscope

Data analysis

Data were entered into an SPSS database (version 21) and analyzed for inter-rater agreement. Consistency between the students and the examiners was analyzed with Cohen's kappa statistic. Descriptive statistics were produced for the clinical competency assessments, and the difference in performance between the first and second cohort were analyzed using a Mann Whitney U test. A significance value of $p < 0.05$ was adopted throughout the analysis.

Refractive error analysis

Based on the literature of repeatability and reproducibility of refractive values, a variance of $\pm 0.75\text{D}$ sphere and cylinder was set as the limit of acceptability for retinoscopy and subjective refraction.²⁴

Examiners

The selection criteria for the external examiner were clinical and academic optometry experience, ability to communicate in Portuguese, familiarity of the health context and availability for placement in Mozambique. The researcher with 14 years clinical and public health experience in optometry and four years experience in the training and evaluation of pre-registration optometry students in the UK met the criteria to carry out the evaluations.

Four of the Unilúrio lecturers, two for each cohort, were recruited as internal optometrist examiners. Two were from Colombia and two from Spain. Two had completed their post-graduate studies, one in Spain and one in the UK. The internal examiners

had an average of 10 years clinical experience and four years teaching experience.

All examiners had knowledge of the methods used and were provided training by the program developers on the use of the standardized checklists along with the performance criteria and competency standards necessary for the students to exhibit entry-level competency in refraction on graduation. Two of the internal examiners assessed the practical competency, and two assessed the theoretical exam consisting of the SAQs and the oral exam (one for each cohort), along with the external examiner.

Assessment Implementation: Results

Clinical competency assessment

Thirty patients were examined (mean range 37.6 years; standard deviation 18.4 years; age range 7 to 72 years; 16 male [53%] and 14 female [47%]) by nine students from the first cohort and six students from the second cohort.

Fourteen patients had low refractive error (sphere within +/-0.75) and seven had best-corrected decimal visual acuity <0.4. Refraction results from the two graders were averaged. Inter-rater K value was >0.6 for all skills, showing a good strength of agreement between the two raters.²⁵ The only significant inter-cohort difference was in binocular balance and near visual acuity. **Table 1** summarizes the mean marks with the standard deviation for both cohorts for every technique, the inter-cohort difference and the total number of students passing every skill.

TABLE 2 Results of Theory Exam	
Mean mark (standard deviation)	Inter-rater Kappa
6.6 (1.8)	0.77
5.5(1.6)	0.74

Table 2: [Click to enlarge](#)

Theory exam

Table 2 demonstrates the number of students passing the two sections of the theory exam. The inter-rater agreement for the theory exam was >0.6, indicating good agreement.

Qualitative observations of clinical assessment

The examiners noticed certain factors in play during the assessments. Eleven students did not carry out binocular balance tests. For both retinoscopy and subjective refraction, there was a lack of clarity with the instructions, with poor fixation targets being presented. The students did not detect a retinoscopy reflex in any of the patients with high myopia. They could not control the subjective response of patients whose response pattern was poor. They took too much time on history and symptoms, which resulted in less time for refraction and other tests. Overall, 10 students did not relate patient symptoms to management.

Discussion

The aim of this study was to evaluate the design of a competency assessment process and gain an understanding of the effectiveness of the process for assessing clinical competency in refraction. Before the clinical assessments were carried out, all the students had a portfolio and had been ‘checked off’ for all the refraction competencies. However, from the results of these assessments, it appeared that the portfolio served to reflect the procedure being performed and audit skills acquisition rather than check on quality or even proficiency.

Overall, only four students passed the clinical competency assessment. As this was a low-stakes assessment there could have been a lack of motivation to perform well on the part of the students. The qualitative observations identified some of the factors that led to the students failing. These were communicated to the lecturers in a feedback session. This input to the faculty, isolated in a developing country context, has enabled them to learn how to refine student training.

There are several factors that need to be considered in assessing the implications of this study: the lack of standardization of patients; the methodology of direct observation of real clinic patients; the use of SAQs and an oral exam; the increasing importance of using OSCEs; the setting of competency standards and the training and recruitment of examiners. These are all discussed below.

Seven students saw patients with severe, untreated pathology and complex refractive errors. The mix of patients being tested and the complexity of skills being assessed can result in a lack of reliability. SPs are people who are simulating real patients with defined criteria to provide students with consistent and equivalent assessment experiences.^{26,27} Overall, the high costs of training and expertise to ensure reproducibility and consistency of scenarios could not be justified in the context of student assessment in Mozambique.⁶ The recommendation is to integrate a degree of standardization for future student assessment. A

focus group discussion by the faculty to set the criteria for standardization is proposed. The criteria could include patient age, range of refractive error (if complex then every student should get a complex case), best-corrected visual acuity, past experience of optometric exam, absence or presence of pathology, and ability to communicate in Portuguese. This will facilitate the selection of patients that meet defined criteria, by faculty, for competency assessments without incurring an increase in cost and ensure that the marks on the assessment correlate well with the assessments of the students over their entire program.

The methodology of direct observation of real clinic patients is increasingly challenged on the grounds of authenticity and unreliability due to examiner and patient variance.⁶ Inter-rater reliability measures the consistency of rating of performance by different examiners.⁶ The use of two trained raters, for every practical and theoretical exam, with good inter-rater agreement (kappa greater than 0.6) helped to increase consistency.²⁵ Providing the examiners with a standardized checklist increased the reliability of direct observation, and this has been shown to be as reliable as an OSCE.²⁶ A 'Hawthorne' effect occurs when a student or practitioner behaves differently because they are being observed. This effect can have a positive impact on student performance;¹² however, the effect is inevitable with any methodology involving direct observation.¹²

Students were familiar with the test formats employed for the theory exams. SAQs were designed to assess problem-solving and data-interpretation skills when faced with common clinical management problems. The oral exam was based on the students' case records, and examined the knowledge, values and attitudes that informed the students' management of the patients. The issue of reliability and validity in this study was addressed by using two trained raters with good inter-rater agreement and checklists for both exams. The exams were mapped to the elements of competencies and performance criteria and the level of difficulty expected to be mastered by the student specified.

As a potential solution to the concerns of reliability and validity of the other assessment methods, the OSCE has gained increasing importance in the assessment of clinical competency in medicine and optometry in the UK and US.^{10,11,28,29} Wide sampling of cases and structured assessment improve reliability, but the OSCE is expensive and labor-intensive.^{4,6} In Mozambique, due to the lack of SPs and expertise among the faculty to implement and grade OSCEs, they were not considered a feasible assessment method for a new program in a low resource environment. In addition, students were not familiar with the format of OSCEs. Direct expenses of an OSCE include the cost of training standardized patients, examiners, support staff, development of scoring tools and venue costs dependent on the number of stations. However, these costs can be reduced by the use of volunteer faculty, volunteer patients and students as raters.²¹ Further research is required on the cost of implementing the OSCE (materials, examiners and patients or patient simulators) and the reliability and validity offered compared with the other methods, specifically in a low resource environment.

In this study, the setting of competency standards was stipulated by the university, backed by a literature review and agreed upon by the focus group (75% clinical and 50% theory).^{5,10} Absolute standards that are criterion referenced are most appropriate for tests of competence.³⁰ In this case, the exams for the two cohorts were not identical as they contained different patients and cases. Hence, percentage scores did not reflect the same level of knowledge. In the long run, a more systematic, transparent approach to standard-setting and pass-fail criteria, supported by a body of published research, needs to be adopted. This involves evaluating the content and difficulty of the examination.³⁰ Standards should be consistent with the purpose of the test and based on expert judgement informed by data about examinee performance.³⁰

The examiners were all experienced and competent optometrists. The use of multiple examiners is a means that has been shown to enhance reliability.⁶ The examiners were all given explicit criteria and training in the use of checklists, performance criteria and competency standards based on good practice.⁵ The ideal proposed for an exit assessment is a group of external assessors, accredited for suitability by a professional body of optometrists, trained at the required level with experience in competency teaching and assessment.³¹ They should all be competent in the area they are to assess and familiar with the competency standards. The selection of examiners in Mozambique will evolve over time as more students graduate, a professional body is formed and accreditation to become an assessor offered.

There are certain limitations to the study of assessment methodology. Our sample of 15 students was small but represented 100% of the final-year optometry students. The study concentrated only on refraction because the spectacle supply system at the university had not been established and access to contact lenses is limited. Intraocular pressures were not assessed as this assessment was concentrating on refraction error management competence. However, this assessment methodology could be expanded to include the additional elements in a more comprehensive "suitability to practice" exit competency assessment.

Conclusion

As optometry continues to move towards competency-based curricula, educators require appropriate tools to support the assessment of competencies. The use of existing checklists and rating skills helped to identify areas of competence deficits.

Overall, the methodology of direct observation, SAQs and an oral structured exam has shown good inter-rater reliability with the use of these standardized checklists. The main recommendations are the provision of clear guidelines to faculty for the standardization of patients during exams for the assessment to be reliable and repeatable, and increasing assessor training. More data on the use of OSCEs and standard-setting to ensure case specificity and increase validity are required for this methodology to be adapted for use in optometry schools with similar academic resource limitations.

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2nd World Congress of Optometry

Features Educators' Track

| Optometric Education: Volume 42 Number 2 (Winter-Spring 2017)

The 2nd World Congress of Optometry will be held in Hyderabad, India, Sept. 11-13, 2017. Focused on the theme of "Accessible, Quality Vision and Eye Health," this year's biennial congress offers optometrists, vision scientists, educators, researchers, students and other visual health professionals a wide-ranging program including lectures and workshops in a variety of areas such as ocular disease, binocular vision, glaucoma, low vision and contact lenses.

Courses offered at the congress will be organized around two principal tracks, a Scientific track and an Educators' track, and will be COPE-approved. The Educators' track includes lectures, workshops, symposia and poster presentations designed to maximize the opportunity to advance the optometric education agenda across the world and through that support the sustainable development of highly needed human resources.

The 2107 congress is a World Council of Optometry initiative in partnership with its members the Asia Pacific Council of Optometry and the India Vision Institute. Read more about the 2nd World Congress of Optometry, including [how to submit abstracts](#) for oral and poster presentations, [online](#). [Click here](#) to register.

Do Students Still Need to be Proficient in Gathering Data?

Aurora Denial, OD, FAAO | Optometric Education: Volume 42 Number 2 (Winter-Spring 2017)

Recently a student assigned to my clinical site commented that retinoscopy and keratometry were useless techniques to master. I was appalled and asked the student to explain the statement. The student said that in previous clinical experiences an autorefractor/keratometer was utilized to obtain a starting point for refraction, and that in the future most potential work environments would also use an autorefractor/keratometer. Although still appalled that a student would question the importance of mastering techniques foundational to our profession, I wondered what it might tell us about preparing our students to practice in today's world.



Aurora Denial, OD, FAAO

The Power of Technology

Over the past several decades, there have been significant advances in the sophistication and quantity of technology available to optometrists. New instruments and technology are sought after to provide better patient care, increase productivity and provide a state-of-the-art experience for patients. According to a survey conducted by *Review of Optometry* in 2014, the technologies most wanted and recently purchased by optometrists were: automated phoropter, optical coherence tomograph, electronic health records system, digital anterior and fundus cameras, tear film osmolality test, corneal topographer, pachymeter, wide-field scanning laser ophthalmoscope, and patient recall system.¹ Most of these instruments allow for data to be easily and accurately gathered by technicians. The ancillary use of technicians in optometry is not new. However, the combined use of technology and technicians frees the optometrist from spending valuable time gathering data. The practitioner can utilize chair time to refine data and talk with patients.

In a more futuristic scenario, patients may be able to gather data on their own. There are currently 50,000 medical apps that allow patients to do so.² In the novel *Cell*, written by physician and best-selling author Robin Cook, a phone app, "iDoc," is poised to replace the primary care physician.² In 2014, Cook told a symposium that a virtual doctor can gather data and "sift through billions of studies and records to make a diagnosis and offer a solution."² In optometry, we are seeing the availability of online eye examinations.

Should Data-Gathering No Longer Be the Primary Focus?

All optometric curricula include courses in clinical methods and techniques. These courses teach skills that allow future optometrists to gather data. The courses usually reflect a significant amount of credit hours and time commitment from students. Most courses have a clinical skills exam or proficiency that insures that students are able to gather data in an accurate and efficient manner. Currently, this is important because students have to pass the entry-level competency exams administered by the National Board of Examiners in Optometry (NBEO) to qualify for licensure. However, if academic curricula changed, would the NBEO follow? Additionally, the argument could be made that certain populations and environments will always demand the need for proficiency in specific data-gathering techniques.

Is data-gathering by the optometrist foundational to our profession and needed to accurately and reliably assess the data? How proficient do students have to be in data-gathering when technology and instrumentation that allow for efficient data collection may be readily available? Do they still need to be proficient in using the binocular indirect ophthalmoscope when they can obtain a wide-field scanning laser ophthalmoscope image? Do students still need to be proficient in retinoscopy? In 2011, ASCO reported that the schools and colleges of optometry "shall ensure that before graduation each student will have demonstrated all the skills required for the diagnosis, triage, management and/or treatment of common visual conditions."³ Can this goal be met by focusing on the analysis of data along with the diagnosis and management of conditions and leave the data-gathering to instruments, technicians and technology? Most first- and second-year optometry program courses focus on technique and data-gathering, but do we need to change the culture of learning in optometry school and shift our focus away from data-gathering?

I often tell my students, "Throughout your careers you will be in awe of new instrumentation, medications and technology, but in the end your mind and ability to think will be the best skill you can bring to your patients." My message reflects the

perception of an optometrist who relies on thinking skills, such as analyzing data, interpreting information, forming conclusions and implementing plans, rather than an optometrist who focuses on data-gathering. I have to ask myself: Why was I initially distraught by the student who discounted retinoscopy as an essential technique? As educators, should we reflect and consider that we are subconsciously hanging on to the role of the optometrist of the past instead of looking into the future?

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Industry News

| Optometric Education: Volume 42 Number 2 (Winter-Spring 2017)

Management of Intermittent Exotropia of the Divergence Excess Type: a Teaching Case Report

Gayathri Srinivasan OD, MS, FAAO | Optometric Education: Volume 42 Number 2 (Winter-Spring 2017)

Background

Intermittent exotropia (IXT) is the most common form of childhood exotropia^{1,2} with an incidence of 32.1 per 100,000 in children under 19 years of age.¹ The strabismus is characterized by an exodeviation of one eye that is interspersed with periods of ocular alignment.³ Reliable measurement of the deviation is often hindered by the variable nature of the strabismus,³ and without careful observation and evaluation IXT can often be missed. Divergence excess (DE) is a type of IXT that is characterized by a larger magnitude exodeviation (phoria or intermittent or constant exotropia) at distance than at near. This report is of a 5-year-old patient with IXT of the divergence excess type managed by overminus therapy. Discussion includes classification of IXT, important clinical findings, diagnostic considerations and management with an emphasis on overminus therapy. The case report is intended for third- and fourth-year optometry students.

Student Discussion Guide

Case description

Patient JT, a 5-year-old African American male presented for his first eye exam following a referral by his pediatrician for a noticeable eye turn. His foster mother of seven months reported that his left eye moved out sometimes during the day. She was unsure if she noticed an eye turn in the right eye and was unable to provide details on the duration, time and severity of the eye turn. She also reported that JT watches TV at a close distance and holds books close to his face. Past ocular history and birth history were unknown. Family ocular history was significant for accommodative esotropia in his biological sister. JT's medical history was significant for asthma and he was using Albuterol (90 mcg inhaler) as needed. He did not have any medical or seasonal allergies. JT was enrolled in preschool and was reported to have a disinterest in reading in school.

Visit 1 (in the order tested)

Entering unaided Snellen visual acuities were 20/20 in the right and left eye at distance and near. Extra-ocular movements were full in each eye. Pupils were round and reactive to light and accommodation. Screening for color vision with the HRR test showed no defect. Stereopsis with Random Dot 2 at near was 100 arc seconds (section c of the test). External observation showed an intermittent left exotropia at distance, manifesting <50% of the time during a 10-second observation. Cover test at distance (20 ft.) revealed an intermittent alternating exotropia and an exophoria at near (16"). Initial prism and alternate cover test (PACT) revealed 16 prism diopters (pd) of exodeviation at distance (20 ft.) and 10 pd of exodeviation at near (40 cm). Average distance deviation after three consecutive measurements was 12 pd at distance and 10 pd at near. Worth Four Dot test revealed fusional response at distance and near. Dry retinoscopy was +0.50 sph in the right eye and plano in the left eye. Anterior ocular health was unremarkable and intraocular pressures measured digitally were soft and equal to touch in both eyes. Dilation was performed using two drops of 1% cyclopentolate hydrochloride instilled 5 minutes apart. Cycloplegic retinoscopy revealed +0.75-0.50×180 in the right eye and +0.75 sph in the left eye. Dilated fundus exam revealed a cup to disc ratio of 0.35 in each eye with normal retinal peripheral retinae OU. The hyperopia was minimal; the patient did not report any visual discomfort; and the chief concern was the eye turn. Correction of minimal hyperopia is less likely to treat the eye turn; therefore, glasses were not prescribed. The foster parent was educated about findings, and a follow-up visit was scheduled in 2 weeks for IXT evaluation. A summary of all visits is listed in **Table 1**.

Visit 2

An extended IXT evaluation was performed to determine the quality of control and to quantify control. IXT was quantified using the Mayo scale⁵ as follows: exotropia was manifest <50% of the time during a 30-second observation period (score 3). Snellen visual acuities were 20/20 in each eye at distance and near. Stereopsis with Random Dot 2 was 100 arc seconds at near (16", section c of the test). Worth Four Dot showed fusion at distance and near.

JT's mother reported full compliance with glasses wear and denied noticing eye turn with glasses. JT reported no asthenopia, headaches or blurred vision with glasses. IXT control was determined to be 2 using the Mayo scale⁵ (stable since previous visit). Snellen acuity at distance and near with correction were 20/20 in each eye. Stereopsis was 100 seconds of arc (section c of the test plate) and local stereopsis was 50 seconds of arc with Random Dot 2. Unilateral cover test revealed exophoria at distance (20 ft.) and near (16"). Worth Four Dot test showed fusion at distance and near with correction. PACT measured 8 pd exodeviation at distance and near. JT was instructed to continue full-time wear and a 6-month follow-up visit was recommended.

Education Guidelines

Learning objectives

1. To describe the natural history of IXT
2. To describe the common signs and symptoms of IXT
3. To differentiate the types of IXT
4. To summarize the diagnostic tests and their role in accurate diagnosis of IXT
5. To be aware of the various treatment options for IXT
6. To describe the advantages and disadvantages of each treatment type

Key concepts

1. Understand the role of accommodation and vergence in distance/near differences in magnitude of IXT
2. Order of testing in the diagnosis of DE
3. Understand the rationale of each treatment type
4. Recognize when and how to treat
5. Understand the importance of follow-up care in patients with IXT

Discussion questions

1. What is the prevalence and etiology of IXT?
2. What are the common presenting symptoms and how is IXT classified?
3. What is the natural course of IXT?
4. Why are some patients symptomatic and others not?
5. What are the methods of quantifying IXT?
6. What are the components of the binocular vision exam in patients with IXT?
7. What are the factors to be considered when choosing an appropriate treatment?
8. What are the various conservative methods of management of IXT?
9. How successful is each treatment option?

Discussion

Background

To facilitate discussion of exam results, students should first be familiar with the definition, prevalence and etiology of IXT. IXT is the most common form of childhood exotropia^{1,2} with an incidence of 32.1 per 100,000 in children under 19 years of age.¹ Onset of the deviation is believed to be in the first few years of life¹⁰ with a female preponderance.¹¹ Patients with IXT typically have normal ocular alignment and sensory fusion during the phoric phase interrupted by periods of ocular misalignment with suppression or anomalous fusion or a combination of the two during the tropic phase.⁴ Although common, the natural history of IXT remains unclear.¹¹⁻¹⁴ In addition, reliable measurement of the deviation is hindered by the variable nature of the strabismus.¹⁵ Without careful observation and evaluation, IXT can often be missed.

Burian classified intermittent exotropia into three types: basic exotropia (BE), DE, and convergence insufficiency (CI).¹⁶ In basic exotropia, the distance deviation is within 10 pd of the near deviation. In DE, the distance deviation is greater than near by 10 pd. DE can be further classified into true vs. simulated divergence excess. In true divergence excess, the near deviation remains less than the distance deviation after a brief period of occlusion. In simulated divergence excess, however, the near deviation approaches distance deviation after occlusion. In CI type IXT, the near deviation is greater than distance by 10 pd (**Table 3**). The difference in magnitude should be taken as a guideline. Clinicians should also look at the proportion of time the deviation occurs and the characteristic of deviation at distance and near to appropriately classify the condition.⁴ This is particularly true in DE, where the larger exodeviation at distance “can either be a phoria, an intermittent exotropia or a constant exotropia.”⁴ Therefore, in JT’s case, even though the difference in magnitude of deviation was <10 pd between distance and near, the exodeviation was an intermittent tropia at distance and a large phoria at near. This qualifies JT’s condition as DE. Appropriate classification is important for making an accurate diagnosis and initiating appropriate treatment and follow-up. For example, vision therapy for basic exophoria (a normal AC/A ratio condition) is modeled differently from therapy for divergence excess (high AC/A ratio) or CI related IXT (low AC/A ratio).

TABLE 3
Classification of Intermittent

	Characteristics at Distance and Near
	D=N (within 10 pd)
	D>N by 10 pd or more
CI)	N>D by 10 pd or more

Table 3: [Click to enlarge](#)

It has been widely believed that a high AC/A ratio plays a major role in distance near discrepancy in divergence excess.^{17, 18} Kushner showed that tenacious proximal fusion (TPF) in addition to AC/A ratio plays a role in distance/near discrepancy.⁹ It is commonly believed that DE is a high AC/A ratio condition;⁴ however, previous studies, such as Cooper et al.¹⁹ (4.5:1-8.0:1) and Von Noorden²⁰ (3.3:1-9.0:1), have shown a wide range of gradient AC/A ratios in patients with DE. It has also been shown that calculated AC/A ratios are generally higher in patients with DE.²¹ It is recommended both calculated and gradient AC/A ratios be evaluated in patients with divergence excess to sequence an appropriate treatment approach.⁴ CI type IXT is caused by reduced positive fusional vergence (PFV). However in some cases, CI can be simulated by an underlying accommodative insufficiency (pseudo convergence insufficiency).⁴ In these cases, reduced accommodative convergence places a greater demand on PFV resulting in a CI diagnosis.

Because not all patients with IXT are symptomatic, students should understand the natural course of IXT in order to identify who needs treatment and when. Several studies have evaluated the change in angle of deviation (3-20 year follow-up) with conflicting results. One retrospective study found a low rate of spontaneous resolution (3.9%) during 9-year follow-up in children younger than 19 years of age.²² In contrast, other studies have shown no deterioration of IXT when patients were followed for ≥10 years.^{12, 14} A majority of these studies are observational, not prospective or population-based, and have small sample sizes. A randomized controlled trial recently has been completed that compared the effect of two commonly prescribed treatment options on the natural history of IXT.²³ The results of this study might be helpful to the clinician in deciding the right treatment approach.

Diagnosis and treatment of IXT begins with a thorough history. Pertinent history questions for an eye turn include laterality of eye turn (left eye vs. right eye vs. both), frequency (constant vs. intermittent), directionality (esodeviation/exodeviation/hyper/hypo deviation), and onset of deviation (sudden vs. gradual). Knowing the frequency of deviation is important in assessing the quality of control. Asking the parents or patient “how often do you notice the eye turn?” is a way of understanding frequency of eye turn at home. Associated symptoms include diplopia, head turn/tilt, photophobia and eye closure. Additional information about recent history of trauma, surgery or illness can be helpful. Several factors, including compensatory vergence, AC/A ratio and inattention, can contribute to symptoms. DE accounts for 25% of all intermittent exotropias,²⁵ the common symptoms of which include noticeable eye turn during periods of inattention, photophobia and monocular eye closure.^{24, 25} Other symptoms of IXT could include headaches, eyestrain, loss of place when reading, and loss of focus while reading (more commonly reported in CI).²⁴ Exam findings in intermittent exotropia typically reveal normal visual acuities at distance and near, good stereopsis at near (during phoric phase), no diplopia, suppression or anomalous correspondence or combination of latter two.⁴ About 25% of DE patients show covariation,²⁵ i.e., anomalous correspondence during the tropic phase and normal correspondence during phoric phase. To eliminate diplopia, patients with divergence excess commonly develop suppression or anomalous correspondence or a combination of the two.⁴ JT’s fusional response during Worth Four Dot testing could be interpreted in the following ways: True fusion experienced during the phoric phase or anomalous fusion during the tropic phase. Evidence of fusion in the presence of a manifest deviation is indicative of anomalous correspondence. Since in JT’s case anomalous correspondence was not ruled out, it is unclear if JT’s fusional response with Worth Four Dot test represents a true fusion or anomalous fusion. Assessment of the status of correspondence is important for sequentially planning orthoptic therapy.⁴

A higher prevalence of myopia and anisometropia has been noted in patients with DE compared to the normal population.²⁵ Accurate measurement of the deviation at distance and near as well as in different settings (described below) is important for

monitoring progression. Students should consider several factors before choosing whether the appropriate treatment is non-surgical or surgical. These include symptoms, differences in magnitude at distance and near, proportion of time the deviation is manifest, and quality of control, as they often relate to the magnitude of the patient's symptoms. Proportion of time the deviation is manifest is as important as the magnitude of deviation as it gives information about the "quality" of control.

Diagnostic considerations for DE

Once the presence of strabismus is established through cover test, the magnitude of the deviation at distance and near can be measured using prism cover test. Cover test plays a very important role in accurate diagnosis and classification of IXT. It is important to use appropriate targets for distance and near fixation and appropriate refractive correction while testing. The student clinician should also be familiar with components of a cover test and what they identify. The results of cover test in IXT can vary from a small-large phoria at distance and/or near to a exotropia at distance and/or near between visits or even within visits. This can understandably be confusing. Useful modifications and additional techniques for performing cover test to accurately diagnose and classify DE type IXT are:

- In patients with suspected DE, cover test at distance and near should be performed using prolonged occlusion (10-15 seconds) during cover-uncover and alternate cover test to reduce the effect of tonic fusional convergence.^{26, 27}
- Far distance cover test refers to a technique in which the distance cover test is performed by having the patient fixate on a target well beyond 20 ft., as this would suspend the effect of tonic fusional convergence.⁶ An indication to do this test would be patient/parent reporting of eye turn at distance or during inattention while cover test findings during the exam are unremarkable. In many DE patients, typical exam room length (10 ft. or less) may not be distant enough to eliminate/reduce the effects of fusional vergence.⁶ Hence, a truly distant target (20 ft. or farther) is used to evaluate strabismus at distance. This test is very effective in identifying patients with DE, in whom it may be recalled that the distance XT is greater than near. A combination of far distance test and patch test has been shown to significantly reduce surgical under-corrections.²⁷
- In addition, the deviation is measured after 30-60 min. (shown to be sufficient time to unmask full deviation) of monocular patching to further reduce the effect of tonic fusional convergence.^{7, 8} This procedure is called the patch test. If the deviation at near equals distance after the patch test, the patient has simulated divergence excess with high AC/A ratio or fusional convergence or mixed mechanism as the underlying cause of this discrepancy. Kushner recommends patch testing in all intermittent exotropes in whom distance deviation exceeds near deviation.⁹ It is crucial to occlude the patched eye prior to removing the patch to eliminate even brief periods of fusion. A +3.00 near add test can also be employed only after monocular occlusion if high AC/A ratio is suspected.⁹ The diagnosis of true vs. simulated divergence excess is of surgical importance and its relevance in vision therapy has been questioned with the same therapy program suggested for both types.⁴

Variability in measurements between, and even within, visits often poses a challenge in accurately diagnosing IXT. Although IXT has been reported to worsen at the end of the day, a recent small-scale study showed less variability during the day. Studies have also shown that assessment of control "at a single point in time" has been shown to not truly characterize control.¹⁵ Multiple measurements within the hour or over the course of the day (with an average score) may be necessary to reliably describe control.¹⁵ As listed in **Table 1**, with JT, multiple measurements of the deviation were performed on two separate visits to establish overall control. Doing so enables the clinician to obtain reliable measurements and reduce variability. Until recently, there have been no quantitative methods to assess "control" in clinic. Quantitative grading of IXT is helpful in monitoring progress or deterioration over time by using standard repeatable set of measures.

Quantifying control

Two quantitative scoring methods are the Newcastle Control Score²⁸ and the Mayo scale.⁵ The Newcastle Control Score uses an ordinal scale to grade clinic (objective scale) and home (subjective scale) control of IXT and has been shown to be repeatable and reliable, although the subjective scale relies on parental observation of deviation.²⁸ Mohney and Holmes developed an objective control scale to quantify the IXT at distance and near by grading phoria and tropia as well as recovery time defined as the time taken to re-establish fusion after dissociation.⁵

Intermittent exotropia control scale (Mayo scale):⁵

5 = Constant exotropia

4 = Exotropia >50% of the exam before dissociation

3 = Exotropia <50% of the exam before dissociation

2 = No exotropia unless dissociated, recovers in >5 seconds

1 = No exotropia unless dissociated, recovers in 1-5 seconds

0 = No exotropia unless dissociated, recovers in <1 second (phoria)

Total score is the sum of scores at distance and near. Levels 0-2 are graded as the worst of three consecutive measurements. Levels 3-5 are graded after an initial 30-sec. observation period and repeated at near.

Treatment of IXT

Even though IXT is the most common form of childhood exotropia, controversy exists with regard to timing and method of treatment (**Table 4 and Table 5**). Non-surgical interventions include:

1. Observation
2. Patching
3. Overminus lens therapy
4. Prisms
5. Vision therapy

It is not uncommon for clinicians to consider multiple treatments on the same patient, e.g., overminus therapy combined with vision therapy, or vision therapy prior to or after surgery. Few studies have reported on the efficacy of these treatment approaches. There is a lack of randomized controlled trials comparing treatment efficacy.^{29,30} The effectiveness of individual treatments supported by evidence is discussed below. Students and clinicians are encouraged to contemplate the advantages and disadvantages of each treatment option.

Correction of refractive error

Correction of the underlying refractive error is the initial step towards management of IXT.³¹ Providing clear retinal images may promote fusion and lead to a reduction or elimination of the deviation in some cases. Full correction of myopia, astigmatism and anisometropia has been recommended with the correction of hyperopia requiring special consideration of the degree of hyperopia.³¹ In young patients, moderate to high hyperopia can be under-corrected, while in older patients this may lead to added demand on accommodation.³² Age of the patient, symptoms, magnitude of IXT at distance and near, magnitude of hyperopia, accommodative amplitude and AC/A ratio are important factors to consider before prescribing for hyperopia.

Observation

The clinical course of IXT remains unclear with past studies reporting either improvement³³ or no improvement over time.³⁴ In addition, choosing the optimal treatment can be tricky when a patient has no symptoms or concerns. How does the clinician decide which patient to treat and which patient to monitor and closely follow? Is it sufficient to just monitor a patient without symptoms or other concerns? A recent multicenter randomized trial studied the effect of two commonly used treatment choices: observation vs. part-time patching (3 hours per day for 5 months) in children from 3 to <11 years of age with previously untreated IXT.³⁵ At 6-month follow-up, patients randomized to observation showed no significant worsening of IXT compared to the patching group. This is the first prospective randomized trial comparing treatments for patients with IXT, and the results indicate that observation alone could be a reasonable approach for some patients. Patient symptoms (cosmesis or functional) are a major deciding factor. If the magnitude of deviation remains stable and well-controlled over a few visits without patient/parental functional and or cosmetic concerns with good stereopsis at near, the patient can be monitored closely.

Patching

Monocular patching of the preferred eye or alternate patching has often been utilized as a method to delay surgery³ in the treatment the IXT with the goal of eliminating suppression, decreasing the magnitude of deviation, or changing the character of the deviation.³ Treatment duration varies from part-time (from 1 hour to several waking hours per day) to full-time patching. Although patching has been advocated as an economical, low-risk treatment, it can cause social stress.³⁴ A recent randomized clinical trial in young children (12-35 months of age) showed no evidence of deterioration during a 6-month follow-up with or without part-time patching.³⁶ Another study, in older children (3 to <11 years of age), reported that the deterioration rate of

TABLE 4 Intermittent Exotropia Treatment Options	
	Consider age, symptoms, quality and magnitude of deviation
Refractive error	- Correct full myopia, astigmatism, anisometropia - Can undercorrect hyperopia in young patients
Overminus therapy	Minimal minus (1-3D) needed to maintain alignment
Patching	Full correction (neutralizing prism) or partial correction (prism) that balances the fusional vergence amplitude
Patching	Consider age, symptoms, quality and magnitude of deviation Part-time for amblyopia or suppression
Vision therapy	Equalize monocular skills (accommodation and occlusion) Train gross convergence, anti-suppression skills, fine convergence
	Long-term follow up is important

Table 4: [Click to enlarge](#)

TABLE 5 Treatment Options by Type of Intermittent Exotropia	
Primary Treatment	
Vision therapy	
Vision therapy	
Vision therapy	

Wong, 2014⁴

Table 5: [Click to enlarge](#)

IXT was only slightly lower (statistically not significant) in the patching group (3 hours per day for 5 months) compared to observation during a 6-month follow-up.³⁵ Although patching is commonly prescribed in young children,³³ results of this study suggest that this treatment may be just as effective as no treatment (i.e., observation) if only slightly better. When considering this option, it is important to think about the benefits (non-surgical) vs. the burden for the patient (compliance, adverse effects, social stress, etc.).

Overminus therapy

This treatment method involves prescription of intentionally overminus spectacles to improve control of IXT. The main objective of overminus therapy is to induce convergence. Conventional theory suggests that accommodative convergence (blur-induced accommodation that drives convergence via high AC/A ratio) plays a crucial role in control of the deviation at near (particularly in DE).^{17,18} However, there is evidence that the amount of convergence needed to control the deviation at near causes over-accommodation (CA/C ratio) leading to reduced deviation at near.^{37,38} That is, the control of exodeviation at near might be convergence-driven rather than accommodation-driven. This alternate explanation might explain why some patients benefit from overminus therapy, which likely reduces the blur caused by excessive accommodation (driven by convergence, CA/C ratio) rather than inducing accommodation, which in turn stimulates convergence (high AC/A ratio). In clinic, AC/A ratios are generally more frequently measured compared to CA/C ratios because there are no accepted ways of measurement.⁴

Common concerns with minus lens therapy include the dose of overminus prescribed, duration of treatment and the possible adverse effects. Past studies have shown use of a wide range of treatment doses from 0.5D³⁹ to 5.00D⁴⁰ with a range of success rates from 12%-72%⁴¹⁻⁴² (pooled success rate of 28%³⁰) for overminus therapy. Limitations of these studies include poor study design and poorly defined treatment and success criteria. Nevertheless, a survey reported that 32% of pediatric ophthalmologists in the United States and Canada who routinely used some form of non-surgical approach used overminus therapy in the treatment of IXT.⁴³ Overminus therapy can be used as a temporary treatment to aid fusion in DE or BE. In CI, since patients have reduced base out vergence ranges, overminus therapy is not indicated.

Using the patient's cycloplegic retinoscopy and adding the predetermined amount of overminus to the cycloplegic refraction is one approach to determining the prescription of overminus lenses. For example, if the cycloplegic refraction is +0.50 in each eye, using a -2.00 sph overminus would result in a final prescription of -1.50 sph OU. Some clinicians use a predetermined overminus regardless of cycloplegic refraction. For example, it may be a practitioner's preference to prescribe a -2.00 overminus prescription for any IXT patient regardless of the refractive error or the accommodative status. Generally speaking, the minimum amount of added minus, a lens that minimizes the deviation while maintaining clear single binocular vision, is prescribed.⁴ Prescription of small magnitude minus lenses (-1.00D to 2.00D) for full-time wear could be considered in children younger than 6 years of age to reduce the frequency of IXT.⁴ In older children who have higher accommodative demands at near, a bifocal or progressive is indicated to reduce asthenopia when reading.⁴ Other factors to consider when determining magnitude of overminus spectacles include AC/A ratio, frequency and magnitude of IXT, vergence ranges at near, and accommodative amplitude. Generally, children with a high AC/A ratio respond well to minus lenses because the added minus may provide clear single binocular vision.⁴

While there is no standard approach for determining the magnitude of overminus, it is important to consider the patient's accommodative status (amplitude of accommodation, dynamic retinoscopy and AC/A ratio), distance and near acuity with overminus lenses, fusional status and refractive status before finalizing the prescription. Ideally, the smallest prescription that provides functional visual acuity at distance and near, fusion at distance and near and acceptable improvement in ocular alignment should be prescribed. A commonly asked question about overminus therapy is whether it induces myopia. A retrospective study showed a statistically non-significant shift in myopia five years after initiation of overminus treatment.⁴⁴ Regardless, periodic follow-up and care is essential to ensure a given overminus lens is prescribed after careful consideration of the patient's refractive error and the visual demands. Overminus therapy can be considered as a viable primary treatment approach for patients with small angle IXT who are symptomatic and not keen on vision therapy or preschool children who may have difficulty with vision therapy. Overminus therapy can also be used in combination with vision therapy in older children or as a temporary treatment while a patient awaits surgery. Large-scale randomized controlled trials with well-defined treatment and success criteria are required to evaluate the optimal dose, duration and efficacy of this treatment.

Vision therapy

The main goals of VT for the treatment of IXT are to promote sensory fusion by eliminating diplopia or suppression and to improve vergence reserves in order to restore normal binocular vision. A combination of anti-suppression therapy and accommodation and vergence therapy is recommended.⁴ First, any significant refractive error should be corrected, and amblyopia (although rare) if present should be treated.³⁰ Actual therapy can then follow, first to equalize monocular skills (i.e., accommodation and eye movements). Therapy is then focused on vergence skills by improving fusional vergence ability and

vergence facility at near for CI and at far, intermediate and near for BE and DE. Diplopia awareness and anti-suppression training is a crucial part of therapy in patients with DE and BE type IXTs. In-office therapy can be scheduled every week or every two weeks (depending on the patient's availability) with home reinforcement between appointments. Completion and successful treatment takes several sessions, typically 12-24 sessions for CI and 24-36 sessions for DE.⁴

Vision therapy is generally successful in improving symptoms and restoring binocular vision in IXT.³⁰ Its effectiveness in treating CI has been well-established in children⁴⁵ and adults.⁴⁶ Coffey et al. reviewed previous studies that evaluated the efficacy of VT in IXT and showed that the pooled success rate of VT (59%) is "essentially identical" to the success rate of surgery (61%) and has the highest success rate compared to all other non-surgical approaches for IXT.³⁰ An effective therapy program in addition to patient motivation and commitment plays a crucial role in achieving success. Some disadvantages of VT include treatment duration, time commitment (office appointments and home exercises) and cost. A commonly posed question about vision therapy is how long the effects last. A recent multicenter study showed the effects of vision therapy for CI lasted up to a year after discontinuation of treatment in children age 9-17 years.⁴⁷ Pre-therapy patient education about compliance, time commitment and long-term effects is crucial for success. VT can be implemented as the preferred therapy before surgery or after other unsuccessful non-surgical treatments or used in combination with other non-surgical options before or after IXT surgery. For example, overminus lenses (usually -4.00D or -5.00D) are sometimes prescribed as "training lenses" for patients in an active VT program for IXT to stimulate accommodative convergence.

In general, VT has not been recommended for children younger than 6 years due to barriers in understanding therapy concepts and verbalizing feedback.⁴ In older children and adults it could produce successful results. In summary, VT could be applied successfully to improve IXT control with motivation, commitment and compliance.

Prism therapy

Prescription of prisms for patients with IXT has varied purposes. Several types can be prescribed. A neutralizing prism reflects the exact magnitude of the deviation and is prescribed for full-time wear. In contrast, a relieving prism corrects a portion of the deviation, resulting in reduced fusional vergence demand, hence its name. Lastly, though rarely used, an over-correcting prism, as the name implies, over-corrects the exodeviation. The idea is that the resulting diplopia from the induced over-correction will stimulate fusional convergence. Relieving prisms and VT can be used successfully in combination. A review of past studies evaluating the efficacy of prism therapy for IXT reported a pooled success rate of 28%.³⁰ Before prescribing prisms for IXT patients, the cost of prism glasses, cosmesis (in particular for Fresnel prisms) and prism adaptation should be considered. Because other non-surgical options (VT in particular) offer significant success in removal of symptoms, prisms are not the primary treatment choice.⁴

Surgery

Current recommendations for surgery include worsening of the tropic phase and manifest deviation during more than 50% of waking hours.³ Richard and Parks reported a success rate of 56% with success defined as postoperative deviation of less than 10 pd during a 4-year mean follow-up period.⁴⁸ The pooled success rate reported for surgery based on review of past studies is 61%.³⁰

Assessment of learning objectives

Assessment of the learning objectives for this teaching case report can occur in the following settings. Students' understanding of signs, symptoms and types of IXT can be assessed using a problem-based approach in which small pieces of information are given out at a time and the student assimilates information provided or lists information needed. Alternatively, the same can be evaluated in a written exam situation either in the form of short essays or multiple-choice questions. Differentiation of types of IXT and knowledge of the role of diagnostic tests in IXT classification can be evaluated using real case videos of diagnostic evaluations (e.g., cover test at distance and near). Students' knowledge and proficiency with diagnostic tests can be evaluated in a clinical proficiency skills exam.

Assessment of students' understanding of treatment options and selection of appropriate treatment can be done using a case analysis-based approach where various case scenarios are presented and the students assimilate information provided and choose whether/when and how to treat. To successfully do this, students should have a clear understanding of the treatment options, pros and cons of each treatment and the natural history of IXT. In addition, a review of the literature on the efficacy of various treatment options and natural progression of IXT can also be used to assess the students' depth of understanding and critical thinking.

Summary

IXT is a common form of childhood exotropia with an unclear natural history. Divergence excess is a type of intermittent exotropia characterized by a larger exodeviation at distance than at near. Variability in measurements combined with the intermittent nature of the strabismus makes accurate diagnosis and treatment difficult for clinicians. Various types of treatment have been discussed in this case report with emphasis on non-surgical approaches. It is important to note that no single treatment approach suits all patients. The magnitude of symptoms, age, economic/social burden of the treatment, compliance and motivation are important factors in deciding the most suitable treatment for each patient.

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Using Technology to Enhance Student Learning and Clinical Teaching Outcomes

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The use of simulation and innovative technology to enhance teaching and clinical training is a common trend in higher education. Training using simulation has been reported in medical and allied health disciplines, but few publications exist in optometry. In this report, we present a teaching model implementing the 3D Eyesi Binocular Indirect Ophthalmoscope simulator (VRmagic, Germany) that has yielded positive learning and teaching outcomes.

Utilization of a BIO Simulation System

Binocular indirect ophthalmoscopy (BIO) is an essential optometric skill that students must master in order to detect sight-threatening conditions such as retinal detachment and diabetic retinopathy. It is a constant challenge for clinical educators to provide immediate, constructive and rich feedback to students performing BIO because the retina cannot be viewed simultaneously by student and educator without one-on-one supervision using a teaching mirror or utilizing imaging equipment (e.g., BIO video camera). Hence, it is difficult for students to improve their BIO skills efficiently and effectively, especially if unsupervised. In addition, students are exposed to only a couple of practice patients with a limited range of retinal conditions when learning the technique. All these factors have made student learning of BIO less enjoyable and engaging.

With a head-mounted display, a model head and two lenses, the Eyesi BIO simulator provides a realistic 3D experience and operates exactly like a real ophthalmoscope. Exact alignment of the laser light source and the lens has to be achieved before a retinal view can be obtained. A camera system tracks the position of the student's head and lens relative to the model head. The software offers training on four different tiers of complexity, which are appropriate for different year levels of our four-year Doctor of Optometry postgraduate program. The live interactive training program provides students with high-quality, comprehensive and instant feedback on their BIO technique as the examined retina is recorded and the retina currently being examined is displayed on the screen in real time. In addition, aspects of the technique such as efficiency, accuracy, thoroughness of the findings and diagnoses of a wide range of retinal pathologies can be evaluated by the computer.

We have enhanced the BIO learning experience for students using the simulator as a teaching and revision tool. In the second year of our program, after receiving the didactic lecture on how to perform BIO, all students attend standard practical classes to learn the technique. Prior to using the simulator, all second-year students need to pass an online orientation course to ensure familiarity with the technology. Then they are assigned to work in groups of three to use the BIO simulator for six two-hour self-directed sessions for the year. A final-year student is allocated to provide peer trouble-shooting advice and critique only for the first session. In the third year, students again have access to the simulator for six two-hour self-directed sessions, but on an individual basis. It is expected that by the end of the third year, students should have completed the first two tiers of the simulator training program.

Assessment of Benefits and Drawbacks

We obtained ethics approval to conduct anonymous surveys over a two-year period to assess students' perception of this technology. A total of 104 students were surveyed (response rate 46%), and 90-100% strongly agreed or agreed that the technology: (i) is a highly valued and useful learning tool, (ii) contributes to them being more confident, competent and proficient in performing BIO, and (iii) improves their stability, orientation and alignment when examining the retina on a real patient.

In our opinion, the implementation of a technology-enhanced learning environment has provided students with a deeply interactive and immersive learning experience. Our observations demonstrate that integration of the BIO simulator into our OD program has improved students' clinical examination and reasoning skills and concurrently minimized the range and variability in clinical performance. We hypothesize that well-structured self-directed BIO simulator sessions in the second and third year have allowed students to achieve technical competency earlier, which then enabled clinical educators to concentrate on the translation of the technique to a real patient in the clinical setting in later years.

Use of the BIO simulator has also led to reduction in teaching workload because the need for intensive one-on-one BIO

technique introduction and refinement with clinical educators is minimized, particularly in the early stages. Increased student interaction and engagement has been achieved by working with same and different year-level peers.

Despite the positive outcomes, the BIO simulator does have drawbacks. It supplements, but still does not replace conventional practical classes. Certain aspects of the technique such as patient instructions, manipulating the patient's lids and head, and altering chair height cannot be taught and evaluated properly using this technology. How the simulator generates a final score based on its assessment criteria remains to be understood. Large class sizes require multiple simulators, and service and repairs are currently available only in Germany.

Considerations for the Future

We anticipate that improved in-situ feedback and assessment mechanisms will translate to increased proficiency and efficiency when students perform BIO on real patients in clinic in later years. Additional studies are warranted to evaluate the efficacy of the BIO simulator in improving student-perceived proficiency and confidence. Furthermore, the suitability of the BIO simulator to be used as an examination tool in clinical competency examinations remains to be explored.