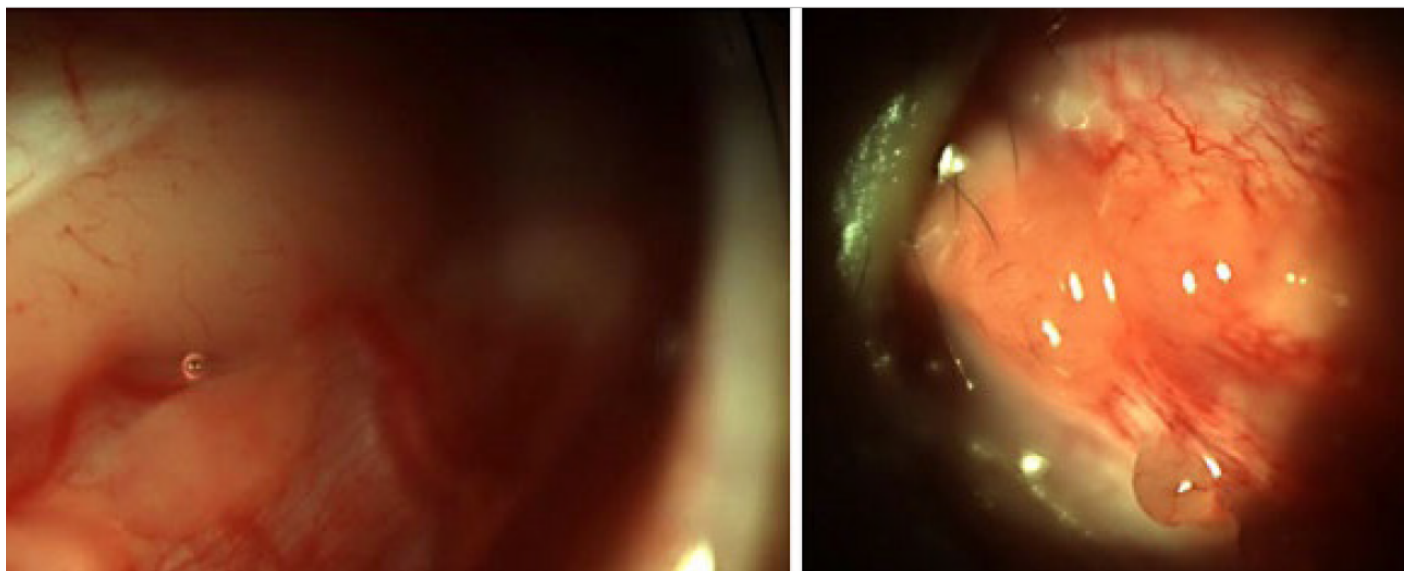


OPTOMETRIC EDUCATION

The Journal of the Association of Schools and Colleges of Optometry

Volume 44, Number 3
Summer 2019



The Benefits of Vision Screening as a Mandatory Component of a First-Year Optometry School Curriculum

Interactive Multimedia Learning vs. Traditional Learning in Optometry: a Randomized Trial, B-scan Example

Conjunctival Lymphoma: a Teaching Case Report

Sudden Blind Spots and Halos: a Teaching Case Report of Acute Optic Neuritis Associated with Multiple Sclerosis

ALSO INSIDE

Editorial: Reaching Out to Generation Z: ASCO Launches *Optometry Gives Me Life* Campaign

Educator's Podium: Personal Financial Planning in the Optometric Curriculum

Educator's Podium: Optometric Education Beyond Borders

Industry News

Student Award in Clinical Ethics





Committed to Quality

Alcon

6201 South Freeway
Fort Worth, Texas 76134
www.alcon.com

Customer Service

(800) 241-5999

Switchboard

(817) 293-0450
[Live Operator](#)

Medical Information Services

(800) 757-9785
medinfo@alcon.com

Medical Safety

(800) 757-9780
[Adverse Event Reporting](#)

Corporate Giving

(800) 222-8103
US Patient Assistance Program
US Medical Need Program

- Product Donations
 - Patient Assistance
 - Medical Missions
- The Alcon Foundation, Inc.
 - 501(c) (3) Nonprofit Status Required
- [Community Partnerships](#)



Alcon
A Novartis Division

© 2018 Novartis 2/18 US-PH-16-E-147/002

[See product instructions for complete wear, care and safety information](#)



Table of Contents

Reaching Out to Generation Z:brASCO Launches emOptometry Gives Me Life/em Campaign 1

The Benefits of Vision Screening as a Mandatory Component of a First-Year Optometry School Curriculum 3

Interactive Multimedia Learning vs. Traditional Learning in Optometry: a Randomized Trial, B-scan Example 10

Conjunctival Lymphoma: a Teaching Case Report 17

Optic Neuritis Associated with Multiple Sclerosis:br a Teaching Case Report 25

Personal Financial Planning in the Optometric Curriculum 35

Winning Clinical Ethics Essay brAddresses Familiar Tough Topic 37

Optometric Education Beyond Borders 40

Industry News 42

Reaching Out to Generation Z:

ASCO Launches *Optometry Gives Me Life* Campaign

Aurora Denial OD, FAAO | Optometric Education: Volume 44 Number 3 (Summer 2019)

[PDF of Article](#)

In any academic environment, it is important to attract high-quality applicants. Success in this area depends on the public's awareness of the profession and the ability to connect to future potential applicants. For optometry schools, the next applicants are the college-age members of Generation Z. To connect with them, ASCO recently embarked on an ambitious public awareness campaign: *Optometry Gives Me Life*. The campaign is highly targeted and designed to raise the visibility of optometry as a career choice, favorably positioning it in the competitive field of health professions education. ASCO reports that early analytics used for gauging the success of the campaign have been robust. (More on that below.)



Aurora Denial, OD, FAAO

Getting to Know Generation Z

Understanding the motivations and characteristics of the members of Generation Z is vital in connecting with them. Generation Z includes individuals who were born from the mid-1990s to the mid-2000s. Having grown up with the Internet they are known as digital natives. Members of this generation, who make up 25% of the U.S. population, outnumber Baby Boomers and Millennials.¹ Gen Z students describe themselves as loyal, compassionate, thoughtful, open-minded, responsible and determined.² They are known to be realistic problem-solvers who appreciate honesty and authenticity.³ Additionally, they are described as entrepreneurial, innovative, and independent learners who want to initiate social change.² This generation grew up with a recession and relatively high unemployment. As a result, it is a generation concerned about financial and job security.⁴ However, although Gen Zers are concerned about financial security, they are not willing to settle for a job that is not fulfilling or meaningful.⁴ Generation Z is also characterized by being constantly connected to laptops, tablets or smart phones. Unlike Millennials, who experienced AOL dial-up Internet, flip phones and separate devices for making a phone call, playing music and accessing the Web, Gen Zers have it all in one device, the smart phone. As a result, they can access an amazing amount of information almost instantaneously.

The Making of the Campaign

Optometry Gives Me Life is a new public awareness tool for both the profession and individual institutions. In creating the national campaign, ASCO conducted research with focus groups of college-age Gen Z students. The students identified earning potential, autonomy and making a difference in people's lives as important characteristics of a potential profession. The campaign therefore highlights the relevant aspects of an optometric career, including an enticing work-life balance, personal fulfillment, job security and more. It encompasses specialized and targeted social media outreach, publications, ancillary promotional materials, e-mails, direct mail and the campaign's landing page at www.futureeyedoc.org. It features video profiles of three practicing optometrists. The videos expose viewers to the personal, social and professional lives of the doctors, who are energetic, engaging and interesting.

The campaign presents online to a specifically defined target audience in response to their search history and age. It reaches college-age students pursuing STEM degrees who have expressed an interest in a health profession but may not yet have considered optometry. Internet users whose online presence does not match the specifically defined criteria will not see the ads or other elements associated with campaign. Only those who fit the targeted criteria are directed to the campaign's www.futureeyedoc.org landing page and videos, from which point they can also easily access the additional information that is available.

Creating the Connection

The information presented as part of the *Optometry Gives Me Life* campaign is meant to engage the target audience. As has been noted, members of Generation Z are independent learners who are accustomed to accessing information on their devices. They are easily able to research the profession once exposed to it. Featuring the lives of practicing optometrists should appeal to the audience's desire for authenticity, and the mainly digital distribution of the campaign syncs well with their digital native preferences.

Determining the long-term success of the campaign may take several years, although early results are positive. ASCO reports that in just over four months, the paid ads have been seen more than 19 million times, which is 40% more than the benchmark used to measure click engagement of this type. The percentage of people who watch the campaign's video stories in their entirety is also high: 76% completion, which is 140% higher than the benchmark 30%. In addition, more than 50,000 people have visited the campaign landing page, www.futureeyedoc.org, and engaged with the information. ASCO has also seen a 151.5% increase in program interest through its OptomCAS system compared to this time last year.

I applaud ASCO for taking the initiative to launch this important campaign. The multi-dimensional campaign is creative and connects to the Gen Zs who are optometry's future students and graduates. Monetary support from optometric institutions enabled ASCO to create and launch the campaign. An increase in public awareness of the profession will ultimately impact the sustainability of optometric institutions and the profession.

References

1. Dill K. 7 things employers should know about the Gen Z workforce. Forbes [Internet]. 2015 Nov 6 [cited 2019 May 24]. Available from: <https://www.forbes.com/sites/kathryndill/2015/11/06/7-things-employers-should-know-about-the-gen-z-workforce/#24bca759fad7>
2. Seemiller C, Grace M. Generation Z goes to college. San Francisco, CA: Jossey-Bass; 2016.
3. Seemiller C, Grace M. Generation Z goes to college. Chapter 10. San Francisco, CA: Jossey-Bass; 2016.
4. Seemiller C, Grace M. Generation Z goes to college. Chapter 6. San Francisco, CA: Jossey-Bass; 2016.



The Benefits of Vision Screening as a Mandatory Component of a First-Year Optometry School Curriculum

Kristy Remick-Waltman, OD, FCOVD, FAAO, Ida Chung, OD, MSHE, FCOVD, FAAO, Stephanie Amonoo-Monney, MPA, AALHE, and Eugene Cheung, OD | Optometric Education: Volume 44 Number 3 (Summer 2019)

[PDF of Article](#)

Introduction

There is consensus among healthcare professionals that their education is enhanced by early “hands-on” experience with patients. Students rate these experiences as a valuable introduction to their professional roles in clinical practice.¹⁻⁵ This alternative model of health professional education includes didactic courses with simultaneous early exposure to direct patient care. It contrasts with the traditional lecture-based model of medical and optometric education in which the first-year curriculum includes only didactic courses and no direct patient care.⁶ Optometric educators have expressed concern that first-year students are not prepared for patient care,⁷ but current literature documents that a curriculum with clear goals for early student-patient encounters is feasible and can be successful.⁸ Yet, in 2016, when we surveyed all of the schools and colleges of optometry in the United States, asking at what point in the program students experience their first direct patient encounters, less than one-third (29.4%, with 17 of 20 schools responding) reported students experiencing direct patient care in the first term of the first year.

Using a mixed research method of quantitative and qualitative surveys, we provide evidence that supports early patient care through vision screenings. The vision screening component integrated into students’ first year at Western University of Health Sciences College of Optometry (WUCO) adds value to the curriculum and supports achievement of the college’s educational goals of excellent clinical skills, preparation for full-scope care, experience with diverse populations and professional self-confidence.

Establishing a New Curriculum

WUCO opened in 2009 along with its newly built Eye Care Institute (ECI).⁹ The ECI serves as the academic-based clinical care facility for students at all levels in the Doctor of Optometry degree program. Having a minimal established patient population at the outset, the ECI needed external sources of patients. An easily accessible source, which fulfilled a community need and matched the skill set of first-year students in the fall semester, was school-age children, who are required to undergo vision screenings.

Vision screening course structure

Since the 2009 academic year, first-year optometry students at WUCO have provided direct patient care in the course Patient Care Services I: Vision Screenings (PCS-I). This course immediately follows the four-week Principles and Practice of Optometry I (PPO-I), a didactic and laboratory immersion-style course that covers the foundations of vision screenings and the vision screening test battery. Students are required to pass PPO-I in order to participate in PCS-I. In academic years 2009-2016, first-year students began vision screenings in the fifth week of the professional program. In 2017, the start of the vision screenings was moved to the eighth week of the program. The study results we report here are based on our evaluation of the 2016 vision screening rotation (OD class of 2020).

Training of students

The test battery used for the vision screenings, shown in **Table 1**, is modified from the Colorado Vision Screening Battery.¹⁰ It includes ocular motility, ocular tracking, accommodation and near point of convergence testing that relates to reading level and academic success.^{11,12} Recent research shows that reading disabilities, visual attention, oculomotor readiness and reading comprehension are linked.¹³ In PPO-I, WUCO students are introduced to the relationship between children’s vision skills and successful learning and the importance of the optometrist’s role in identifying and treating children with learning-related vision problems.

Selection of screening sites

TABLE 1
Vision Screening Test Battery

Visual acuity	Refer at 6 yrs 20/40
Distance	Refer if can read 20/30 line or less
CFT (auto refractor/keratometer)	Optional
near vision	Refer any tropia or large phoria
near with accommodation	Refer if restricted or jerky with
D pattern, checking for	
E at 60 cm	Refer 2 or less correct out of 4
ERR plates (Richman)	Refer if less than 3 out of 3 are
ERR with ColorDx (Kern)	
using CITT protocol	Refer if break > 5 cm or resolve on third try
learning-related vision problems	Refer if any pos.

9. Treatment Plan

The timing of the curriculum coincides with the need among local schools for vision screening services, which is at the beginning of the school year. WUCO students perform vision screenings at multiple elementary, middle and high schools within the Pomona Unified School District (PUSD). District administrators choose which schools use the screenings based on a status of “low performance,” which is defined as 70% eligibility for low-income lunch and ranking in the lowest 30% on the standardized testing that is administered to all California school children.

Table 1. [Click to enlarge](#)

Unintended benefits to the local school district

California law mandates vision screenings consisting of distance visual acuity, near visual acuity (since 2014) and color vision testing (males only) for school children in their first year of enrollment and/or in kindergarten, second, fifth and eighth grades. Prior to WUCO’s involvement, school nurses working for PUSD conducted the vision screenings along with hearing screenings. The district appreciates the more comprehensive vision screening provided through WUCO. Before 2014, the nurse screenings utilized the Snellen distance visual acuity chart and primarily detected children with myopia while missing those with hyperopia. A screening battery consisting solely of distance vision testing is known to miss up to 40% of vision problems, especially those related to learning in the elementary grades, such as uncorrected hyperopia and binocular dysfunction.¹⁴ A recent report by Kulp et al. demonstrated that even a moderate amount of uncorrected hyperopia in young children results in poor performance on tests of early literacy.¹⁵

Even with the state-mandated addition of near vision testing to the screening battery, vision problems may still go undetected. Recent research has also demonstrated that early detection of reduced near point of convergence in school-age children helps them to avoid some reading problems.¹⁶ In July 2016, the American Academy of Optometry published a Policy Statement on Childhood Vision Screening, which reads “in order to facilitate early detection of children’s vision problems and meet the vision needs of all children, the American Academy of Optometry recognizes the value of a continuum of eye care that includes both evidence-based vision screenings and access to comprehensive eye examinations by optometrists or ophthalmologists.”¹⁷

All children who do not pass the WUCO vision screening are referred, and their parents receive, before the end of the calendar year, an official letter from a PUSD nurse recommending a comprehensive eye examination. Optometry students enrolled in a community service learning course assist PUSD nurses with follow-up of the referred children. They help with paperwork, contact parents by phone and speak directly to students at the school sites. They educate the children, their parents and teachers about the importance of vision in learning. They contact every student referred for a comprehensive vision examination in an effort to ensure they obtain the needed services and prescription glasses. In addition to delivering vision screening services and follow-up to the school district’s children, WUCO now serves as a resource for the PUSD health services director, nurses and teachers. Since the inception of the screening program, 21,768 children have received vision screenings.

Student scheduling

The WUCO vision screenings, provided by a team of 8-14 first-year students, a supervising optometrist and two third-year student supervisors, take place on 15-22 days each year. Each first-year optometry student performs 6-7 full vision screenings per day. WUCO faculty members, who are California-licensed optometrists, supervise the optometry students. Working in pairs, students perform all vision screening tests on a single patient. At the end of each vision screening session, the faculty supervisor gathers the students to discuss the interesting cases of the day. Supervising optometrists and third-year students lead debriefing sessions that allow for discussion, reflection and feedback regarding the pediatric vision conditions and challenges the first-year students encountered. On average, each student experiences 35.6 direct patient care encounters by week 15 of the curriculum.

Course Assessment

Preceptor evaluation of student performance

TABLE 2 Rubric for Faculty Grading of Student Skills and Behavior	TABLE 3 Student Evaluation of the Clinical Experience
<p>vision: frequently each student was independent and correct (by right) - not "half" - greater than "half" - almost all the time, or all the time on the day</p> <p>to perform screening tests with proper technique, produce accurate</p> <p>se: demonstrates knowledge of expected vs. abnormal findings and (of anomalies looked for in vision screenings)</p> <p>engagement: correctly able to distinguish between children who "pass" (valued)</p> <p>se skills: conveys and obtains information (e.g., good instructions) (se: personal skills and respect)</p> <p>Slide towards learning (e.g., accepts criticism and correction as well seeking out ways to improve)</p> <p>in dealing with patients, peers and other professionals: particular (in class code, prepared to deliver vision screening in a timely manner sets this standard, place the number 1 in the cell for "all the time"; if it is not met all components of the standard, place the number 1 in the cell)</p> <p>mentholus caring, compassion and concern for the child as a human</p>	<p>on: frequently the following statements matched their personal as (only even: less than "half", greater than "half", almost all the time, or all the time)</p> <p>se grade did your vision screening experience earn?</p> <p>to make the investment of my time in the clinical experience was</p> <p>expected of me during vision screenings</p> <p>screenings had a positive impact on my technical skills</p> <p>screenings had a positive impact on my clinical thinking</p> <p>screenings had a positive impact on my patient communication skills</p> <p>screenings by my preceptors during vision screening was appropriate</p> <p>screen screenings made an important contribution to the community</p> <p>and respected member of the vision screening team</p> <p>challenged by the variety and complexity of patient problems (in variety of complicating factors, the severity of conditions, etc.)</p> <p>ing clinical experience contributed to the breadth & depth of my</p>

Table 2.
[Click to enlarge](#)

Table 3.
[Click to enlarge](#)

Faculty supervision is associated with better patient care as well as faster acquisition of clinical skills by students.¹⁸ To assess the performance of the optometry students on the day of the vision screening, the faculty supervisor uses a rubric to grade their behavior and skills (**Table 2**). The assessment includes seven criteria: technical skills, knowledge base, accurate diagnosis and management, communication skills, attitude towards learning, professionalism and humanism. Each criterion is fundamental to becoming a good clinician.¹⁹ By the end of the course, students who receive an evaluation of “almost all the time” or “all the time” in each of the seven graded areas pass the course. Throughout the years of this vision screening course, all students have received a passing grade, which supports the appropriateness of vision screening as direct care encounters early in the curriculum for first-year students.

Student self-assessment

To help us assess the value of this course, the 2016 first-year optometry students completed a self-assessment survey of their experience (**Table 3**). The survey asked students to assign a letter grade to their experience. One hundred percent of the students completed the assessment of their vision screening experience, and 100% were evaluated by their clinical supervisors or preceptors. The course assessment showed that 90.5% of students assigned a grade of ‘A’ to their experience during PCS-I; 8.9% of students assigned a grade of ‘B’; and 0.60% gave the course a grade of ‘C’ or lower. One-hundred percent of students indicated that performing numerous vision screenings early in their first year added value to their clinical education, as represented by these personal reports and reflections:

“I thought the vision screenings were a great way to dip our feet in the clinical pool! Not only did we get to help the community, but we had an awesome learning experience!”

“Vision screenings were very important to me because I had the opportunity to use and practice my skills on real patients.”

“Vision screenings were so helpful. I gained a lot of confidence and improved my technical skills. I hope next year’s students will continue to do this!”

“Vision screenings were great in introducing us to the community and building our skills as future optometrists.”

“Learning by the textbook is one thing; learning through hands-on experience is another thing. Knowing that WUCO has direct patient care in the first year was one of the determining factors on why I chose this school.”

“Knowing that these vision screenings may be a crucial stepping stone in a child’s path to academic success, it’s very rewarding to be a part of a team that provides this service to the community.”

Overall, students rated the course as a successful learning experience in their first-year curriculum. This demonstrates that the curriculum design can support early entry of patient care.

Benefits to Students

Spiral curriculum

The benefits of early introduction to direct patient care reinforce the view that optometric education should focus on clinical training from the first year and develop within a spiral curriculum.²⁰ In a spiral curriculum, key concepts are presented repeatedly with deepening layers of complexity. The approach supplements the traditional layered curriculum in which basic sciences provide the necessary foundation for further learning.²⁰ For example, in our study’s post-course survey, 83% of students reported being able to differentiate between normal and abnormal findings. Differentiating normal from abnormal findings is the foundation for clinical thinking and differential diagnosis. The vision screenings provide early experiential learning with the opportunity to revisit and emphasize concepts in subsequent patient care courses as well as didactic courses. Early introduction to direct patient care demonstrates applications and relevance of the basic sciences to the practice of optometry from the very beginning of the educational process. Empathy is explored through human interactions, and thus direct patient care aids in the development of empathy and professionalism.²¹

Professionalism

Role models for students include faculty as well as peers, with faculty being the most influential.²² According to Baernstein et al., preclinical students at the University of Washington School of Medicine stated that role modeling was the primary mode of learning professionalism.²² Professionalism is a necessity in any healthcare profession as it helps to develop a strong bond between doctors and patients through respect.

pre-survey with addition of italicized text

y student, how much of an impact if any, do you
vision screenings?

wareness of interprofessional interactions of opto
g experience?

you feel to provide direct patient care to school
nce?

e you in communicating with school-age children
screening experience?

is cultural competence, including possessing the
nding community after your vision screening exp

N	Pre- and Post- VS	50th (Median)
96	Q1 Pre-VS	5
96	Q2 Pre-VS	4
96	Q3 Pre-VS	4
96	Q4 Pre-VS	4
96	Q5 Pre-VS	4
76	Q1 Post-VS	5
76	Q2 Post-VS	4
76	Q3 Post-VS	5
76	Q4 Post-VS	4.5
76	Q5 Post-VS	4

VS = vision screening

[Click to enlarge](#)

Click to enlarge

Pre- and post-vision-screening survey of students



A Wilcoxon signed-rank test indicated that students' experiences in the vision screening course elicited a statistically significant change in most of their perceptions, as in questions 2 through 5:

- The median score rating was 4.00 both pre-and post-vision-screening experience for students' level of awareness of interprofessional interactions between optometrists and school nurses. The median score ratings for the other pre-and post-

vision-screening experience questions are found in **Table 5**. This survey supports the appropriateness of vision screening direct patient care encounters for all first-year optometry students, and thus is similar to previous research with medical students.^{1,6}

The students' exposure to interactions between supervising optometrists and school nurses supports the evolving profession of optometry and the need for interprofessionalism to solve complex cases. It is also important to note the optometry students indicated a higher level of cultural competence at the end of their vision screening experiences.²³ Vision screenings as direct patient encounters early in the optometry curriculum contributed to development of cultural competence due to the nature of the school children selected for screenings.

Discussion

The WUCO vision screening course supports several optometric educational guidelines and goals. Specifically, vision screenings in areas of low social and economic status meet these requirements by expanding the breadth of education experienced by optometry students.²⁴ This can also help ameliorate the visual function and visual processing deficits that have been associated with neuro-integrative impairments commonly found in children with reading disabilities.²⁵ The vision screening course conforms to these guidelines. It is integrated into the local community and is part of a curriculum designed with specific learning objectives using the innovative outcomes-based education (OBE).²⁶ We assessed outcomes by using specific evaluation rubrics. Our results show that first-year optometry students greatly benefit from early direct patient care as it reinforces key clinical skills as well as enhances development of essential interpersonal skills such as professionalism and empathy. Faculty evaluations of students demonstrated that students acquired a wide range of the expected skills and attributes. The results of student evaluations of their vision screening experience demonstrated that they valued performing vision screening tests on patients, rather than screening simulations or testing classmates. As a whole, students were very enthusiastic about their early exposure to patient care. Their ability to clinically apply the concepts learned in didactic courses enriched their learning experience both in the classroom and in the community. Specifically, the vision-screening course was highly beneficial at meeting its student learning outcomes. Our data are consistent with prior reports, which have also shown that clinical training in the community helps to develop several important clinical attributes, including verbal and non-verbal communication skills and empathy towards patients.²⁷

While performing screenings, the first-year optometry students communicate, interact and develop a connection with the elementary school children. They develop professionalism through interaction with school personnel such as nurses and teachers as well as with the different supervising faculty optometrists. Furthermore, the basic sciences provide students with a wide range of thinking and problem-solving skills, in particular those that relate to optometry and clinical learning.²⁸ After reviewing history questions with the children, optometry students learn to relate these symptoms to the findings obtained during the vision screening. For example, a child complains of losing her place when reading, and the optometry student finds low scores on pursuit accuracy testing. With this experience, the optometry students are able to listen, begin to interpret, communicate and manage the visual problems of the school children.

In 2017, as a result of ongoing curricular review at our optometry school, we moved the start of the vision screening program from the fifth week to the eighth week of the fall semester of the first year. We had two reasons for making this change. One reason was elementary school children tend to perform better at the screenings when they are more acclimated to the school. This is especially true for new enrollees, such as kindergarten students. PUSD school nurses and teachers informed us that as the children become more adjusted to their surroundings, teachers can observe their behaviors and performance in the classroom, regardless of grade. This input provides additional information to the optometrists as they make pass/refer decisions, particularly in cases of borderline test results. The second reason for the change was the additional opportunity for students to practice their newly learned skills on each other in the preclinical setting. Students had reported this in their course evaluations, and supervising faculty observed that the students' screening test ability and speed improved as a result of the additional practice.

The vision screening experience provides optometry students an opportunity to interact with patients early in the professional education program. Transitioning from university-based to clerkship-based education is challenging, but after the vision screening experience, optometry students feel more prepared to provide direct patient care in their future professional career.²⁹ Future studies can evaluate the effects of first-year vision screenings on the clinical and professional performance of students in subsequent patient care courses.

Conclusion

The PCS-I course at WUCO provides educationally relevant learning experiences as it engages our optometry students in community-based vision screenings early in their education, in the fall term of the first year. A minority of optometric

institutions offer a course early in the first-year curriculum that incorporates direct patient care. Our findings indicate it would be valuable for other optometric institutions to form partnerships with local school districts to implement a mandatory course involving school vision screenings early in the first-year curriculum.

Based on the great value WUCO students place on their experience with real patients early in the professional program, our study supports an alternative to the traditional lecture-based education model..

Acknowledgement

We wish to acknowledge Daniel Kurtz, PhD, OD, FAAO, as the founding Dean of Academic Affairs and his contribution to curriculum development, and Robin Drescher, OD, MS, as the founding course leader for PPO-1 and PCS-1. We thank them both for their intellectual contributions to the development of this manuscript.

References

1. Howe A, Dagley V, Hopayian K, Lillicrap M. Patient contact in the first year of basic medical training – feasible, educational, acceptable? *Med Teach*. 2007;29(2-3):237-45.
2. Válková L. First early patient contact for medical students in Prague. *Fam Pract*. 1997 Oct;14(5):394-6.
3. Vera-Diaz FA, Johnson C. Perceived enhanced clinical readiness for second-year optometry interns. *Optometric Education*. 2016 Summer;41(3).
4. Labreche T, Christian LW, Hrynychak P. Initial evaluation of an optometric outreach educational program. *Optometric Education*. 2016 Summer;41(3).
5. Helmich E, Bolhuis S, Laan R, Koopmans R. Early clinical experience: do students learn what we expect? *Med Educ*. 2011;45(7):731-40.
6. Christianson CE, McBride RB, Vari RC, Olson L, Wilson HD. From traditional to patient-centered learning: curriculum change as an intervention for changing institutional culture and promoting professionalism in undergraduate medical education. *Acad Med*. 2007;82(11):1079-88.
7. Penisten DK. The expanding scope of practice and the optometric curriculum. *J Am Optom Assoc*. 1992;63(11):779-80.
8. Ottenheijm RP, Zwietering PJ, Scherpbie AJ, Metsemakers JF. Early student-patient contacts in general practice: an approach based on educational principles. *Med Teach*. 2008;30(8):802-8.
9. Hoppe E. Focused on the future. *Optom Vis Dev*. 2009;40(1):14-15.
10. Bosse J, Condit RS, Fitzpatrick B, et al. Guidelines for school vision screening programs, Colorado Department of Public Health and Environment. 2nd edition, Sept. 1991.
11. Rouse M, Borsting E, Mitchell GL. Academic behaviours in children with convergence insufficiency with and without parent-reported ADHD. *Optom Vis Sci*. 2009 Oct;86:1169-77.
12. Scheiman M, Mitchell GL, Cotter SA, et al, CITT-ART Investigator Group. Convergence Insufficiency Treatment Trial – Attention and Reading Trial (CITT-ART): design and methods. *Vis Dev Rehabil*. 2015 Oct;1(3):214-228.
13. Scheiman M, Rouse M. *Optometric management of learning-related vision problems*, 2nd Edition. Mosby Elsevier, 2006.
14. Bodack MI, Chung I, Krumholtz I. An analysis of vision screening data from New York City public schools. *Optometry*. 2010;81(9):476-84.
15. Kulp MT, Ciner E, Maguire M, et al., VIP-HIP Study Group. Uncorrected hyperopia and preschool early literacy: results of the vision in preschoolers-hyperopia in preschoolers (VIP-HIP) study. *Ophthalmology*. 2016;123(4):681-9.
16. Dusek WA, Pierscionek BK, McClelland JF. An evaluation of clinical treatment of convergence insufficiency for children with reading difficulties. *BMC Ophthalmol*. 2011 Aug 11;11:21.
17. Ciner E, Cotter S, Kulp M, et al. American Academy of Optometry policy statement childhood vision screening. *American Academy of Optometry*. 2016 Aug:1-3.
18. Kogan JR, Holmboe ES, Hauer KE. Tools for direct observation and assessment of clinical skills of medical trainees: a systematic review. *JAMA*. 2009 Sept 23;302(12):1316-26.
19. Rizo CA, Jadad AR, Enkin M. What's a good doctor and how do you make one? Doctors should be good companions for people. *BMJ*. 2002 Sep 28;325(7366):711.
20. Super S. The spiral curriculum in optometric education. *Optom Vis Sci*. 1989 Oct;66(10):705-9.
21. Helmich E, Bolhuis S, Laan R, Koopmans R. Early clinical experience: do students learn what we expect? *Med Educ*. 2011;45(7):731-40.
22. Baernstein A, Oelschlager AE, Chang TA, Wenrich MD. Learning professionalism: perspectives of preclinical medical students. *Acad Med*. 2009;84(5):574-81.
23. Association of Schools and Colleges of Optometry. Guidelines for culturally competent eye and vision care. 2008. Available from: https://optometriceducation.org/files/Guidelines_CulturallyCompetentEyeAndVisionCare.pdf
24. Solan HA, Mozlin R. Biosocial consequences of poverty: associated visual problems. *Optom Vis Sci*. 1997 Apr;74(4):185-9.
25. Solan HA, Larson S, Shelley-Tremblay J, Ficarra A, Silverman M. Role of visual attention in cognitive control of oculomotor

- readiness in students with reading disabilities. *J Learn Disabil*. 2001 Mar-Apr;34(2):107-18.
26. Berman MS. Priorities for optometric education: outcomes of the curriculum conference. *Optom Vis Sci*. 1994 Feb;71(2):87-90.
27. Thompson BM, Lovie-Kitchin JE. Interpersonal skills training for optometry students: what should be taught? *Optometric Education*. 1988 Winter;13(3):84-8.
28. Woodruff CE. The evolution of optometric education in America. *Optometry*. 2001;72(12):779-86.
29. Surmon L, Bialocerkowski A, Hu W. Perceptions of preparedness for the first medical clerkship: a systematic review and synthesis. *BMC Med Educ*. 2016 March 12;16:89.



Interactive Multimedia Learning vs. Traditional Learning in Optometry: a Randomized Trial, B-scan Example

Elena Z. Biffi, OD, MS, FAAO, and Misty Woodbury, MA | Optometric Education: Volume 44 Number 3 (Summer 2019)

[PDF of Article](#)

Introduction

With the advancement of technology and increased use of electronic devices, interactive multimedia learning has been a point of interest in medical education.^{1,2} Interactive multimedia learning is defined as online instruction that combines multimedia formats (text, video, audio, images) with activities that help the learner apply and receive feedback on their understanding.^{3,4} Whereas traditional learning is defined, for the purposes of this study, as content delivered in the format of a textbook and/or PowerPoint slides without an interactive assessment component.

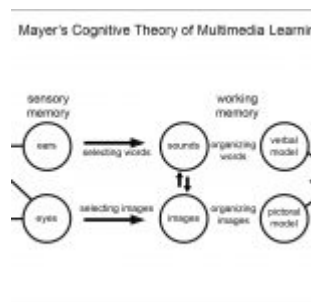


Figure 1. Adapted from *Multimedia Learning*, 2nd edition, Mayer (2009).
[Click to enlarge](#)

Several studies have associated greater learning efficiency, problem-solving abilities and satisfaction rates with interactive multimedia online lectures.^{5,6,7} Schneider et al. reported an average of 20% better test scores for students who used computer-based patient cases vs. students who used textbooks to prepare for testing on diagnoses in urology.⁸ Another study showed test scores improved as much as 46% for students who used a multimedia e-book vs. students who used a traditional PowerPoint lecture format for learning blood-cell morphology.⁹ Similarly, researchers at the University of Manchester found “a significant increase ($p \leq 0.01$) in the mean examination scores” after multimedia online modules were introduced in an anatomy course for first-year optometry students.¹⁰ Based on a study by Issa et al. Third-year medical school students who used a multimedia lecture to study the topic of shock significantly outperformed students who used traditional PowerPoint lectures on both immediate and delayed knowledge retention and transfer.¹¹ Moreover, research shows that “blended learning environments” (those with an online component) not only improve learning outcomes but also are preferred by students.¹²

TABLE 1
porated in Mayer's Cognitive T

Working memory (as opposed to long-term memory) can process a finite amount of information at any one time.
Working memory does not store information. Instead, different systems work together to process information.
Working memory processes information separately.

Table 1.
[Click to enlarge](#)

TABLE 2 Mayer's Principles for Effective Multimedia Design ¹	
Principle	Description
1. Redundancy	Do not repeat or restate words, pictures, sounds, or actions.
2. Signaling	Provide cues such as highlighting, circles, arrows, etc. to signal important words or organization of concepts.
3. Coherence	Present corresponding narration and animation simultaneously and sequentially.
4. Modality	Avoid redundant images + narration + text. Do for images: narration or images + text to reduce extraneous processing.
5. Contiguity	Place corresponding words and graphics as close as possible as responses, close together (i.e., not on opposite sides of the screen).
6. Segmenting	Present learning materials in learner-paced segments that are in chunks into smaller chunks.
7. Previews	Provide explanations of key concepts in a lecture for beginners.
8. Consistency	Consistent types of words and images that pair well (e.g., text and video, on-screen text and video, shadows, text with words, graphics with text on-screen text and animation).
9. Animations	Words and pictures are more effective than words alone.
10. Persistence	The repetition of words on screen does not enhance learning.
11. Multimedia	Diagrammatic representation enhances learning.
12. Individualization	Use a personalized learning tool (e.g., text, video, audio, animation, etc.).

Table 2.
[Click to enlarge](#)

To improve information comprehension, Effective Use of Educational Technology in Medical Education (2007) from the Association of American Medical Colleges recommends the use of Mayer's multimedia principles in designing effective educational material for students.^{13,14} Mayer's cognitive theory of multimedia learning explains how learners process multimedia information and how to better design learning materials to maximize learning gains. His theory builds on cognitive load theory, working memory theory and dual-processing theory (**Table 1**) to explain how learners process, select, organize and integrate words and images with prior knowledge (**Figure 1**).^{3,16} According to Mayer, when learners process multiple sources of visual information (e.g., text, photos, illustrations, video) their attention becomes “split,” adding to cognitive load and making it more difficult to process the information.¹⁷ Therefore, Mayer has developed a framework for creating multimedia learning materials that helps learners more effectively process information. This framework includes the integration of 12 key empirically based design principles (**Table 2**).³

The combination of multimedia learning and interactivity in the form of self-assessment has the potential to enhance the effectiveness of course preparation practices in optometry. Research shows that the incorporation of an interactive component

further improves student learning and retention, and that students have better learning outcomes and course satisfaction when immediate feedback is given.⁴ Interactivity should include more than a learner navigating through a learning module or pointing and clicking hyperlinks and images. To be effective, interactivity must engage the learner in applying knowledge and offer ongoing feedback.⁴

Many colleges now incorporate online components in their traditional, face-to-face courses. Although a significant body of research on the effectiveness of interactive multimedia learning has been published, little has been reported with regard to clinical procedures, specifically instruction on optometric procedures. The purpose of this study was to design an interactive multimedia teaching module following Mayer's multimedia principles (**Tables 1 and 2**) and test its effectiveness with a procedural optometric topic, B-scan ultrasound. The investigators proposed that using interactive multimedia modules to prepare for the procedural B-scan ultrasound topic, as opposed to traditional approaches such as reading a text or viewing a slide show, would result in:

1. Better preparedness for the hands-on in-person training
2. Improved pre- and post-lab session testing scores
3. Improved self-estimation of fund of knowledge and competence after a procedural teaching course
4. Higher learner satisfaction rates after completion of a procedural training course

Methods

Study duration and subject visits

This study was conducted in the summer 2015 semester at the New England College of Optometry (NECO). The subjects were NECO OD3 students (OD2017 graduating class) taking the Advanced Diagnostic Techniques (ADT) 1 course at study inception. Students in the first lab training session (summer 1) served as the control group. Students in the second lab training session (summer 2) served as the intervention group. Randomization relied exclusively on session assignment. No other randomization parameters, e.g., prior knowledge of B-scan, were used. This randomization scheme ensured that the control group could not provide information about test questions or answers to the intervention group. (The summer 2 session takes place after the summer 1 session.)

The only exclusion criterion for participation in the study was self-reported inability to use the interactive multimedia module due to physical or mental disability, as tested in question 1 of an initial 10-question online survey (**Appendix I**). Prior familiarity with the B-scan topic was captured via testing as described below and adjusted for. Summary (not individual) information on prevalence of attention/learning disorders and disabilities was obtained for comparison purposes, thus ensuring comparability of intervention and control subjects.

Initially, all participants took the 10-question online survey (Appendix I), which was designed to quantify familiarity with the B-scan topic prior to exposure to any course material. All surveys were completed by one week prior to study inception as set in the study timeline (**Appendix II**). One week prior to the start of the B-scan lab training, the course preparation was provided online as either traditional reading material from a textbook chapter¹⁸ (for control group) or as an online interactive multimedia module (for intervention group). No additional equipment was necessary. Course preparation was carried out by students on a personally defined time schedule, with no restrictions in terms of location (i.e., no dedicated facilities required). On the basis of automated reports from the course management software platform employed at NECO, all students in the study successfully completed lab preparation material independently. A pre-lab quiz and questionnaire were administered to each training group at the beginning of the B-scan lab training session. After the initial testing was complete, subjects underwent the in-person hands-on B-scan ultrasound lab portion of the ADT 1 course, conducted by the same instructor. A post-lab quiz and questionnaire were administered one week after the B-scan lab training in multiple sessions to accommodate students' class schedules and other exams.

Testing materials

Online survey

All study participants completed a 10-question online survey (Appendix I), which included one self-screen question about ability to use the interactive multimedia module; one self-report question on familiarity with B-scan; and eight questions for quantifying B-scan topic familiarity (physics, indications, contraindications, types of B-scans, image interpretation) prior to exposure to any course material.

Pre-lab quiz/self-report questionnaire

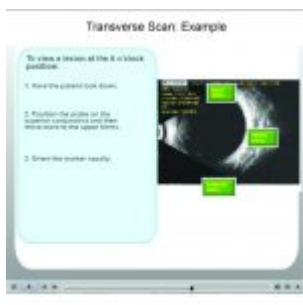
Students took an initial pre-lab quiz and completed a self-report fund of knowledge/competence questionnaire at the beginning of their B-scan lab training session. The pre-lab quiz consisted of 25 multiple-choice questions (**Appendix III**). The tested topics included B-scan physics (two questions), indications (three questions), contraindications (one question), procedural knowledge (five questions) and image interpretation (14 questions). The questionnaire consisted of five self-report questions about knowledge/competence and satisfaction (**Appendix IV**).

Post-lab quiz/self-report questionnaire

After one week of B-scan lab, all students took a post-lab quiz and filled out a post-lab self-report fund of knowledge/competence questionnaire. The post-lab quiz consisted of the same 25 multiple-choice questions as the pre-lab quiz. To prevent test-memorization confounding, the question sequence and answer coding were randomized in the post-lab quiz. The self-report fund of knowledge/competence and satisfaction questionnaire remained the same but was tailored to evaluation of the overall course (**Appendix V**).

Interactive multimedia module

Traditional course preparation material (for control group) consisted of reading material from a book chapter, scanned and copied to be available online. The interactive multimedia module (for intervention group) followed Mayer's cognitive theory of multimedia learning design principles (**Table 2**).³ The interactive multimedia module was created with an application that delivered content in a mix of media including text with large-font letters and deleted non-related material; images with cues (highlights, arrows, etc); a conversational-style voice presentation with superimposed contiguous graphs and images; and videos of the B-scan procedure with narration to highlight the most important points (**Figure 2**). Brief interactive assessments were also included at the end of each topic (every 5-7 minutes of projected presentation time).



All content was presented in learner-paced segments, and interactivity was incorporated in the form of 2- to 3-question assessments that tested the learner's ability to apply the new knowledge by answering various types of questions. For incorrect answers, remediation (links to the related module content for review) was offered. Students had two opportunities to answer each question correctly. After a second incorrect answer, in-depth explanations of correct and incorrect answers were provided. Students answering the questions correctly also had access to all in-depth explanations for further review.

Statistical methods

Data collection (chi-square test, Fisher's exact test, Student's t-test and Wilcoxon rank-sum test) was successfully completed by the end of August 2015. Data were entered into Excel to be analyzed using univariable testing procedures. Multivariable analyses utilized linear regression models to identify associations between group assignment and outcomes of interest. Study endpoints were: 1) pre- and post-topic in-person lab training test scores, difference between intervention and control group; 2) pre- and post-lab training self-perceived knowledge and competence, difference between intervention and control group; and 3) satisfaction with the lab teaching process, difference between intervention and control group.

The NECO Institutional Review Board approved the study.

Results

A total of 133 students were enrolled in the study. They were randomized by session membership as previously described in an intervention group (n = 65, 49.2%) that received the interactive multimedia module and a control group that received traditional review materials (n = 67, 50.8%). Based on self-reported inability to utilize the interactive multimedia module, no students were excluded from the study. **Table 3** shows the baseline demographic and academic data. Intervention group students had a lower average GPA than control group students (2.68 vs. 3.00, p = 0.039) but did not differ in self-reported topic familiarity (p = 0.30).

In univariable analyses, exposure to the interactive multimedia module resulted in significantly improved performance on standardized testing prior to the in-person lab training. The pre-lab quiz median score was 17/25 (68%) in the intervention group vs. 12/25 (48%) in the control group ($p < 0.001$), representing a 20% improvement on material transfer in the intervention group. The gap between the two groups notably narrowed after the in-person lab training. The post-lab quiz median score was 20/25 (80%) in the intervention group vs. 19/25 (72%) in the control group, $p = 0.001$. However, even after the in-person lab training, the intervention group outperformed the control group and had an 8% improvement in knowledge retention (**Figure 3 and Table 4**). Multivariable analyses adjusted for student characteristics (gender, GPA, self-reported B-scan topic familiarity) confirmed statistically significant differences in testing scores both before and after in-person lab training, as shown in **Table 4**.

TABLE 4
Intervention Group vs. Control Group: Questionnaire Score Results

	Pre-Lab	Post-Lab	Control	Intervention	Unadjusted p-value	Adjusted p-value
Q1	Pre-Lab: 15 (12-17)	12 (10-15)	17 (15-19)	17 (15-19)	<0.001	4.9 (3.8)
	Post-Lab: 18 (17-21)	18 (17-20)	20 (18-22)	20 (18-22)	0.004	1.8 (0.5)
Q2	Pre-Lab: 4 (3-5)	3 (3-4)	5 (4-5)	5 (4-5)	<0.001	0.7 (0.3)
	Post-Lab: 5 (4-5)	4 (4-5)	5 (4-5)	5 (4-5)	0.009	0.3 (0.1)
Q3	Pre-Lab: 4 (3-5)	3 (2-4)	4 (4-5)	4 (4-5)	<0.001	1.0 (0.3)
	Post-Lab: 4 (4-5)	4 (4-5)	5 (4-5)	5 (4-5)	0.012	0.4 (0.1)
Q4	Pre-Lab: 3 (3-4)	3 (3-4)	4 (3-5)	4 (3-5)	<0.001	0.8 (0.3)
	Post-Lab: 4 (4-5)	4 (4-5)	5 (4-5)	5 (4-5)	0.040	0.2 (0.1)
Q5	Pre-Lab: 3 (3-4)	3 (2-3)	4 (3-5)	4 (3-4)	<0.001	1.1 (0.3)
	Post-Lab: 4 (4-5)	4 (3-5)	5 (4-5)	5 (4-5)	0.16	0.2 (0.2)
Q6	Pre-Lab: 3 (3-4)	3 (2-3)	4 (4-5)	4 (4-5)	<0.001	1.0 (0.3)
	Post-Lab: 4 (4-5)	4 (4-5)	5 (4-5)	5 (4-5)	0.001	0.8 (0.1)

Median (inter-quartile range) for a maximum of 5 points, unless otherwise specified
n = 25 points

Table 4.
[Click to enlarge](#)

Discussion

This study compared two learning methods used in preparation for in-person hands-on lab training in B-scan ultrasound, a clinical procedure commonly used by optometrists and ophthalmologists. As course preparation material for the in-person lab training, the control group of students received conventional preparation material that consisted of reading material from a textbook chapter.¹⁸ The intervention group received an online interactive multimedia module that followed Mayer's multimedia principles (**Table 1 and Table 2**).³ The module was based on the same information from the same book chapter given to the control group. The main study outcomes focused on comparisons of the groups' standardized test performance, self-reported topic proficiency/familiarity and learner satisfaction. The study results revealed that use of the interactive multimedia module resulted in a 20% improvement in material transfer. In addition, knowledge retention was improved by 8% for the intervention group in comparison to the control group (80% vs. 72%), who received conventional preparation material.

Results also showed that hands-on in-person lab training significantly improved material understanding for both the intervention and control groups. Furthermore, analyses identified a narrowing of the gap in standardized testing performance between the control and intervention groups after in-person lab training. However, students in the intervention group continued to outperform students in the control group to a statistically significant degree. The two student groups enrolled in the study were well-matched for total number of participants, gender and initial self-reported B-scan topic familiarity. However, the intervention group had a lower average GPA than the control group. While this represents a limitation of the matching procedures, it does not increase risk of the study generating false positive results.

After likely underestimation of benefit from deployment of the interactive multimedia module was accounted for, the study findings underscored potential long-term benefits of the multimedia approach. Furthermore, the data demonstrated that intervention group students were more satisfied with material coverage than control group students even though both groups

TABLE 3
Baseline Demographic and Academic Data

Identifiers	Control	Intervention
n	67	65
Female (%)	20 (30%)	25 (38%)
GPA	3.00 (2.60 - 3.39)	2.68 (2.40 - 3.2)
Age (years)	3 (2 - 4)	3 (2 - 4)

Median (inter-quartile range) unless otherwise specified

Table 3.
[Click to enlarge](#)

According to univariable analyses, students in the intervention group were more satisfied with the course preparation material both before and after the lab (both $p < 0.001$) and felt that both the preparation material and the in-person training covered the topic adequately (both $p < 0.01$). The largest difference between the groups, seen on the pre-lab questionnaire, was on the question of whether the B-scan prep material covered all course-required topics adequately and in-depth. For this question, the control group reported an average satisfaction rate of 3/5, while the intervention group average was 5/5 ($p < 0.001$). Also notable among the univariable comparisons were, for the intervention group, higher self-reported knowledge level and confidence in ability to perform the B-scan independently before the in-person lab (both $p < 0.025$). Detailed results of multivariable analyses adjusted for student characteristics (gender, GPA, self-reported B-scan topic familiarity) are presented in **Table 4**. After adjustment, students exposed to the interactive multimedia module reported greater overall satisfaction with the course (both before and after in-person training) and were more confident in self-reported knowledge and ability to perform procedures independently prior to the in-person training.

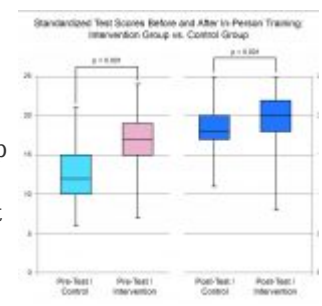


Figure 3.
[Click to enlarge](#)

received the same information prior to the hands-on training. These additional benefits (besides improved transfer of teaching material) represented a notable strength for the interactive multimedia approach, as they may have impacted learners' approach to in-person lab training. It is worth mentioning that the intervention group students were more satisfied with the material provided, despite demonstrating superior self-perception of knowledge prior to the hands-on in-person training as well as after the training. It may therefore be summarized that the interactive multimedia learning strategy provided a clearer assessment of students' familiarity with the topic, without generating undue distress or anxiety about future teaching activities (as reflected by greater satisfaction).

The study findings support Mayer's theory that interactive multimedia learning materials enhance the learning process by providing multiple representations of content as well as consistent, formative feedback.^{3,4} Additionally, the findings are consistent with a previous report of improved test scores for students who used computer-based patient cases rather than textbooks for diagnoses in urology.⁸ Moreover, the interactive component of the module, which allowed learners to test their understanding without negative consequences, supports the idea of a learner-centered approach for improving learning outcomes and learner satisfaction.⁴

Many instructors are at ease creating learning materials that incorporate audio and visual components, but the complexity of combining so many different elements can sometimes prove ineffective and even detrimental to learning if the designs are focused solely on incorporating the technology and not grounded in learning research and theory. As such, the development of effective online learning material that includes interactive multimedia may require a multidisciplinary team and can be time- and resource-intensive.^{19, 20}

The study reported here has some limitations. For example, it was not possible to measure the time each student took to prepare for the B-scan hands-on lab training or whether time spent on lab preparation could influence the overall knowledge acquisition outcome. Overall, the relatively large number of students who participated in the study is likely to have outweighed individual deviations from average preparation practices, lessening the impact of this limitation. Ultimately, the randomized nature of the utilized approach implies that unaccounted effects in the intervention group (e.g., greater time spent in preparation) are likely to be related to the intervention itself (e.g., more time spent in preparation due to more accurate self-perception of familiarity), rather than related to chance alone. Better capture of time allocated to self-preparation would have allowed better comparison of the intervention and control groups.

Another potential limitation of the study is the timing of study procedures. The control group underwent preparation and in-person training first (session 1 in the summer period), followed by the intervention group (session 2 in the summer period). It is therefore conceivable that test questions could be verbally shared by students in the control group with students in the intervention group, resulting in systematic bias in testing outcomes. Therefore, simultaneous test preparation and in-person training for the two groups would be preferable in future studies. Additional studies looking at material retention and competence maintenance long-term (weeks to months) after in-person training are warranted to fully explore the potential benefits of interactive multimedia learning in optometric education.

Conclusion

This study reveals the effectiveness of using an interactive multimedia module to prepare for in-person training in a clinical procedure commonly used by optometrists and ophthalmologists, B-scan ultrasound. The use of the interactive multimedia module resulted in a 20% improvement in material transfer, 8% improvement in knowledge retention and significantly improved satisfaction rates with the course preparation.

Further, this study provides a clear method for creating tangible learning gains through the integration of educational technology and supports current learning theory. It is recommended that design practices based on the work of Mayer be used in order to avoid cognitive overload.³ It is also recommended that an interactive component that helps learners apply and get feedback on their understanding be incorporated.

References

1. George PP, Papachristou N, Belisario JM, et al. Online eLearning for undergraduates in health professions: a systematic review of the impact on knowledge, skills, attitudes and satisfaction. *J Glob Health*. 2014 Jun;4(1):010406.
2. Choules AP. The use of elearning in medical education: a review of the current situation. *Postgrad Med J*. 2007 Apr;83(978):212-6.
3. Mayer RE. *Multimedia Learning*. Cambridge University Press. 2009.
4. Cairncross S, Mannion M. Interactive multimedia and learning: realizing the benefits. *Innovations in Education and Teaching International*. 2001;38(2):156-164.
5. Davids MR, Chikte UM, Halperin ML. Development and evaluation of a multimedia e-learning resource for electrolyte and

acid-base disorders. Adv Physiol Educ. 2011 Sep;35(3):295-306.

6. Duncan SF, Hendawi TK, Sperling J, Kakinoki R, Hartsock L. iPhone and iPad use in orthopedic surgery. Ochsner J. 2015 Spring;15(1):52-7.
7. Lee LA, Chao YP, Huang CG, et al. Cognitive style and mobile e-learning in emergent otorhinolaryngology-head and neck surgery disorders for millennial undergraduate medical students: randomized controlled trial. J Med Internet Res. 2018 Feb 13;20(2):e56.
8. Schneider AT, Albers P, Müller-Mattheis V. E-learning in urology: implementation of the learning and teaching platform CASUS® - Do virtual patients lead to improved learning outcomes? A randomized study among students. Urol Int. 2015;94(4):412-8.
9. Hsiao CC, Tiao M, Chen CC. Using interactive multimedia e-books for learning blood cell morphology in pediatric hematology. BMC Med Educ. 2016 Nov 14;16(1):290.
10. Choudhury B, Gouldsborough I, Gabriel S. Use of interactive sessions and e-learning in teaching anatomy to first-year optometry students. Anat Sci Educ. 2010 Jan-Feb;3(1):39-45.
11. Issa N, Mayer RE, Schuller M, Wang E, Shapiro M, DaRosa DA. Teaching for understanding in medical classrooms using multimedia design principles. Med Educ. 2013;47(4):388-96.
12. Kiviniemi MT. Effects of a blended learning approach on student outcomes in a graduate-level public health course. BMC Med Educ. 2014 March 11;14:47.
13. DiGiacinto D. Using multimedia effectively in the teaching-learning process. J Allied Health. 2007 Fall;36(3):176-9.
14. Effective Use of Educational Technology in Medical Education. Colloquium on Educational Technology: Recommendations and Guidelines for Medical Educators. Association of American Colleges. March 2007; 9.
15. Clark JM, Paivio A. Dual coding theory and education. Educ Psychol Rev. 1991 Sept;3(3):149-210.
16. Chandler P, Sweller J. Cognitive load theory and the format of instruction. Cogn Instr. 1991;8(4):293-332.
17. Mayer RE, Moreno R. A split-attention effect in multimedia learning: evidence for dual processing systems in working memory. Journal of Educational Psychology. 1998;90(2):312-320.
18. Casser L, Fingeret M, Woodcome HT. Atlas of Primary Eyecare Procedures. Stamford: Appleton & Lange, 1997: Section 66 B-Scan Ultrasound, 268-271.
19. Akl EA, Mustafa R, Slomka T, Alawneh A, Vedavalli A, Schünemann HJ. An educational game for teaching clinical practice guidelines to internal medicine residents: development, feasibility and acceptability. BMC Med Educ. 2008 Nov 18;8:50.
20. Topaz M, Rao A, Masterson Creber R, Bowles KH. Educating clinicians on new elements incorporated into the electronic health record: theories, evidence, and one educational project. Comput Inform Nurs. 2013;31(8):375-9.

Appendix I
10-Question Online Survey

The purpose of the 10-Question Online Survey is to check your familiarity with the subject prior to exposing you to B-scan reading material and lab. It is NOT graded and it is anonymous. If you do not know the correct answer, you are highly encouraged to guess the best answer. Please do not use any outside source of information (such as Google, B-scan books, etc.), as it will compromise the results of the study. For the same reason, you are also highly encouraged to answer the questions by yourself without anyone else's help.

Question 1: Do you have any experience with online interactive learning modules? (i.e., part of a course in which you actively participate online with various learning materials such as lecture material, videos, assessments, etc.)

A. I have never heard of it
B. I have some idea of what it is, but it's not very clear
C. I know what it is, but I never used it in the past
D. I know what it is, I used it before in my studies, and I believe it was a good learning tool
E. I know what it is, I used it in the past, but I don't believe it was a good learning tool

Question 2: How familiar are you with a B-scan ultrasound?

A. I have never heard of it
B. I have heard of it, but don't know what it is
C. I have some idea of what it is, but it's not very clear
D. I know what it is and could explain what it's used for
E. I know what it is and when to use it, and I feel confident using it independently

Question 3: What type of energy does a B-scan use?

A. Light
B. Radio
C. Magnetic field
D. X-ray
E. Gamma ray

Question 4: All of the following are indications for ordering a B-scan on a patient, EXCEPT:

A. Retinal detachment
B. Optic nerve head disease
C. Vitreous hemorrhage
D. Large elevated choroidal nevus
E. Dense vitreous hemorrhage

Question 5: All of the following are contraindications for ordering a B-scan on a patient, EXCEPT:

A. Penetrating injury
B. Intracocular surgery
C. Orbital abscess
D. Dense cataract
E. All of the above are considered a contraindication

Question 6: What type of scan represents a complete topographical B-scan? Select ALL that apply:

A. Longitudinal
B. Transverse
C. Axial
D. Sagittal
E. Coronal

Question 7: Which statement about B-scan is FALSE?

A. B-scan can only be performed when the eye is open
B. B-scan is a 2-dimensional scan
C. Orientation of a marker on the probe represents the top of the undistorted image
D. The projected image, when doing a B-scan, is called an echogram
E. When performing B-scan, the face of the probe gets in contact with the globe

Question 8: When doing a transverse scan (the patient looks superior and the probe is placed inferior), what part of the retina is being examined?

A. Superior
B. Inferior
C. Nasal
D. Temporal
E. Transverse scan scans posterior pole only

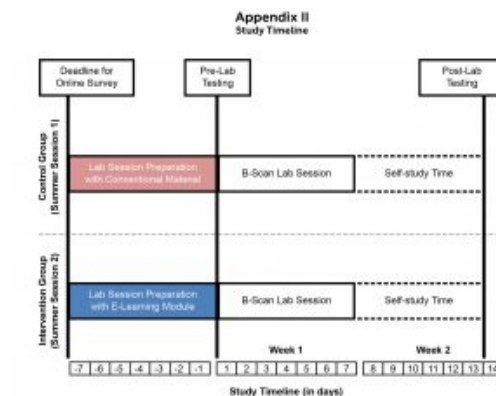
Question 9: Which type of probe position will allow the best localization of the optic nerve?

A. Transverse nasal scan
B. Transverse temporal scan
C. Longitudinal nasal scan
D. Longitudinal temporal scan
E. Axial scan

Question 10: How many clock hours does a typical B-scan image show?

A. 1-2 clock hours
B. 4-6 clock hours
C. 8-9 clock hours
D. 12 clock hours
E. It can be any combination of the above

Appendix I. [Click to enlarge](#)



Appendix II. [Click to enlarge](#)

Appendix III
Click to enlarge

This appendix contains a detailed list of questions and answers related to B-scan ultrasound. The questions cover topics such as the purpose of the survey, familiarity with online learning modules, B-scan ultrasound, energy used by B-scan, indications and contraindications for ordering a B-scan, types of scans, probe position, and clock hours shown in a typical B-scan image. The answers are provided for each question, with some questions having multiple correct answers.

Appendix III. [Click to enlarge](#)

Appendix IV Pre-Lab Self-Report Fund of Knowledge Questionnaire

The following is an evaluation survey for the B-scan technique preparation material you were given prior to this lab session. In order to improve the quality of the class and provide a better learning experience for future students, we kindly ask that you complete the following survey as accurately as possible.

Question	Strongly agree				Strongly disagree
	5	4	3	2	1
The B-scan prep material content covered all course-required topics adequately and in-depth.					
The B-scan prep material content was adequately tailored to your initial familiarity with the B-scan technique.					
You now have an adequate knowledge and understanding of the B-scan basics, indications and contraindications.					
The knowledge you acquired through the prep material provided an adequate foundation for you to perform a B-scan independently.					
Overall, you are satisfied with the way the B-scan prep material helped you to prepare for the B-scan lab.					

Appendix IV. [Click to enlarge](#)

Appendix V Post-Lab Self-Report Fund of Knowledge Questionnaire

The following is an evaluation survey for the ~~2020~~ B-scan course material (preparation material and lab portion) you were given during this course. To improve the quality of the class and provide a better learning experience for future students, we kindly ask that you complete the following survey as accurately as possible.

Question	Strongly agree				Strongly disagree
	5	4	3	2	1
The overall B-scan course content covered all course-required topics adequately and in-depth.					
The overall B-scan course content was adequately tailored to your initial familiarity with the B-scan technique.					
You now have an adequate knowledge and understanding of the B-scan basics, indications and contraindications.					
The knowledge you acquired through the overall B-scan course (prep material and lab) provided an adequate foundation for you to perform a B-scan independently.					
Overall, you are satisfied with the way the B-scan lab was organized and taught.					

Appendix V. [Click to enlarge](#)



Conjunctival Lymphoma: a Teaching Case Report

Jasmine Wong Yumori OD, FAAO, Naida Jakirlic OD, FAAO, and Kenneth Van, OD | Optometric Education: Volume 44 Number 3 (Summer 2019)

[PDF of Article](#)

Background

This teaching case report describes the diagnosis and care of an otherwise healthy 24-year-old Asian male with conjunctival lymphoma. The case report is appropriate as a teaching guide for optometry students at all levels. It provides a thorough review of conjunctival anatomy and physiology along with explanations of key findings, common clinical presentations, differential diagnoses, epidemiology, pathophysiology, risk factors, treatment and management options and prognosis for conjunctival lymphoma. Although conjunctival lymphomas are typically slow-growing, unilateral and rarely metastatic, students and facilitators are reminded that early diagnosis is critical to minimize the need for aggressive treatment and to optimize patient prognosis.

Case Description

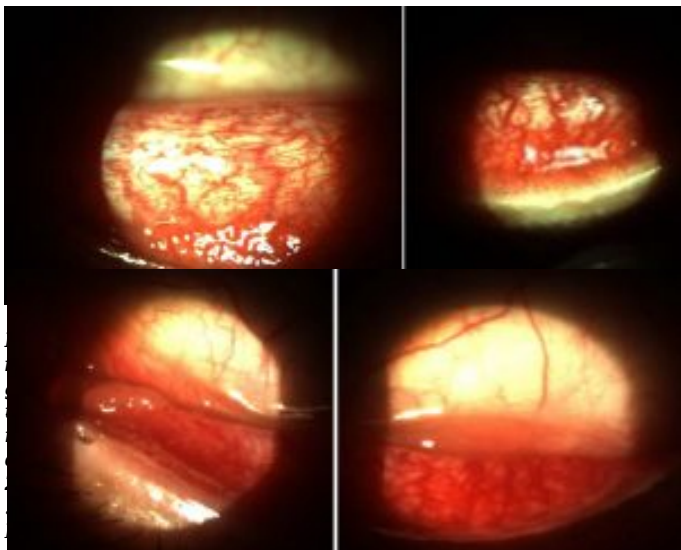
An initially asymptomatic 24-year-old Asian male was referred to Eye Care Institute at Western University of Health Sciences (Pomona, CA) for evaluation of multiple long-standing large follicles in the inferior conjunctiva of both eyes and newly noted salmon-colored gelatinous masses located in the inferior fornix of both eyes. The patient's systemic history included seasonal allergies and eczema. His family medical history was positive for an unknown stomach lymphoma in his paternal grandmother. His ocular history included chronic allergic conjunctivitis in both eyes. The patient denied any significant family ocular history. He reported no current medications. The patient indicated drug allergies to erythromycin, neomycin, fluorometholone and loteprednol, the latter two having been used recently to treat his suspected allergic conjunctivitis, which was unresponsive to more conservative therapy.

His best-corrected visual acuity was 20/20 in each eye. Slit-lamp examination revealed salmon-pink gelatinous masses in the inferior fornix of each eye (**Figures 1A and 1B**). The remainder of the examination was normal. The patient denied any known history of a recent viral illness, and preauricular, submandibular and cervical lymphadenopathy were absent. The patient was referred to a corneal specialist for a conjunctival biopsy.

Bilateral conjunctival biopsies were performed at Pacific Eye Care Institute (Upland, CA). The biopsy report showed a population of small- to medium-sized lymphocytes with high nuclear to cytoplasmic ratio, clumped chromatin with inconspicuous nucleoli and rounded nuclear contours with mildly irregular and clefted centrocytes. The cytoplasm was moderate to abundant with absence of necrotic debris. Immunohistochemistry stains showed population of neoplastic B-cells that were positive for BCL-2 and CD20, and lambda light chain restriction was found. The immunohistochemistry stains were negative for CD3, CD5, CD10, CD23 and CD43 markers. These histopathological findings were consistent with mucosa-associated lymphoid tissue (MALT) lymphoma.

The patient was referred to the hematology department at Keck Medicine of USC (Los Angeles, CA) for an extensive evaluation including full-body computed tomography (CT) and magnetic resonance imaging (MRI) of the head. Both were negative for active tissue beyond the orbit. The patient was referred to the radiation department at Keck Medicine of USC for treatment. External beam radiation therapy (EBRT, 16 treatments of 1.5 Gy for a total of 24 Gy) was delivered to both orbits.

Therapy was relatively well-tolerated. The patient experienced ocular dryness, which was successfully addressed with artificial tears. No changes in vision, eyelid edema or erythema, or other symptoms were noted. The patient had been followed closely after radiation treatment, and no evidence of disease recurrence had been seen by the time of this publication (**Figure 2**).



Educator's Guide

Learning objectives

At the end of this case discussion, readers should be able to:

- Identify the anatomical zones and main functions of the conjunctiva
- List appropriate differential diagnoses for a suspicious conjunctival mass
- Explain common assessment strategies for a conjunctival mass
- Describe the epidemiology, pathophysiology and risk factors associated with conjunctival lymphoma
- Describe key findings for conjunctival lymphoma
- Explain common treatment and management strategies for conjunctival lymphoma
- Describe the necessary systemic evaluation following a diagnosis of conjunctival lymphoma
- Discuss the expected prognosis and common complications for patients treated with EBRT for conjunctival lymphoma

Key concepts

- Recognize concerning signs of suspicious conjunctival masses
- Describe an abnormal conjunctival mass in a systematic manner
- List common assessment strategies for a conjunctival mass
- Recognize characteristic signs of conjunctival lymphoma
- Identify possible ocular complications associated with radiation therapy

Discussion questions

Knowledge and concepts required for critical review of the case

- what are the histological features of the conjunctiva?
- what anatomical structures are located within the conjunctiva?
- list the functions of the conjunctiva
- how do you systematically describe a conjunctival mass?
- describe the epidemiology, pathophysiology and risk factors associated with conjunctival lymphoma
- describe key clinical findings in patients with conjunctival lymphoma
- describe systemic complications associated with conjunctival lymphoma

2. Differential diagnoses

- a. list the main concerning and characteristic signs of a suspicious conjunctival mass
- b. list appropriate differential diagnoses for a suspicious conjunctival mass
- c. what assessment strategies are helpful in formulating a differential diagnosis?

3. Disease treatment and management

- a. which specialists should you involve in the care of a patient with a suspicious conjunctival mass?
- b. what is the appropriate timeline to refer patients with suspicious conjunctival lesions to the necessary specialist(s)?
- c. what is the gold standard for the treatment of localized conjunctival lymphoma?
- d. list alternative/additional treatment strategies and discuss the rationale behind each
- e. discuss the most likely prognosis and possible complications following treatment of patients with conjunctival lymphoma
- f. what is the follow-up schedule for patients with suspected and confirmed conjunctival lymphoma?
- g. what are potential ocular complications associated with radiation therapy?

4. Patient education

- a. how would you educate the patient regarding your suspected diagnosis?
- b. what is the most likely long-term prognosis for this patient?

5. Critical thinking

- a. how would you have managed this case? Justify your answer based on the findings
- b. what would have been a sign of poor prognosis?

Learning activity

1. Assign the case with selected discussion questions as homework during the Anterior Segment Disease course or as part of the clinical assignment
2. Require students to provide at least 2-4 recent, peer-reviewed articles to support their answers
3. Block off 1-2 hours during class or clinic time to allow students to present their answers and learn from each other; encourage questions from other students by providing participation credit incentives

Learning assessment

1. Assess knowledge regarding conjunctival lymphoma and differential diagnoses by use of multiple-choice and/or short-answer questions
2. Facilitate demonstration of clinical skills associated with anterior segment slit lamp examination including systematically describing abnormal clinical findings
3. Incorporate the case into clinical or didactic discussions

Discussion

Identify anatomical zones and main functions of the conjunctiva

The conjunctiva is a thin, translucent mucous membrane that starts at the eyelid edge between the outer and inner canthi and extends from the inner surface of the eyelids (i.e., palpebral or tarsal region) to the corneoscleral limbus on the globe (i.e., bulbar conjunctiva).¹ The conjunctival fornix connects the palpebral and bulbar sections. The conjunctiva is composed of non-keratinized stratified columnar-cuboidal epithelium overlying a layer of loose connective tissue termed the conjunctival

substantia propria.² Nerves, blood vessels, lymphocytes, mast, goblet and Langerhans cells, and the Wolfring and Krause accessory glands are located within the conjunctiva.³ It is crucial to highlight that lymphocytes are found in the superficial layer of the lamina propria, thus making up the MALT, i.e., the tissue that undergoes malignant transformation in conjunctival lymphoma. This is precisely the anatomic reason why conjunctival lymphoma presents as a mobile salmon-pink mass in the palpebral conjunctival fornices and why it can potentially metastasize to other parts of the body via lymph node dissemination.

Functions of the conjunctiva include:⁴

1. Protecting the orbit from the external environment
2. Facilitating movement of the eyelids and globe
3. Contributing to the immune defense system (e.g., secreting antibodies and antimicrobial proteins, and mediating cellular responses)
4. Supporting the optical function of the cornea
5. Tear secretion

List differential diagnoses for a conjunctival mass

While patients with a conjunctival mass can present with complaints of irritation, pain, discharge, epiphora and photophobia,^{5,6} most are asymptomatic. Thus, the initiation of the differential diagnostic process for an abnormal conjunctival mass is based on key signs, with a focus on concerning signs associated with possible malignancy. It is critical to highlight that lesion appearance should raise red flags for urgent investigation, but that the definitive diagnosis of a conjunctival lymphoma is ultimately determined via tissue biopsy. Nevertheless, students can follow a rule that is used to summarize clinical features of melanoma as a structured and systematic description of an amelanotic conjunctival mass and the initial groundwork for differential diagnoses. Known as the “ABCDE” rule,⁷ the acronym stands for:

- Asymmetry
- Border irregularity
- Color variation: both intralesional and interlesional
- Diameter: greater than 6 mm is more concerning for possible melanoma
- Evolving: new or changing lesion
- Funny-looking: unlike other lesions

Other concerning signs of a suspicious conjunctival mass include the presence of dilated feeder vessels, leukoplakia (surface keratinization) and transformation of surrounding tissue.⁸⁻¹⁰ **Figure 3** provides a summary of the differential diagnostic approach for abnormal conjunctival lesions.

Conjunctival lymphoma can present with asymmetry, irregular borders, color variation, larger diameter, signs of evolution and “funny-looking” characteristics. More specific key signs for a conjunctival lymphoma include the presence of a fleshy, vascularized, salmon-colored/fish-flesh swollen patch that is freely mobile and usually unilateral.² While definitive diagnosis is made through conjunctival biopsy with histopathologic examination, differential diagnoses for a conjunctival mass include:

- Papillary conjunctivitis
- Follicular conjunctivitis
- Ocular surface squamous neoplasia
- Squamous papilloma of the conjunctiva
- Conjunctival intraepithelial neoplasia (CIN)
- Carcinoma in situ
- Conjunctival squamous-cell carcinoma (SCC)
- Cystic benign melanosis (CBM) of the conjunctiva
- Conjunctival nevi
- Primary acquired melanosis (PAM)
- Conjunctival malignant melanoma (CMM)
- Oculodermal melanocytosis (ODM) or Nevus of Ota
- Conjunctival lymphoma

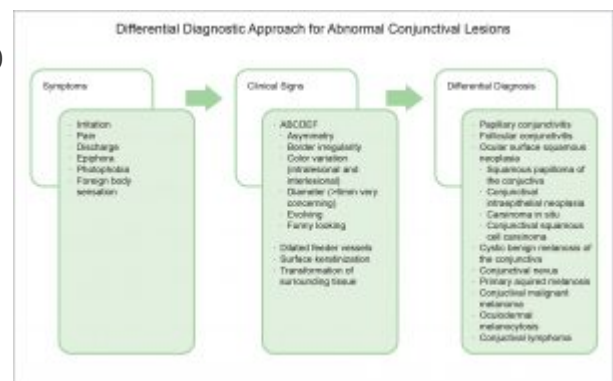


Figure 3.
[Click to enlarge](#)

Table 1 outlines key characteristics associated with these common conjunctival abnormalities.

Explain common assessment strategies for a conjunctival mass

Clinical descriptions of color, size, shape, consistency, symmetry, pigmentation, borders, elevation, presence of feeder vessels and exact anatomic location — whether conjunctival, subconjunctival or fixed to the globe — are crucial for distinguishing between diagnoses.¹¹ Assessment of the extent of the mass in the exam room can include:

- Cotton-tipped applicator wetted with topical anesthetic drop: easy movement implies localization to the conjunctiva
- Slit lamp biomicroscopy: clinical descriptions should include encroachment onto the cornea; evaluation involving eyelid elevation and ocular rotation is instrumental because masses can be hidden under the eyelid or in the fornix
- Gonioscopy: to assess the degree of intraocular angle involvement
- Lymph node examination: preauricular, submandibular and upper deep cervical lymph node examination is important to assess the presence and degree of lymph node involvement and disseminated disease

Ultrasound biomicroscopy, CT scans and/or MRI scans focusing on the anterior orbit, with gadolinium enhancement using 2-mm cuts, may also be considered to assess the degree of globe involvement and, with CT and MRI, possible orbital extension. Because it can be difficult to establish a diagnosis based on clinical examination alone, impression cytology, in-vivo confocal microscopy and/or biopsy with a systemic evaluation is usually necessary.

Describe the epidemiology, pathophysiology and risk factors associated with conjunctival lymphoma

Lymphoma is a malignant neoplasm stemming from a monoclonal proliferation of B-lymphocytes, T-lymphocytes and, rarely, natural killer cells.² Lymphoma may be divided into two types: Hodgkin and non-Hodgkin. MALT lymphoma is a subtype of non-Hodgkin lymphoma.²⁰ Conjunctival lymphoma constitutes approximately 25% of all ocular adnexal lymphoma and falls into the following subtypes, ranked in order of frequency: extranodal marginal zone lymphoma (EMZL; 96% of cases), follicular lymphoma, diffuse large B-cell lymphoma, and mantle-cell lymphoma.² Conjunctival lymphoma is the most common primary neoplasm²¹ and has been found in approximately 30% of patients with disseminated lymphoma.^{22,23} Although conjunctival lymphoma tends to be slow-growing, unilateral and indolent, systemic metastasis is seen in approximately 20% of patients; risk of metastasis increases in patients with a bilateral presentation; and the incidence of MALT ocular lymphoma is rising.^{22,23}

While conjunctival lymphoma is primarily seen in the elderly, it has been described in individuals as young as 33 months; trends have been identified regarding subtypes based on age, gender and pathogenesis. Chronic antigenic stimulation from pathogens including *Helicobacter pylori*, *Chlamydia psittaci* and hepatitis C² has been associated with conjunctival EMZL. Autoimmune disorders such as Sjögren syndrome,²⁴ systemic lupus erythematosus²⁵ and Hashimoto thyroiditis²⁶ have also been implicated in the pathogenesis of conjunctival EMZL. Additionally, chronic exposure to bioactive solvents and reagents²⁷ and genetic abnormalities such as translocations, inactivating mutations and trisomies² have been suspected to be related to conjunctival EMZL.

Describe key findings for conjunctival lymphomas

Patients report few symptoms because conjunctival MALT lymphoma lacks a connective tissue stroma and is thus able to mold to surrounding tissue without causing ocular irritation.¹¹ Therefore, careful slit lamp examination is crucial for identification of the malignant lesions. Characteristic findings of conjunctival lymphoma identified during slit lamp biomicroscopy include the presence of a fleshy, vascularized, salmon-pink patch that is readily movable.² Because differentiating between benign inflammation and a malignant lymphoid tumor is challenging based on clinical exam alone, patient referral for biopsy with histopathologic examination is necessary for a definitive diagnosis.¹⁹

Explain common treatment and management strategies for conjunctival lymphoma

TABLE 1 Common Conjunctival Masses and Associated Key Characteristics*	
Conjunctival abnormalities	Key characteristics
Papillary conjunctivitis	Flattened cobblestone nodules with central vascularized zone, redness on the surface, more pain at the base, commonly associated with allergic response, foreign body (contact lens, ocular prostheses) ¹¹
Follicular conjunctivitis	Small dome-shaped nodules without a prominent vascularized core, commonly associated with viruses, atypical bacteria, toxins ¹¹
Squamous papilloma of the conjunctiva	Besule (papilloma) or pedunculated with single or multiple cauliflower-like masses that contain central fibrovascular cores ^{11,14}
Conjunctival intraepithelial neoplasia (CIN)	Poorly defined gelatinous mass with leukoplakia, commonly sessile, involves the replacement of conjunctival epithelial cells with atypical squamous cells without invasion of the sublamellae propria ¹¹
Carcinoma in situ	Opaque pinkish mass with minimal leukoplakia, occurs at the limbus, full-thickness replacement of conjunctival epithelial cells with malignant cells ¹¹
Conjunctival squamous cell carcinoma (CSC)	Raised gelatinous mass with adjacent feeder vessels located at the corneoscleral limbus, usually or temporarily associated with ocular ultraviolet radiation; fusiform intraepithelial virus, and human papillomavirus, affects the epithelial basement membrane and sublamellae propria, may invade other contiguous tissues, rarely leads to distant metastases ¹¹
Cystic benign melanosis (CBM) of the conjunctiva	Flat, non-vascularized, freely to loosely granular brown pigmentation that contains cysts, usually bilateral, may be asymmetric; generally occurs in the peripheral and interpalpebral zone of the bulbar conjunctiva; commonly seen in dark skin persons with racial melanosis, less well-defined edges, may involve the corneal epithelium ¹¹
Ocular dermal melanocytosis (ODM) or Nevus of Ota	Conjunctival slate-gray periorbital fat cutaneous pigmentation; associated episcleral, orbital and nasal pigmentation; unilateral; does not move with movement of conjunctiva, potentially associated with glaucoma and melanomas, more common in Black and Asian races ^{11,14}
Conjunctival nevi	Well-defined, focal, elevated, mobile mass at the interpalpebral area; usually pigmented, may be avascular; often contains intraneural melanocytic cysts, does not involve the cornea, manifests during the first two decades of life, can change in appearance with hormonal changes (pregnancy, puberty); very small risk of developing into conjunctival malignant melanoma ¹¹
Primary acquired melanosis (PAM)	Flat, well-defined, variably brown superficial patches that move with the conjunctiva, size and pigmentation varies and varies, usually unilateral; can cover large aspects of the conjunctiva, can transform into conjunctival malignant melanoma (more commonly seen in field with atypia) ¹¹
Conjunctival malignant melanoma (CMM)	Elevated, immobile nodular malignancy with feeder vessels, variable pigmentation, high vascularity that leads to easy bleeding surface, arises from anywhere involving bulbar, limbal, palpebral conjunctiva or the canaliculi, most commonly originates from PAM, may also arise de novo or from nevus, may extend beyond the fornices to enter orbit, spreads systemically ^{11,14}
Conjunctival lymphoma	Fleshy, vascularized, salmon-colored/flush flesh-colored patch; freely mobile, usually unilateral ¹¹

Table 1.
[Click to enlarge](#)

The main roles of primary care optometry in the care of a patient with a conjunctival lymphoma include:

1. Identifying and describing clinical findings
2. Appropriately educating the patient regarding clinical suspicion and planning; while the level of detail is dependent on clinical findings and characteristics of both the provider and patient, a focus on providing the correct amount and type of information, aiding accurate recall and understanding, incorporating the patient's perspective, and ensuring shared decision-making are important²⁸
3. Referring the patient for further evaluation including consideration for a conjunctival biopsy with an ophthalmologist, specifically a corneal specialist because others may not have the appropriate resources or experience

While no specific guidelines exist regarding the ideal timeline to refer patients for biopsy, a prompt referral with increasing urgency based on more suspicious clinical findings is appropriate. The initial referral for conjunctival biopsy should be made to an oculoplastic or corneal specialist. Pathology should also likely be involved to provide definitive diagnosis before involvement with hematology, radiology and other specialties for staging and initiating treatment.

Isolated conjunctival MALT lymphoma is most often treated by radiology with EBRT²⁹ with or without chemotherapy. EBRT is highly effective and is the current gold standard treatment, with a complete remission rate of 86-100% and a five-year overall survival rate for approximately 94%.¹¹ While no specific consensus has emerged regarding the optimal planning target volume of radiotherapy for treating patients with conjunctival lymphoma, the normal EBRT dose range is 15-45 Gy.² Including the entire conjunctiva and eyelid within the treatment area has been recommended because the conjunctiva has intrinsic lymphoid tissue.²⁹ Alternative treatment methods include chemotherapy, immunotherapy with monoclonal antibodies and/or interferon- α , brachytherapy, complete excision, cryotherapy and careful observation.² Single-agent or combination chemotherapy is typically used for patients with disseminated disease,²² and there is a recent movement towards use of monoclonal antibody therapy for better local control, less tissue toxicity and better overall systemic control compared to orbital radiotherapy.²¹ Other variables that can influence management include the patient's symptoms, ocular surface health and quality of life.

Describe the systemic evaluation associated with a diagnosis of conjunctival lymphoma

Conjunctival lymphoma presents with co-existing systemic lymphoma in approximately one-third of patients.²¹⁻²³ Thus, if the diagnosis of conjunctival lymphoma is confirmed, a thorough clinical examination is necessary. It is necessary to include basic hematologic screening tests (complete blood count, white blood cell differential, serum immunoprotein electrophoresis), full-body positron emission tomography and CT or MRI, and bone marrow biopsy.^{2,21} A gastrointestinal endoscopy is also recommended for patients with MALT lymphoma because gastrointestinal tract involvement is frequent.³⁰ Characteristics of conjunctival lymphoma that increase the risk for disseminated systemic lymphoma include fornicial or mid-bulbar location, multifocality and bilaterality.²³

Discuss the expected prognosis and common complications for patients treated with EBRT for conjunctival lymphoma

Successful treatment of conjunctival lymphoma generally has a very good prognosis regardless of type.² Low-grade B-cell NHL carries the best prognosis followed by EMZL in which only 9% of patients experience progression or recurrence within the first year of treatment.² T-cell NHL has the worst prognosis. Specifically, while 90% of conjunctival lymphoma cases do not progress or recur within the first year of treatment, a staggering 50% of patients with T-cell NHL undergo progression or recurrence of the cancer. Other factors that influence prognosis include stage of the cancer, patient age, and non-bulbar location of the lesion. Standard follow-up is every three months for the first year followed by every six to 12 months thereafter.²² It has been suggested that response to treatment, specifically a slow response to radiotherapy, may be associated with the development of metachronous lesions so more frequent follow-up may be required for such patients.²⁹

Common complications for patients treated with EBRT for conjunctival lymphoma include xerophthalmia, keratitis, cataract and retinal damage.¹¹ Such complications are important to discuss and address with patients. For example, lens shielding can minimize cataract development,²⁹ and continued follow-up is needed.

Prognosis of untreated conjunctival MALT lymphoma

While conjunctival lymphoma is rarely lethal, and tumors tend to remain confined to the involved conjunctiva, systemic spread via lymph node infiltration, systemic dissemination to extranodal organs, and contralateral conjunctival involvement can occur, particularly if the cancer is left untreated. If systemic lymphoma develops, the prognosis is determined mainly by the grade of the lymphoma.

Conclusion

Though relatively uncommon, conjunctival lymphoma can present in young adults. Careful clinical evaluation using appropriate assessment strategies is critical to identify concerning conjunctival masses. It is important to promptly involve appropriate specialists to definitively diagnose, treat and manage this cancer because delays may lead to systemic dissemination, a more complicated treatment and poorer prognosis.

References

1. Remington LA. Clinical anatomy of the visual system. St. Louis, MO: Elsevier; 2005.
2. Kirkegaard MM, Coupland SE, Prause JU, Heegaard S. Malignant lymphoma of the conjunctiva. *Surv Ophthalmol*. 2015;60(5):444-58. Epub 2015/05/25. doi: 10.1016/j.survophthal.2015.05.001. PubMed PMID: 26003619.
3. Yanoff M, Fine B. Conjunctiva. In: Yanoff M, Fine B, editors. *Ocular pathology*. St. Louis, MO: Mosby; 2002.
4. Sehu K, Lee WK. *Ophthalmic pathology: an illustrated guide for clinicians*. Oxford: BMJ Books/Blackwell Pub; 2005.
5. Mehta M, Fay A. Squamous cell carcinoma of the eyelid and conjunctiva. *Int Ophthalmol Clin*. 2009;49(1):111-21. Epub 2009/01/07. doi: 10.1097/IIO.0b013e3181928fb9. PubMed PMID: 19125070.
6. Yumori JW, Ilse P, Bright DC. Conjunctival plasmacytoma. *Optometry*. 2010;81(5):234-9. Epub 2010/05/04. doi: 10.1016/j.optm.2009.11.006. PubMed PMID: 20435269.
7. Jensen JD, Elewski BE. The ABCDEF rule: combining the "ABCDE rule" and the "ugly duckling sign" in an effort to improve patient self-screening examinations. *J Clin Aesthet Dermatol*. 2015;8(2):15. Epub 2015/03/06. PubMed PMID: 25741397. PubMed Central PMCID: PMC4345927.
8. Hamam R, Bhat P, Foster CS. Conjunctival/corneal intraepithelial neoplasia. *Int Ophthalmol Clin*. 2009;49(1):63-70. Epub 2009/01/07. doi: 10.1097/IIO.0b013e3181924ec3. PubMed PMID: 19125065.
9. Laird PW, Woodward MA, Williams JG, Lee WB, Grossniklaus HE. Cystic benign melanosis of the conjunctiva. *Cornea*. 2012;31(11):1273-7. Epub 2012/10/10. doi: 10.1097/ICO.0b013e31823d1ec4. PubMed PMID: 23044615. PubMed Central PMCID: PMC467456.
10. Oellers P, Karp CL. Management of pigmented conjunctival lesions. *Ocul Surf*. 2012;10(4):251-63. Epub 2012/10/23. doi: 10.1016/j.jtos.2012.08.002. PubMed PMID: 23084146.
11. Othman IS. Ocular surface tumors. *Oman J Ophthalmol*. 2009;2(1):3-14. Epub 2009/01/01. doi: 10.4103/0974-620X.48415. PubMed PMID: 21234217. PubMed Central PMCID: PMC3018103.
12. American Academy of Ophthalmology. Papillary versus follicular conjunctivitis 2018 [cited 2018 June 5th]. Available from: <https://www.aao.org/bcscsnippetdetail.aspx?id=9d2ac3f7-43cb-4096-9c26-3c7b6d052e20>
13. Sjo N, Heegaard S, Prause JU. Conjunctival papilloma. A histopathologically based retrospective study. *Acta Ophthalmol Scand*. 2000;78(6):663-6. Epub 2001/02/13. PubMed PMID: 11167228.
14. Huang YM, Huang YY, Yang HY, et al. Conjunctival papilloma: clinical features, outcome, and factors related to recurrence. *Taiwan J Ophthalmol*. 2018;8(1):15-8. Epub 2018/04/21. doi: 10.4103/tjo.tjo_2_18. PubMed PMID: 29675344. PubMed Central PMCID: PMC5890578.
15. Crim N, Fornies-Paz ME, Monti R, Esposito E, Maccio JP, Urrets-Zavalía JA. In situ carcinoma of the conjunctiva: surgical excision associated with cryotherapy. *Clin Ophthalmol*. 2013;7:1889-93. Epub 2013/10/05. doi: 10.2147/OPTH.S50762. PubMed PMID: 24092968. PubMed Central PMCID: PMC3788814.
16. Ong SS, Vora GK, Gupta PK. Anterior segment imaging in ocular surface squamous neoplasia. *J Ophthalmol*. 2016;2016:5435092. Epub 2016/11/02. doi: 10.1155/2016/5435092. PubMed PMID: 27800176. PubMed Central PMCID: PMC5069377.
17. Swann PG, Kwong E. The naevus of Ota. *Clin Exp Optom*. 2010;93(4):264-7. Epub 2010/06/11. doi: 10.1111/j.1444-0938.2010.00484.x. PubMed PMID: 20533926.
18. Plateroti AM, Scavella V, Abdolrahimzadeh B, Plateroti R, Rahimi S. An update on oculodermal melanocytosis and rare associated conditions. *Semin Ophthalmol*. 2017;32(4):524-8. Epub 2016/04/16. doi: 10.3109/08820538.2015.1118133. PubMed PMID: 27083007.
19. Shields CL, Kels JG, Shields JA. Melanoma of the eye: revealing hidden secrets, one at a time. *Clin Dermatol*. 2015;33(2):183-96. Epub 2015/02/24. doi: 10.1016/j.clindermatol.2014.10.010. PubMed PMID: 25704938.
20. Swerdlow S, Campo E, Harris N. WHO classification of tumours of haematopoietic and lymphoid tissues. 4th edition ed. Lyon: IARC Press; 2008.
21. Hatef E, Roberts D, McLaughlin P, Pro B, Esmaeli B. Prevalence and nature of systemic involvement and stage at initial examination in patients with orbital and ocular adnexal lymphoma. *Arch Ophthalmol*. 2007;125(12):1663-7. Epub 2007/12/12. doi: 10.1001/archophth.125.12.1663. PubMed PMID: 18071119.
22. Sein J, Stefanovic A, Karp C. Diagnosis and treatment of conjunctival lymphoma 2012 [cited 2018 Sept 12, 2018]. Available from: <http://www.aao.org/eyenet/article/diagnosis-treatment-of-conjunctival-lymphoma/>.
23. Honavar SG, Manjandavida FP. Tumors of the ocular surface: a review. *Indian J Ophthalmol*. 2015;63(3):187-203. Epub 2015/05/15. doi: 10.4103/0301-4738.156912. PubMed PMID: 25971163. PubMed Central PMCID: PMC4448231.
24. Bjerrum KB. Primary Sjogren's syndrome and keratoconjunctivitis sicca: diagnostic methods, frequency and social disease

- aspects. *Acta Ophthalmol Scand Suppl.* 2000(231):1-37. Epub 2002/01/05. PubMed PMID: 11763500.
25. Arevalo JF, Lowder CY, Muci-Mendoza R. Ocular manifestations of systemic lupus erythematosus. *Curr Opin Ophthalmol.* 2002;13(6):404-10. Epub 2002/11/21. PubMed PMID: 12441845.
26. Hyjek E, Isaacson PG. Primary B cell lymphoma of the thyroid and its relationship to Hashimoto's thyroiditis. *Hum Pathol.* 1988;19(11):1315-26. Epub 1988/11/01. PubMed PMID: 3141260.
27. American Academy of Ophthalmology. Orbit, eyelids, and lacrimal system, section 7. San Francisco: American Academy of Ophthalmology; 2014.
28. Kurtz S, Silverman J, Benson J, Draper J. Marrying content and process in clinical method teaching: enhancing the Calgary-Cambridge guides. *Acad Med.* 2003;78(8):802-9. Epub 2003/08/14. PubMed PMID: 12915371.
29. Uno T, Isobe K, Shikama N, et al. Radiotherapy for extranodal, marginal zone, B-cell lymphoma of mucosa-associated lymphoid tissue originating in the ocular adnexa: a multiinstitutional, retrospective review of 50 patients. *Cancer.* 2003;98(4):865-71. Epub 2003/08/12. doi: 10.1002/cncr.11539. PubMed PMID: 12910532.
30. Niksirat H, Sarvi K, Amiri BM, Karami M, Hatef A. In vitro storage of unfertilized ova of endangered Caspian brown trout (*Salmo trutta caspius*) in artificial media. *Anim Reprod Sci.* 2007;100(3-4):356-63. Epub 2006/09/22. doi: 10.1016/j.anireprosci.2006.08.019. PubMed PMID: 16987621.



Optic Neuritis Associated with Multiple Sclerosis: a Teaching Case Report

Betty Wang, OD, FAAO, and Callista Belles, OD | Optometric Education: Volume 44 Number 3 (Summer 2019)

[PDF of Article](#)

Background

Optic neuritis is an acute inflammatory demyelinating injury to the optic nerve. Optic neuritis is the presenting feature in up to 20% of multiple sclerosis (MS) patients and occurs in up to 50% of MS patients at some point during their lifetime. The two most common symptoms of acute optic neuritis are vision loss and eye pain. Optic nerve edema is seen in one-third of MS patients, and two-thirds of patients have a normal optic nerve appearance, known as retrobulbar optic neuritis. Gadolinium contrast-enhanced magnetic resonance imaging (MRI) of the brain and orbits, showing hyperintense white matter abnormalities, is used for diagnosis. In the Optic Neuritis Treatment Trial (ONTT), intravenous corticosteroids accelerated visual recovery and oral corticosteroids alone did not improve visual outcome and were associated with an increased rate of optic neuritis recurrence. Baseline gadolinium contrast-enhanced MRI of the brain and orbits is an essential tool for the diagnosis and management of optic neuritis and also serves as a predictor of recurrent episodes. Chronic features of optic neuritis include reduced visual acuity, color desaturation, optic atrophy and visual field loss.

The patient in this case report presented to clinic reporting acute onset of blurred vision, blind spots and halos in the left eye. Although his visual acuity and color vision remained normal, he had a new visual field defect in the left eye and optic nerve swelling. The patient was promptly treated with a four-day course of intravenous corticosteroids. At the two-week follow-up exam, his symptoms and visual field defect were resolved. For prompt evaluation and treatment, it is crucial for eye physicians to educate patients with a history of MS on the symptoms and signs of optic neuritis.

Student Discussion Guide

Case presentation

A 38-year-old Caucasian male presented to the Orlando VA Eye Clinic on Oct. 24, 2017, for a scheduled six-month ocular health exam and follow-up on MS with no history of optic neuritis. The patient reported no changes in vision since his previous eye exam on June 22, 2017. He stated that he still saw blue rings in both eyes two to three times a week and experienced occasional blurred vision following exercise or hot showers, which was reported at his last eye exam. The patient's ocular history included dry eye syndrome OU, forme fruste keratoconus OD, early cataracts OU, lattice degeneration with atrophic retinal holes OU, and MS with no history of optic neuritis. However, the patient did experience Uhthoff's symptoms of blue rings in vision when overheated or after exercise. The patient was diagnosed with MS in 2014, which was managed by the VA neurology clinic. His most recent brain MRI without contrast was on June 14, 2017, consistent with the clinical impression of MS with presence of infratentorial and supratentorial lesions. The scan was stable with no interval development of new lesions from his prior brain MRI on Jan. 7, 2016. His systemic medications for MS included dimethyl fumarate (Tecfidera) 240 mg twice a day, aspirin 325 mg once a day and Vitamin D3 1000 IU supplement twice a day. The patient's systemic health was otherwise unremarkable. The only ocular medication used was artificial tears two to four times a day as needed for dry eye symptoms.

Visual acuity in the right eye was 20/25 due to mild keratoconus, which was stable, and 20/20 in the left eye. Pupils were equal, round and reactive to light without a relative afferent pupillary defect (APD). Confrontation visual fields and extra ocular motility testing were normal in both eyes. Color vision tested with the Farnsworth Panel D-15 was normal in each eye. Anterior segment exam showed mild corneal thinning of the right eye but was otherwise unremarkable in both eyes. Intraocular pressure was 12 mmHg in each eye. Anterior cortical lenticular changes were present in both eyes. The optic nerves of both eyes were healthy with no edema or pallor; a positive spontaneous venous pulsation was present. Optic nerve glial tissue was present in both eyes (**Figure 1**). The cup to disc ratio was 0.35 in the right eye and 0.25 in the left eye. Peripheral retinal lattice with atrophic holes was present in both eyes and was stable from the patient's prior dilated fundus exam. Optical coherence tomography (OCT) of the retinal nerve fiber layer (RNFL) was performed (Spectralis, Heidelberg Engineering). The RNFL was normal in all quadrants and sectors compared to age-matched normative data and stable to the scan obtained at the prior visit (**Figure 2**). Humphrey visual field 24-2 SITA Standard testing was completed prior to pupil dilation and revealed a full field in each eye (**Figure 3**).

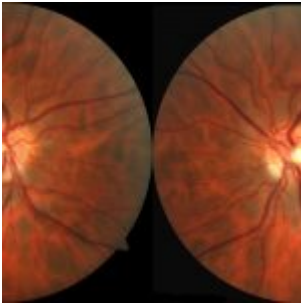


Figure 1. Optic nerve photographs of the right eye and left eye.
[Click to enlarge](#)

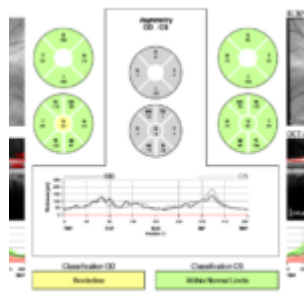


Figure 2. OCT of the retinal nerve fiber layer.
[Click to enlarge](#)

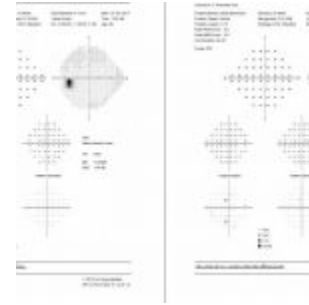


Figure 3. Humphrey 24-2 SITA Standard visual field test of the left eye and right eye.
[Click to enlarge](#)

The patient was informed of stable clinical optic nerve findings with no signs of optic neuritis. He was advised to follow-up with his neurologist as scheduled on Feb. 26, 2018, and to return to the eye clinic in six months for a follow-up. He was educated on the symptoms of acute optic neuritis and instructed to return to clinic immediately if any acute eye pain, vision loss or other acute changes in vision occurred prior to his next appointment.

Follow-up #1

The patient returned to clinic 10 days later, on Nov. 3, 2017, as an urgent care walk-in reporting acute onset of blurred vision, blind spots and halos in the left eye, which started one day prior. He verified no vision loss and no eye pain associated with his symptoms.

Visual acuity remained stable at 20/25 in the right eye and 20/20 in the left eye. Pupils were equal, round and reactive to light without a relative APD. Confrontation visual fields and extra ocular motility testing were normal in both eyes. There was no pain with eye movement. D15 color vision testing was repeated and remained normal in each eye. Humphrey visual field 24-2 SITA Standard was completed on the left eye only and showed a new superior cluster of points appearing as a vertical line just temporal from center (**Figure 4**). The mean deviation and pattern standard deviation worsened since the visual field test on October 24, 2017. The mean deviation was reduced from -0.28 to -3.96 decibels, and the pattern standard deviation increased from 1.07 to 2.22 decibels (**Figure 4**). Due to time constraints on the day of this urgent care visit, a second visual field test of the left eye was not completed to determine repeatability of the new field defect.

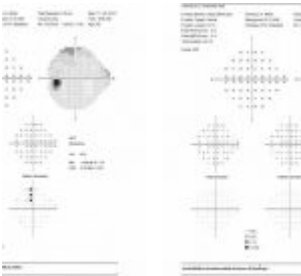


Figure 4. Humphrey 24-2 SITA Standard visual field test of the left eye on Nov. 3, 2017 (left) compared to Oct. 24, 2017 (right).
[Click to enlarge](#)

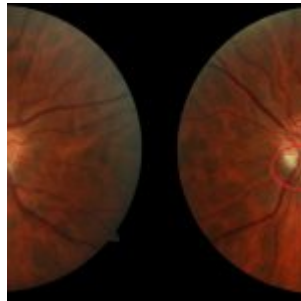


Figure 5. Optic nerve photos of the right eye and left eye at the first follow-up visit.
[Click to enlarge](#)

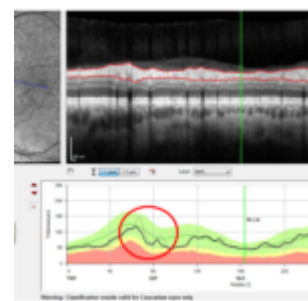


Figure 6. OCT of the retinal nerve fiber layer of the left eye. The thicker black line corresponds to the scan on Nov. 3, 2017. The thinner grey line corresponds to the baseline scan.
[Click to enlarge](#)

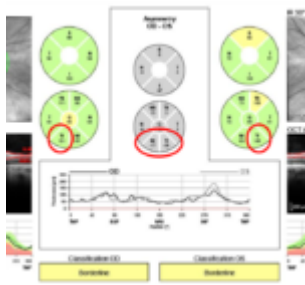


Figure 7. OCT of the retinal nerve fiber layer of the right and left eye. Note the asymmetry of the inferior quadrant and inferior temporal sector showing thicker retinal nerve fiber layer in the left eye, particularly the 38-micron difference in the inferior temporal sector.

[Click to enlarge](#)

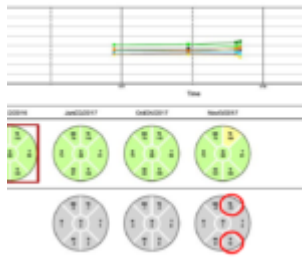


Figure 8. OCT retinal nerve fiber layer progression report for the left eye.

[Click to enlarge](#)

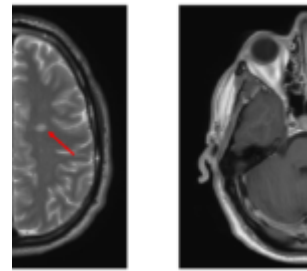


Figure 9. MRI of the brain with and without contrast showing new intracranial white matter T2 hyperintensities.

[Click to enlarge](#)

Anterior segment exam was significant for mild corneal thinning in the right eye, which was noted at the patient's previous visit and stable. All other anterior segment findings were normal. Intraocular pressure was 11 mmHg in the right eye and 14 mmHg in the left eye. Optic nerve evaluation was unremarkable in the right eye (**Figure 5**). The left optic nerve showed blurring of the disc margin from 6-11 o'clock and mild sectoral disc edema with associated elevation of the RNFL in the inferior quadrant (**Figure 5**). The cup to disc ratio was 0.35 in the right eye and 0.25 in the left eye. Both optic nerves were pink and showed a spontaneous venous pulse. There were no hemorrhages in either eye. The glial tissue inferior nasal in the left eye was previously noted.

OCT of the RNFL of the left eye showed a decrease in thickness compared to baseline in the superior temporal sector and a slight increase compared to baseline and the Oct. 24, 2017, scan in the inferior temporal sector (**Figure 6**). Comparison of OCT of the RNFL in the right and left eye showed asymmetry inferior showing thicker RNFL in the left eye than right, particularly in the inferior temporal sector where there was a 38-micron difference between the eyes (**Figure 7**). The RNFL progression report for the left eye showed an increase of 13 microns in the inferior temporal sector and a decrease of 10 microns in the superior temporal sector from baseline 11 months prior (**Figure 8**). The increased thickness of the inferior temporal sector correlated to both the clinical exam showing mild disc edema inferior and a new superior visual field defect.

The differential diagnoses for the findings of acute unilateral sectoral disc edema with an associated visual field defect were non-arteritic anterior ischemic optic neuropathy, Leber's hereditary optic neuropathy, compressive optic neuropathy, inflammatory, infectious, infiltrative optic neuropathies, and acute optic neuritis associated with MS.

Based on the patient's presenting symptoms of blurred vision, blind spots and halos in the left eye, history of MS and clinical exam findings of a new superior visual field defect that corresponded to inferior optic nerve edema seen clinically and confirmed with OCT, the patient was diagnosed with acute optic neuritis of the left eye associated with MS. The on-call neurologist was contacted to discuss the case, and the patient was directed to the Orlando Lake Nona VA emergency department for additional lab testing, brain MRI and possible admission for intravenous steroids.

The patient was evaluated at the Lake Nona emergency department that afternoon. Additional laboratory testing included erythrocyte sedimentation rate, complete blood count and c-reactive protein, all of which were within normal ranges. MRI of the brain with and without contrast was performed and showed new intracranial white matter T2 hyperintensities as well as scattered foci of enhancement consistent with active and new demyelination superimposed on a background of MS (**Figure 9**). MRI of the orbits showed normal optic nerves in both eyes, which were symmetrical in size and signal. The patient was admitted for a course of intravenous methylprednisolone (Solumedrol) 1 gram daily for four days. He was discharged on Nov. 7, 2017, in stable condition, and he reported that his blurred vision, blind spots and halos were improving. The neurologist and hospitalist recommended the patient follow-up with the eye clinic in one to two weeks and continue his current medications (Tecfidera 240 mg twice a day, aspirin 325 mg once a day and Vitamin D3 1000 IU supplement twice a day).

Follow-up #2

The patient returned to the eye clinic on Nov. 17, 2017, for a follow-up visit reporting that his symptoms of blurred vision, blind spots and halos resolved three days after being discharged with no recurrence. Visual acuity remained stable at 20/25 in the right eye and 20/20 in the left eye. Pupils were equal, round and reactive to light without a relative APD. Humphrey visual field 24-2 SITA Standard testing was completed prior to dilation and revealed a full field in each eye (**Figure 10**). The visual field

defect in the left eye noted on Nov. 3, 2017, was resolved.

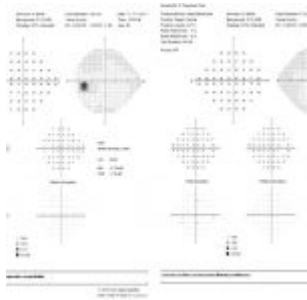


Figure 10. Humphrey 24-2 SITA Standard visual field test of the left eye and right eye at the second follow-up visit. [Click to enlarge](#)

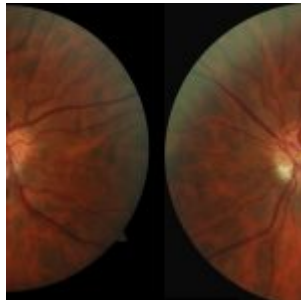


Figure 11. Optic nerve photos of the right eye and left eye at the second follow-up visit. [Click to enlarge](#)

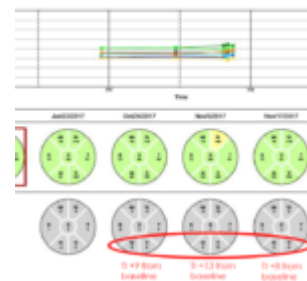


Figure 12. OCT retinal nerve fiber layer progression report for the left eye at the second follow-up visit. [Click to enlarge](#)

Anterior segment examination of both eyes revealed no changes since the prior visit. Intraocular pressure was 10 mmHg in right eye and 11 mmHg in the left eye. Optic nerve evaluation remained unremarkable in the right eye, and the left optic nerve showed residual sectoral edema inferior (**Figure 11**). The cup to disc ratio was stable, 0.35 in the right eye and 0.25 in the left eye. The OCT RNFL progression report showed the thickness of the inferior temporal quadrant on Nov. 17, 2017, was reduced compared with Nov. 3, 2017, and had returned to within 1 micron of the thickness compared with Oct. 24, 2017 (**Figure 12**). The RNFL thickness changes measured by OCT correlated with the clinical optic nerve evaluation and visual field test results for the left eye as well as with the patient's symptoms.

The patient was informed of the improved optic nerve and visual field findings for his left eye. He was advised to follow-up with his neurologist as scheduled on Feb. 26, 2018, and to return to the eye clinic in six weeks for a follow-up exam. He was reminded about the symptoms of acute optic neuritis, informed that the condition could return, and instructed to return to clinic immediately if any acute eye pain, vision loss or other acute changes in vision occurred prior his next appointment.

Key concepts

1. Optic neuritis is an acute inflammation of the optic nerve that is typically monocular and presents with sudden vision loss and eye pain
2. Optic neuritis is the presenting feature in up to 20% of MS patients and occurs in up to 50% of MS patients
3. In the ONTT, one-third of patients were found to have signs of optic nerve inflammation; two-thirds of patients had a normal optic nerve appearance, known as retrobulbar optic neuritis
4. The ONTT showed that high-dose intravenous corticosteroid treatment is beneficial for acute attacks and that oral corticosteroid alone is contraindicated due to increased risk of recurrence
5. Gadolinium contrast-enhanced MRI of the brain and orbits provides confirmation of optic neuritis, and baseline MRI findings are an important predictor of the future risk of MS
6. With prompt and appropriate detection, treatment and referral, eye physicians can play a significant role in reducing the risk of permanent vision impairment associated with optic neuritis

Learning objectives

1. To define optic neuritis, list etiologies of the disease and understand its association with MS
2. To gain knowledge about the signs and symptoms of optic neuritis associated with MS
3. To gain insight into the optometrist's role in the management and follow-up of patients with MS, the importance of regular dilated eye exams, and the incorporation of additional testing and imaging including visual fields, color vision, optic nerve photographs and RNFL OCT
4. To describe the main findings of the ONTT and their relevance to the management and treatment of optic neuritis associated with MS
5. To gain knowledge about contrast-enhanced brain MRI findings in the diagnosis of MS and optic neuritis, and to predict the risk for future recurrence as found in the ONTT
6. To understand the importance of educating MS patients on the signs and symptoms of acute optic neuritis and the need for prompt evaluation and treatment to prevent optic nerve and RNFL damage, which can lead to permanent vision loss

Discussion questions

1. Background knowledge of optic neuritis and MS

- a. Define optic neuritis and MS
- b. List the etiologies for optic neuritis
- c. Explain the pathogenesis of optic neuritis in MS
- d. In the ONTT what were the two most common symptoms reported?
- e. Discuss the clinical signs of optic neuritis and the additional tests and imaging needed for diagnosis
- f. Discuss the chronic features of optic neuritis
- g. What were the significant findings of the ONTT for treatment of optic neuritis?
- h. Explain why oral corticosteroids alone are contraindicated for the treatment of acute optic neuritis
- i. Explain the need for prompt referral and treatment of optic neuritis
- j. Discuss the correlation between brain lesions on MRI and the risk of developing MS at 5, 10 and 15 years as found in the ONTT study

2. Primary care optometrist's role in the management of this patient with MS

- a. Discuss the role of the optometrist in co-managing patients with MS with and without a history of optic neuritis
- b. Discuss the importance of a baseline dilated eye exam and regular follow-up exams in patients with MS
- c. List the additional tests, retinal and/or optic nerve imaging, and scans that can be obtained as part of the eye evaluation for patients with MS
- d. What signs and symptoms of acute optic neuritis should the optometrist include in patient education/discussions; how soon should patients be seen if they are experiencing acute symptoms?
- e. Explain the appropriate time frame for referral and treatment of patients with acute optic neuritis

3. Critical-thinking questions

- a. How frequently should MS patients with or without a history of optic neuritis have dilated eye exams?
- b. Should baseline visual fields, color vision testing, optic nerve photos and/or RNFL OCT scans be obtained on MS patients with no prior history of optic neuritis; how frequently should these additional tests be repeated?
- c. In this case, the patient presented with a complaint of sudden blind spots and halos with no vision loss or eye pain: If you were the optometrist managing this case, would you have evaluated the patient the same day; what additional tests would you have ordered at this visit?
- d. If a patient is diagnosed with acute optic neuritis, to whom and to where should the optometrist refer the patient for prompt treatment?

Educator's Guide

The educator's guide includes the information necessary for discussing the case. This teaching case report is appropriate for optometry students, residents and practicing optometrists. Optometrists serve a crucial role in co-managing patients with MS with and without a history of optic neuritis and can prevent permanent vision loss with prompt diagnosis and immediate referral for treatment. OCT of the RNFL is used routinely to detect and manage retinal and optic nerve disorders, but is also useful in the management of neurological conditions such as MS. This case report discusses the role of OCT in monitoring MS, which is relevant to the clinical training of optometry students and residents.

Optic neuritis associated with multiple sclerosis

Optic neuritis is defined as acute inflammation of the optic nerve that is typically monocular and presents with sudden vision loss and eye pain.^{1,2} The etiologies of acute optic neuritis include demyelinating diseases (MS), viral infections, inflammation of the orbit or sinuses and granulomatous inflammatory conditions (sarcoidosis, tuberculosis, and syphilis). It is highly associated with MS, which is a demyelinating disease of the central nervous system. In up to 20% of MS patients, optic neuritis is the initial presenting manifestation and has been shown to occur in up to 50% of patients during their disease course.³ The patient in this case report was diagnosed with MS in 2014 with no history of optic neuritis.

Optic neuritis associated with demyelinating disease occurs more commonly in women, at 75% compared to 25% in men, which closely matches the epidemiology of MS. The condition occurs between ages 20 and 50 with a peak age of onset between 30 and 40 years.⁴ Geographically, the incidence is higher in northern areas such as the northern United States and Eastern Europe and lowest in areas closer to the equator. The annual incidence of optic neuritis in the United States has been reported as high as 6.4 per 100,000.⁵

Pathophysiology of optic neuritis

The pathophysiological changes that cause inflammatory demyelination in optic neuritis are comparable to the processes in MS. Inflammation causes edema in myelinated nerve fibers and retinal vessel endothelial tissue, which leads to myelin damage and breakdown. Clinically, these changes manifest as retinal nerve fiber swelling, optic nerve swelling and retinal vein sheathing.⁶ The exact mechanism and target antigen that causes inflammatory demyelination in optic neuritis is unknown; however, it is hypothesized that the process is immune-mediated with T- and B-cell activation. Studies have shown systemic T-cell activation at symptom onset and B-cell activation in cerebrospinal fluid of optic neuritis patients.^{7,8}

Clinical presentation of optic neuritis

Acute optic neuritis typically presents as monocular vision loss and eye pain. In the ONTT, which involved 457 patients age 18-46 with acute unilateral optic neuritis, vision loss and eye pain were the two most common symptoms reported.⁹ More than 90% of patients in the ONTT reported a decrease in central visual acuity. Vision loss occurred over a period of hours to several days and peaked between one and two weeks after symptom onset. The severity of vision loss was dependent on the area of central visual field affected. Visual acuities ranged significantly from 20/20 in 11% of patients to no light perception in 3% of patients; however, the majority of visual acuities ranged from 20/25 to 20/190. The median visual acuity was 20/60. Eye pain that increased with eye movement occurred in 92% of patients in the ONTT.⁹

The patient presented in this case experienced blind spots in vision of the left eye but maintained a best-corrected central visual acuity of 20/20 with no associated eye pain. Additional visual symptoms associated with optic neuritis include photopsia (reported in 30% of patients in the ONTT),⁹ changes in color perception and peripheral visual field loss. Blurred vision, flashing/flickering lights, blind spots and other visual disturbances can be precipitated by the patient becoming overheated, which is known as Uhthoff's phenomenon. The photopsia reported in 30% of patients in the ONTT frequently occurred with eye movement.⁹ The patient in this case had a history of Uhthoff's phenomenon-like symptoms and reported sudden blurred vision, blind spots and halos in the left eye the day he was diagnosed with acute optic neuritis.

In cases of monocular optic neuritis, several studies have shown deficits in visual acuity, visual field, color vision and contrast sensitivity in the contralateral eye with no reported symptoms.^{10,11} In a prospective study, Beck et al. investigated visual abnormalities of the contralateral eye in 448 eligible patients from the ONTT. They found that 67% of patients demonstrated a visual deficit in at least one of four parameters tested: visual acuity, visual field, color vision and contrast sensitivity. Abnormalities in the fellow eye were found on measurement of visual acuity in 13.8%, contrast sensitivity in 15.4%, color vision in 21.7%, and visual field in 48% of patients.¹⁰

Clinical signs of acute optic neuritis include reduced visual acuity, APD if the contralateral eye is unaffected, abnormal color vision, reduced contrast sensitivity, visual field defect, optic nerve inflammation, which can present as optic nerve edema, hyperemia and blurred disc margins, and optic nerve hemorrhages. In the ONTT, one-third of patients were found to have signs of optic nerve inflammation. Two-thirds of patients had retrobulbar optic neuritis with a normal optic nerve appearance. Retrobulbar optic neuritis is inflammation posterior to the globe without clinical optic nerve edema.⁹ In addition to demyelinating diseases such as MS, retrobulbar optic neuritis can be secondary to systemic lupus erythematosus, infections such as syphilis, or granulomatous inflammatory conditions such as sarcoidosis or Wegener's granulomatosis.¹² RNFL thickness measured by OCT shows thinning in 85% of optic neuritis cases.¹³ Abnormal color vision was found in 88% of cases tested with Ishihara plates and in 94% of cases tested with the Farnsworth-Munsell 100 hue test. Prior to the ONTT, an isolated central scotoma was thought to be the visual field defect typically associated with acute optic neuritis.¹⁴ However, only 8% of patients in the ONTT had a central scotoma defect based on the Humphrey 30-2 threshold automated perimetry test. Diffuse depression was most common, occurring in 48% of patients, followed by altitudinal defects, which occurred in 15% of patients. Fang et al. investigated visual field defects associated with optic neuritis using the database of the 457 patients in the ONTT and concluded that visual field abnormalities including localized altitudinal, central or cecocentral, or quadrant defects extended throughout the 30 degrees of the visual field tested and that optic neuritis does not preferentially affect one visual field location. Instead, the condition is a diffuse process that affects more than one group of axons and therefore causes a diffuse depression of the visual field.¹⁵ The patient presented in this case had a depressed total deviation and a superior cluster defect appearing as a vertical line just temporal from center on pattern deviation, which correlated with inferior optic nerve edema that was not noted on his normal visual field ten days prior.

Chronic features and complications of optic neuritis

Chronic features of optic neuritis include color desaturation, optic atrophy, visual field loss, Uhthoff's phenomenon and a delayed pattern-shift visual evoked response. A relative APD remains in approximately one-fourth of patients two years after presentation.¹¹ The prognosis for visual acuity is relatively favorable. Beck et al. found that nearly all patients recovered one line of acuity or better after three weeks, and median acuity at six months was 20/16.¹⁶ At the five-year follow-up in the ONTT, 87% of patients had a visual acuity of 20/25 or better. Patients can experience deficits in color vision, contrast sensitivity and

perception of light brightness years after resolution of optic neuritis.⁹ The National Eye Institute Visual Function Questionnaire was administered to 244 ONTT patients five to eight years after treatment for optic neuritis to assess perceived health-related quality of life and visual impairment. They scored lower compared with the disease-free reference group in nearly all categories including general health, general vision, ocular pain, driving ability, color vision, peripheral vision, social functioning, mental health and dependency.¹⁷

The role of OCT for the clinical monitoring of multiple sclerosis and optic neuritis

OCT is a non-invasive imaging technique that has become an essential tool in managing neuro-ophthalmologic conditions, including MS and optic neuritis. The pathogenesis of demyelination in MS contributes to axonal loss and thinning of the RNFL and ganglion cell layer, which can be quantified by OCT. OCT is a highly sensitive and reliable method for evaluating changes in the RNFL and ganglion cell layer in optic neuritis. In 1999, Parisi et al. were the first to publish a study that found significant decreases in average RNFL thickness and temporal RNFL thickness as measured by OCT in optic neuritis patients at one-year follow-up. RNFL thinning was also seen in MS patients who did not have optic neuritis compared with controls.^{18,19} OCT can also detect subclinical axonal loss in patients with normal visual acuity and normal visual fields.¹⁸ Klinstorner et al.'s study of patients with unilateral optic neuritis and MS showed RNFL thinning as measured by OCT in 85% of cases.¹³ In the acute phase of optic neuritis, OCT can help to confirm optic nerve swelling with an increase in thickness, which would be followed by axonal loss and thinning.¹⁹

This case is an example of how OCT is used for quantitative evaluation of RNFL changes in optic neuritis. OCT of the RNFL was obtained at each follow-up visit. When the patient presented with acute optic neuritis on Nov. 3, 2017, OCT showed RNFL changes consistent with the clinical exam findings of optic nerve and RNFL swelling. The inferior temporal sector showed a 13-micron increase from baseline. The superior temporal sector showed a 10-micron decrease, which represents axonal damage/thinning, which has been shown in literature to occur in patients with optic neuritis in the non-acute phase. These changes were shown throughout the patient's follow-up visits, but the significant decrease was seen from Oct. 24 to Nov. 3, 2017 (**Figure 13**).

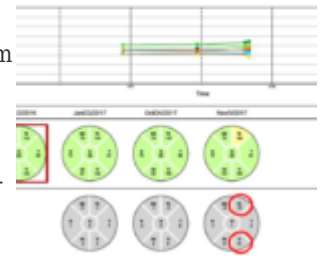


Figure 13. OCT provides quantitative information useful for monitoring retinal nerve fiber layer changes in optic neuritis. In this patient, significant changes were seen between October 24 and November 3. [Click to enlarge](#)

A recent study published in *Neurology* by Ratchford et al. of 164 patients with MS showed thinning of the ganglion cell/inner plexiform (GCIP) layer and RNFL compared to healthy control patients. The study also found that the rate of GCIP layer thinning was significantly higher in MS patients compared to control patients and therefore is more associated with clinical measures of MS progression.²⁰

One limitation of this teaching case report is that OCT of the ganglion cell layer was not obtained during the course of follow-up. Given recent literature supporting the value of ganglion cell layer OCT in monitoring the axonal integrity of MS patients with and without a history of optic neuritis, this scan will be completed at his future visits and for other patients with MS. OCT is now considered an essential tool in assessing the disease activity in MS and optic neuritis and has been used in most recent MS clinical trials. The authors recommend that MS patients have baseline OCT scans of the RNFL and the ganglion cell layer, which should be repeated yearly along with dilated clinical evaluations of the optic nerve and RNFL. Dilation and repeat OCT scans of the RNFL and ganglion cell layer should be completed sooner if the patient reports any visual changes or if MRI reveals new demyelinating lesions.

MRI of the brain with gadolinium contrast enhancement for diagnosis and management

MRI of the brain with gadolinium contrast enhancement is a key tool to aid in the diagnosis of optic neuritis. Inflammation of the optic nerve manifests as a hyperintense signal with contrast-enhanced MRI.²¹ The hyperintense signal, consistent with demyelination, is seen in approximately 95% of optic neuritis patients and can persist for a mean of 30 days after onset.^{22,23} Optic nerve signal abnormalities can remain after recovery in vision and are present in up to 60% of patients with MS with no history of optic neuritis.²³ White matter lesions of the brain seen on MRI are typically larger than 3 mm, ovoid and periventricular. In the ONTT, approximately 40% of patients had MRI lesions.⁹ A study conducted by Dalton et al. involving 115 optic neuritis patients showed a low yield for MRI of the spine; only four patients had spine abnormalities with a normal brain MRI.²⁴ Abnormal cerebral spinal fluid findings in optic neuritis patients include oligoclonal bands in up to 69%, IgG in up to 36%, and myelin basic protein in 20%.²⁵

Diagnosis of MS follows the McDonald Criteria for Diagnosis of Multiple Sclerosis created by an international panel of 30 MS experts and updated in December 2017.²⁶ The following conditions need to be met for diagnosis of MS: evidence of damage in

two or more separate areas of the central nervous system (optic nerve, brain, or spinal cord), evidence that the damage occurred at least one month apart, and the damage did not occur due to another disease. Three key changes in the 2017 updated criteria were: 1) positive findings of oligoclonal bands in the cerebral spinal fluid can substitute for demonstration of dissemination of lesions in time in some settings, 2) asymptomatic and now symptomatic MRI lesions can be considered in determining dissemination in space or time, and 3) cortical lesions were added to juxtacortical lesions for use in determining MRI criteria for dissemination of lesions in space.²⁶

The Optic Neuritis Treatment Trial

The ONTT provided valuable information about the clinical profile of optic neuritis patients, the benefits and adverse effects of corticosteroid treatment, and the risk of developing MS in patients with optic neuritis. The ONTT enrolled 457 patients with acute optic neuritis between 1988 and 1991 who were followed prospectively for 15 years with final examination in 2006. Patients were seen within eight days of symptom onset with unilateral vision loss in an eye without prior history of optic neuritis. Patients were randomized to one of three treatment groups: oral prednisone (1 mg/kg/day) for 14 days; intravenous methylprednisolone (250 mg every 6 hours) for 3 days, followed by oral prednisone (1 mg/kg/day) for 11 days; and oral placebo for 14 days. The oral prednisone and placebo groups were double-masked. The intravenous methylprednisolone group was single-masked. Visual acuity, contrast sensitivity, color vision and visual field were evaluated at baseline, at seven follow-up exams in the first six months and then yearly to determine the rate of visual recovery and long-term outcome. The primary purpose of the ONTT was to determine whether oral or intravenous steroids altered the visual outcome in patients with optic neuritis. The results showed that a three-day course of methylprednisolone given intravenously in a dose of 250 mg every six hours followed by two weeks of daily oral prednisone in a dose of 1 mg/kg/day accelerated visual recovery but did not improve the eventual visual outcome. Treatment with oral prednisone alone in a dose of 1 mg/kg/day for two weeks also did not improve visual outcome and was associated with an increased rate of optic neuritis recurrence.⁹

An unanticipated finding of the ONTT was that intravenous steroids had a protective effect and reduced the risk of a second demyelinating attack consistent with MS: 16% of patients who received intravenous corticosteroids followed by oral corticosteroids developed MS over two years compared to 30% of the patients treated with oral steroids or placebo.²⁷ This protective effect, however, was not seen in the third year, where the risk for recurrence was equal among the patients treated with intravenous steroids, oral steroids and placebo.²⁷

The ONTT also revealed a correlation between baseline brain MRI lesions and the risk of developing MS at five, 10 and 15 years. In the trial, 25% of patients with normal brain MRI scans developed MS within five years, which significantly increased to 50% if one or more MRI lesions were present. At 10 years, the risk of developing MS was 56% in patients with one or more MRI lesions compared to 22% of patients with normal MRI scans. At 15 years, 72% of patients with one or more MRI lesions developed MS compared to 25% of patients with no lesions.²⁸ The researchers concluded that findings on baseline brain MRI at the time of the first episode of optic neuritis was the single most important predictor of future risk of MS.^{27,28}

Teaching instructions and assessment methodology

This teaching case report is most appropriate for fourth-year optometry students and optometry residents who have learned about optic neuritis associated with MS in a didactic setting and will be gaining more clinical experience during rotations or residency. After a thorough review of this patient's case, follow-up visits and discussion of optic neuritis, fourth-year optometry students and optometry residents should have a better understanding of the pathogenesis of the condition, clinical findings, treatment and follow-up guidelines and the conclusions of the ONTT. Students and residents should also have gained insight into the optometrist's role in the management of patients with MS, the importance of regular dilated eye exams and how to incorporate additional testing and imaging including visual fields, color vision, optic nerve photos and RNFL OCT to aid in patient management and follow-up care.

This teaching case report can be delivered to fourth-year optometry students and/or optometry residents as a journal club reading assignment for discussion in an ocular disease or primary care clinic rotation or residency. Students and residents would also independently answer the discussion and critical-thinking questions. During journal club, the students and/or residents should share their answers and discuss the case, the major findings of the ONTT, and the insight they gained from the case regarding how to manage MS patients with and without a history of optic neuritis.

One way to assess the understanding of this case is a role play during which one student/resident plays the role of a patient with MS and the other student/resident plays the role of the optometrist. The team can simulate a baseline eye exam and the student/resident playing the role of the doctor can ask the appropriate questions, discuss the additional tests or imaging that should be completed, and complete the patient education. The student playing the role of the patient could also imitate having sudden changes in vision or eye pain, and the team could discuss what tests need to be performed and where the patient

should be referred if optic neuritis is diagnosed. Other options are a group discussion with students and residents sharing cases of patients they may have seen with MS or other demyelinating neuro-ophthalmologic conditions and how they can use OCT scans of the RNFL and ganglion cell layer in monitoring these diseases.

Conclusion

Optic neuritis is an inflammatory demyelination of the optic nerve that is highly associated with MS. Optic neuritis occurs in up to 50% of patients with MS. The two most common symptoms of optic neuritis are vision loss and eye pain. Signs of optic neuritis include decreased visual acuity, APD, abnormal color vision, visual field defects and reduced contrast sensitivity. One-third of patients have visible optic nerve inflammation and two-thirds have a normal-appearing optic nerve, which is known as retrobulbar optic neuritis. The ONTT showed that high-dose intravenous corticosteroid treatment is beneficial for acute attacks and that oral corticosteroid alone is contraindicated due to increased risk of recurrence. Gadolinium contrast-enhanced MRI of the brain and orbits provides confirmation of optic neuritis, and baseline MRI findings are an important predictor of the future risk of MS. Eye physicians play a critical role in the co-management of MS patients with and without a prior history of optic neuritis.

This case report shows the value of obtaining baseline fundus photos, RNFL OCT scans and visual field testing on MS patients to help assess changes that occur throughout the course of the disease. It is also crucial for eye physicians to counsel patients with MS on the signs and symptoms of optic neuritis and the need for immediate evaluation if any acute symptoms occur. Prompt diagnosis and treatment of optic neuritis are needed to prevent optic nerve and RNFL atrophy, which can lead to chronic vision loss, reduced contrast sensitivity, color vision deficits and visual defect defects.

References

1. Behbehani R. Clinical approach to optic neuropathies. *Clin Ophthalmol*. 2007 Sep;1(3): 233-46.
2. Ebers GC. Optic neuritis and multiple sclerosis. *Arch Neurol*. 1985;42(7):702-4.
3. Frohman EM, Frohman TC, Zee DS, et al. The neuro-ophthalmology of multiple sclerosis. *Lancet Neurol*. 2005;4(2):111-21.
4. Beck RW, Trobe JD, Moke PS, et al. High- and low-risk profiles for the development of multiple sclerosis within 10 years after optic neuritis: experience of the optic neuritis treatment trial. *Arch Ophthalmol*. 2003;121(7):944-9.
5. Percy AK, Nobrega FT, Kurland LT. Optic neuritis and multiple sclerosis. An epidemiologic study. *Arch Ophthalmol*. 1972;87(2):135-9.
6. Lightman S, McDonald WI, Bird AC, et al. Retinal venous sheathing in optic neuritis. Its significance for the pathogenesis of multiple sclerosis. *Brain*. 1987 Apr;110(Pt 2):405-14.
7. Roed H, Frederiksen J, Langkilde A, Sørensen TL, Lauritzen M, Sellebjerg F. Systemic T-cell activation in acute clinically isolated optic neuritis. *J Neuroimmunol*. 2005 May;162(1-2):165-72.
8. Söderström M, Link H, Xu Z, Fredriksson S. Optic neuritis and multiple sclerosis: anti-MBP and anti-MBP peptide antibody-secreting cells are accumulated in CSF. *Neurology*. 1993; 43(6):1215-22.
9. Optic Neuritis Study Group. A randomized, controlled trial of corticosteroids in the treatment of acute optic neuritis. *N Engl J Med*. 1992 Feb 27;326(9):581-8.
10. Beck RW, Kupersmith MJ, Cleary PA, Katz B. Fellow eye abnormalities in acute unilateral optic neuritis: experience of the optic neuritis treatment trial. *Ophthalmology*. 1993;100(5):691-8.
11. Brusa A, Jones SJ, Plant GT. Long-term remyelination after optic neuritis: A 2-year visual evoked potential and psychophysical serial study. *Brain*. 2001 Mar;124(Pt 3):468-79.
12. Kemp PS, Winges KM, Wall M. Optic neuritis. *EyeRounds.org*. Posted Sept. 30, 2012. Available from <http://www.EyeRounds.org/cases/159-optic-neuritis.htm>
13. Klistorner A, Arvind H, Nguyen T, et al. Axonal loss and myelin in early ON loss in postacute optic neuritis. *Ann Neurol*. 2008 Sep;64(3):325-31.
14. Balcer LJ. Clinical practice. Optic neuritis. *N Engl J Med*. 2006 March 23;354(12):1273-80.
15. Fang JP, Donahue SP, Lin RH. Global visual field involvement in acute unilateral optic neuritis. *Am J Ophthalmol*. 1999 Nov;128(5):554-65.
16. Beck RW, Cleary PA, Backlund JC. The course of visual recovery after optic neuritis. Experience of the Optic Neuritis Treatment Trial. *Ophthalmology*. 1994;101(11):1771-8.
17. Cole SR, Beck RW, Moke PS, Gal RL, Long DT. The National Eye Institute Visual Function Questionnaire: experience of the ONTT. Optic Neuritis Treatment Trial. *Invest Ophthalmol Vis Sci*. 2000 April;41(5):1017-21.
18. Rebolleda G, Diez-Alvarez L, Casado A, et al. OCT: new perspectives in neuro-ophthalmology. *Saudi J Ophthalmol*. 2015 Jan-Mar;29(1):9-25.
19. Lamirel C, Newman NJ, Biousse V. Optical coherence tomography (OCT) in optic neuritis and multiple sclerosis. *Rev Neurol (Paris)*. 2010 December;166(12):978-86.
20. Ratchford JN, Saidha S, Sotirchos ES, et al. Active MS is associated with accelerated retinal ganglion cell/inner plexiform

layer thinning. *Neurology*. 2013;80(1):47-54.

21. Kale N. Optic neuritis as an early sign of multiple sclerosis. *Eye Brain*. 2016 Oct 26;8:195-202.

22. Rocca MA, Hickman SJ, Bö L, et al. Imaging the optic nerve in multiple sclerosis. *Mult Scler*. 2005 Oct;11(5):537-41

23. Hickman SJ, Toosy AT, Miszkiel KA, et al. Visual recovery following acute optic neuritis – a clinical, electrophysiological and magnetic resonance imaging study. *J Neurol*. 2004;251(8):996-1005.

24. Dalton CM, Brex PA, Miszkiel KA, et al. Spinal cord MRI in clinically isolated optic neuritis. *J Neurol Neurosurg Psychiatry*. 2003;74(11):1577-80.

25. Nilsson P, Larsson EM, Maly-Sundgren P, Perfekt R, Sandberg-Wollheim M. Predicting the outcome of optic neuritis: evaluation of risk factors after 30 years of follow-up. *J Neurol*. 2005;252(4):396-402.

26. Thompson AJ, Banwell BL, Barkhof F, et al. Diagnosis of multiple sclerosis: 2017 revisions of the McDonald criteria. *Lancet Neurol*. 2018;17(2):162-173.

27. Beck RW, Cleary PA, Trobe JD, et al. The effect of corticosteroids for acute optic neuritis on the subsequent development of multiple sclerosis: The Optic Neuritis Study Group. *N Engl J Med*. 1993 Dec 9;329(24):1764-9.

28. Optic Neuritis Study Group. Multiple sclerosis risk after optic neuritis: final optic neuritis treatment trial follow-up. *Arch of Neurol*. 2008;65(6):727-32.



Personal Financial Planning in the Optometric Curriculum

Steven H. Schwartz, OD, PhD | Optometric Education: Volume 44 Number 3 (Summer 2019)

[PDF of Article](#)

Ample evidence affirms that student indebtedness is a major challenge facing graduates of health professions schools.¹ The cost of education has increased for nearly all health professions programs while reimbursement for providing care has decreased. Data from the Association of Schools and Colleges of Optometry (ASCO)² show optometry school graduates with loans owed \$174,165 on average in 2017 (not including undergraduate indebtedness), while the U.S. Bureau of Labor Statistics reports a mean income for employed optometrists of \$119,980 per year.³ The latter figure is based on data from 37,220 optometrists.

None of this is a secret. The high debt-to-income ratio in healthcare professions can be easily ascertained on the Internet in a matter of minutes by anyone with an interest in doing so.⁴ This, along with other factors, has arguably led to a crisis in pharmacy education.⁵ Online forums are replete with posts admonishing prospective pharmacy students to think twice about entering a profession with such a low return on investment.

While the desire to help others is a strong motivating factor for optometry students, so is a desire for financial security. Increasing student indebtedness challenges the profession like never before to address student expectations for financial stability. Although there are no easy solutions to this challenge, educators can take steps to help better prepare students for the financial challenges they may encounter. Foremost among these is to ensure graduates are financially literate by teaching them the basic aspects of personal financial planning.

What is Personal Financial Planning?

Optometry programs have traditionally offered courses in practice management, many of which include elements of personal financial planning. While integration of personal financial planning topics into practice management courses is a welcome initial step, such an approach can lead to conflation of the principles underlying these distinct disciplines.⁶

Practice management deals with contracts, billing, patient insurance, business loans and other items related to running a business whether it be a solo or group practice or an independent contractor scenario. It also addresses employment as an optometrist. Practice management is essentially business management applied to professional optometric practice. In contrast, personal financial planning is concerned with how people manage their financial resources regardless of the source of their income or wealth. It includes topics such as the time value of money, investment vehicles, retirement, asset protection, real estate, debt management, personal budgeting and tax planning.⁷ These topics are as important to the success of a teacher, plumber or lawyer as they are to the success of an optometrist. Personal financial planning is a well-established academic discipline and profession.

Status of Personal Financial Planning Education in Optometry Programs

Optometry programs recognize a need for education in personal financial planning and have taken steps to provide students with relevant information. As mentioned above, practice management courses often cover certain topics relevant to financial planning. Student affairs or other offices sometimes arrange talks and programs for students that are delivered by financial planners.

These efforts, while important, may not be sufficient. Given the decreasing number of healthcare practitioners who operate their own practices, the importance of personal financial planning vis-à-vis traditional practice management has increased. Including personal financial planning as a component of a larger practice management course may neither reflect current practice patterns nor address current student needs and expectations. Practice management and personal financial planning are distinct disciplines, and each requires its own set of learning objectives as well as knowledgeable and skilled instructors.

Extracurricular programs provided by financial planners can be problematic. There are many financial planning professionals who would be eager to give lectures or talks to optometry students. However, such professionals often, but not always, derive income from selling products or steering clients toward certain investment vehicles.⁸ This creates a conflict of interest that is incompatible with sound pedagogy.

Components of a Personal Financial Planning Course/Module

The basic components of a course or module on personal financial planning are well-established⁷ and include:

- Time-value of money
- Use of a simple financial calculator
- Personal budgeting
- Investment vehicles
- Retirement savings vehicles and retirement projections
- Debt management, including student debt
- Asset protection
- Real estate
- Tax planning

Many books and online resources are available to support student learning. It's important, however, for educators to be cognizant of the source of these materials and the possibility for conflicts of interest that may result when authors promote investment products in which they have a financial interest.

The selection of the instructor for a personal financial course is critical. Not only must the material be treated with the same level of rigor as other topics in the curriculum, which argues for an instructor with formal training in the field, caution must be exercised to ensure the instructor does not have a conflict of interest or bias with respect to investment products. This is particularly important when considering outside or guest speakers who are employed within the financial industry and/or sell financial products.

Conclusion

Personal financial planning skills have always been important to graduating health professionals, but with increasing levels of student loan indebtedness, education in this field is no longer optional. The emphasis optometry programs have historically placed on practice management, while important, does not substitute for nor preclude separate instructional courses or modules on personal financial planning. It is hoped this article will encourage the development of such courses/modules at schools and colleges of optometry. Formulation of a standardized personal financial planning curriculum for the profession would be helpful.

References

1. Asch DA, Nicholson S, Vujicic M. Are we in a medical education bubble market? *N Engl J Med*. 2013 Nov 21;369(21):1973-5.
2. Association of Schools and Colleges of Optometry. Annual student data report; academic year 2017-2018 [Internet]. [cited 2019 Mar 25]. Available from: <https://optometriceducation.org/wp-content/uploads/2018/05/ASCO-Student-Data-Report-2017-18.pdf>
3. Occupational employment and wages, May 2018. Bureau of Labor Statistics [Internet]. [cited 2019 Mar 25]. Available from: <https://www.bls.gov/oes/current/oes291041.htm#st>
4. Which graduate degrees deliver more debt than income? [Internet]. Credible; c2019 [cited 2019 Mar 25]. Available from: <https://www.credible.com/blog/data-insights/graduate-degree-debt-income/>.
5. Cain J, Campbell T, Congdon HB, et al. Pharmacy student debt and return on investment of a pharmacy education. *Am J Pharm Educ*. 2014 Feb 12;78(1):5.
6. Ahmad FA, White AJ, Hiller KM, Amini R, Jeffe DB. An assessment of residents' and fellows' personal financial literacy: an unmet medical education need. *Int J Med Educ*. 2017 May 29;8:192-204.
7. CFP Board [Internet]. [cited 2019 Mar 25]. Available from: <https://www.cfp.net/>.
8. Bar-Or Y. Empowering physicians with financial literacy. *J Med Pract Manage*. 2015 Jul-Aug;31(1):46-9.



Winning Clinical Ethics Essay Addresses Familiar Tough Topic

| Optometric Education: Volume 44 Number 3 (Summer 2019)

[PDF of Article](#)

ASCO and its Ethics Educators Special Interest Group are pleased to announce Negar Sohbaty as the winner of the 2019 Student Award in Clinical Ethics. Negar is a member of the Illinois College of Optometry's Class of 2020. Her winning essay, "Optometrist as Mandatory Reporter: What is Our Obligation to Keep the Roads Safe for All?" appears below.



The award competition, sponsored by Alcon, is open to optometry students during any point in their professional program at an ASCO-affiliated school or college of optometry. The winner receives an engraved plaque and \$1,000. ASCO thanks all the students who submitted essays.

Optometrists as Mandatory Reporters: What is Our Obligation to Keep the Roads Safe for All?

By Negar Sohbaty

Given that driving is a highly visual task, the role of vision in road safety requires careful consideration.¹ In Illinois, it is a driver's responsibility to report any vision deterioration to the Secretary of State within 10 days of becoming aware or being notified.² Optometrists are not required to report any changes in a patient's visual acuity or visual field to the Department of Motor Vehicles (DMV) because Illinois is not a mandatory reporting state.²



Negar Sohbaty

Researchers have found that older drivers with cataract have restriction in driving mobility, a decrease in safety on the road, and a higher rate of crash involvement than those without cataract.^{3,4} Because driving is directly linked to mobility and independence, individuals may not fulfill their duty to report vision impairment for fear of receiving a license restriction or revocation.⁵ In light of this, optometrists should carefully consider how driving restrictions are discussed with patients. First, they must consider reporting procedures in their jurisdiction, as the criteria for restricted licenses are often set by state DMVs. Second, optometrists should consider how to best discuss driving limitations with their patients with special attention to impact on the patients' quality of life. Currently, only 12% of states require mandatory reporting.⁶

One could argue it may be safer for all states to require reporting by optometrists. Perhaps optometrists should be asking about patients' driving habits and confirming driving eligibility at each visit. In caring for these patients, optometrists may face moral and ethical dilemmas, aspects of which are considered in this case report.

Older Drivers on the Road

Older individuals make up a large percentage of drivers on the road.⁷ Given that cataract is the leading cause of vision impairment in adults older than 60, it is important to consider its associations with road safety.⁴ Cataract can cause deficits in visual acuity and contrast sensitivity and problems with glare in older individuals.⁸ These factors are associated with difficulty driving in the rain, at night, during rush hours, alone, and making left turns in traffic.⁴ Several studies have found a statistically significant association between cataract

and at-fault crash involvement.^{3,4} Elderly drivers may have a hard time accepting their visual impairment as it is directly tied to their independence. Sarkin et al. showed that among 376 pre-cataract-surgery patients, only 12.3% reported stopping nighttime driving due to visual impairment.⁹ This demonstrates that, although cataract surgery can improve vision, some patients may choose to ignore their visual limitations.

Patient Reports Cloudy Vision, Difficulty with Glare while Driving

Patient RT presented to the Illinois Eye Institute in December 2018 with a chief complaint of cloudy vision including difficulty with glare when driving. These symptoms, however, did not prevent her from driving daily. She worked in a cafeteria for a catering company and reported driving herself to and from work, often in the dark during the winter months. She had entering best-corrected visual acuity of 20/70 OD, 20/100 OS, and 20/70 OU. Her suprathreshold driving visual field test results (Humphrey Field Analyzer, Carl Zeiss Meditec, Dublin, CA) showed greater than 140° of peripheral visual field. Vision was not improved with refraction in either eye. Slit lamp evaluation revealed bilateral 2+ nuclear sclerotic and 3+ cortical cataracts.

Per the state's DMV guidelines, drivers require a minimum binocular visual acuity of 20/40 and 140° of peripheral vision.² Drivers with binocular visual acuity between 20/41 and 20/70 are limited to daylight driving only.² Drivers with monocular visual acuity of 20/100 or worse in one eye are permitted to operate only vehicles that have both outside rearview mirrors.² According to these standards, this patient required a restriction: daytime only driving and both rearview mirrors. With her borderline visual acuity, it was stressed that at a future visit she may no longer meet the cut-off to drive at all.

Contrast sensitivity also plays a significant role in safe driving; reduced levels put older drivers with cataract at an elevated risk for accidents.⁷ Specifically, drivers with a history of crash involvement are six times more likely to have severe contrast sensitivity impairment in both eyes when compared to their crash-free counterparts.⁷ Bal et al. evaluated cataractous eyes and found that 31% of individuals with visual acuity meeting driving requirements would be considered unfit to drive based on a contrast sensitivity cut-off value of below 1.25 log.⁸ Moreover, this patient population is at risk of being involved in car accidents, even if decreased contrast sensitivity is present in only one eye.⁹ These study results suggest states should consider not only visual acuity but also decreased contrast sensitivity in determining driving fitness.

Because contrast sensitivity is not one of the required tests for driving certification in Illinois, it wasn't included in RT's initial workup. However, it could be a consideration at a follow-up visit should the patient continue to drive. If the DMV were to consider revising current requirements to undertake a more comprehensive assessment of safety, adding contrast sensitivity testing may be a simple addition. Validated contrast sensitivity tests such as the Pelli-Robson, MARS or Vistech chart could be administered to drivers older than 60 with visual acuity worse than 20/40. Further research would be necessary to determine precise cut-offs for any test implemented.

Mandatory Reporting for All States?

Legal and ethical quandaries surround the discussion of the safety of elderly motorists. Optometrists who practice in non-mandatory reporting states may strive to find a balance between protecting themselves from legal action, while also protecting their patients and those with whom they share the road. Conversations with patients are challenging because driving cessation can lead to a loss of independence and an overall decrease in general well-being.^{1,5} In Illinois, optometrists cannot be included in any lawsuit filed by victims of a car accident in the event the at-fault party had continued to drive against their recommendation to cease driving or to self-report.² However, being proactive and mandating reporting for all states could spur the creation of infrastructure to connect patients to social services or transportation options, while also preserving public safety.

Patient RT was educated on her vision changes and the nature of her cataract. She was informed that, contrary to her personal beliefs, her vision couldn't be corrected with an updated spectacle prescription. Surgical intervention would be required to improve her vision for safe driving at night. As is the case with many patients, she was hesitant about surgery and did not think it was an immediate necessity. However, she did agree to schedule a cataract consultation for February 2019. The Illinois Vision Report Form was completed to demonstrate to the patient her driving limitations and exact restrictions. Although the need for her to self-report to the DMV was emphasized, when my attending faculty left the room, the patient repeatedly asked, "You will not be submitting any forms to the DMV, right?" Given the explanation of the situation, the patient felt a sense of loss of independence and automatically verbalized her dissatisfaction. She continued to be in denial of the information given to her and to ask questions such as "How am I to get back home from work every night?" She expressed that she did not want to burden her daughter with driving her around.

As outlined in the code of ethics published by the American Optometric Association, "It shall be the ideal, resolve, and duty of all optometrists to keep their patients' eye, vision, and general health paramount at all times; to respect the rights and dignity

of patients regarding their health care decisions.”¹² Thus, it is an optometrist’s duty to understand the patient’s living situation and the availability of any support system. Other options for these patients may include requesting leave through the Family and Medical Leave Act, if their condition is disabling. The law provides employees with up to 12 weeks of unpaid, job-protected leave per year.¹¹ Those who are willing to undergo surgery in the short-term may not feel the need to self-report nor acquire a restricted license, only to get it re-instated after surgery; therefore, careful discussions and documentation of recommended limitations should occur with each patient, including his or her obligations with the DMV.

Considering the statistics on elderly driving accidents, current reporting procedures as well as criteria for a restricted license in Illinois could be deemed insufficient. Furthermore, if optometrists were mandated to report vision changes such as those in this case study to the DMV, patients might be more willing to cease driving when recommended knowing they are legally bound to do so. In addition, given the symptoms of cataract, the DMV could require additional information about drivers’ contrast sensitivity to better determine driving eligibility, especially for nighttime driving. These measures could help remedy the alarming rates at which older drivers with deteriorating vision are involved in at-fault motor vehicle accidents. Road safety cannot be overlooked, and these preventative measures could help optometrists lead the way toward much needed improvements in public safety.

References

1. Wood JM, Owsley C. Vision and driving: a look at the research road ahead. *Clin Exp Optom*. 2016 Sep;99(5):393-4.
2. Illinois rules of the road 2019 [Internet]. Springfield, IL: State of Illinois. Available from: https://www.cyberdriveillinois.com/publications/pdf_publications/dsd_a112.pdf
3. Owsley C, McGwin G Jr, Sloane M, Wells J, Stalvey BT, Gauthreaux S. Impact of cataract surgery on motor vehicle crash involvement by older adults. *JAMA*. 2002 Aug 21;288(7):841-9.
4. Owsley C, Stalvey B, Wells J, Sloane ME. Older drivers and cataract: driving habits and crash risk. *J Gerontol A Biol Sci Med Sci*. 1999 Apr;54(4):M203-11.
5. Edwards JD, Lunsman M, Perkins M, Rebok GW, Roth DL. (2009). Driving cessation and health trajectories in older adults. *J Gerontol A Biol Sci Med Sci*. 2009 Dec;64(12):1290-5.
6. Current screening and assessment practices. State policy affecting community mobility: variability across the country [Internet]. Washington, DC: National Highway Traffic Safety Administration; [cited Jan 16, 2019]. Available from: <https://one.nhtsa.gov/people/injury/olddrive/CommMobilityDementia/pages/CurrentScr-StatePolicy.htm>
7. Owsley C, Stalvey BT, Wells J, Sloane ME, McGwin G Jr. Visual risk factors for crash involvement in older drivers with cataract. *Arch Ophthalmol*. 2001 Jun;119(6):881-7.
8. Bal T, Coeckelbergh T, Van Looveren J, Rozema JJ, Tassignon MJ. Influence of cataract morphology on straylight and contrast sensitivity and its relevance to fitness to drive. *Ophthalmologica*. 2011;225(2):105-1.
9. Rubin GS, Adamsons IA, Stark WJ. Comparison of acuity, contrast sensitivity, and disability glare before and after cataract surgery. *Arch Ophthalmol*. 1993 Jan;111(1):56-61.
10. Sarkin AJ, Tally SR, Wooldridge JS, Choi K, Shieh M, Kaplan RM. Gender differences in adapting driving behavior to accommodate visual health limitations. *J Community Health*. 2013 Dec;38(6):1175-81.
11. Family and Medical Leave Act [Internet]. Washington, DC: U.S. Department of Labor. [cited Jan 7, 2019]. Available from: <https://www.dol.gov/whd/fmla/>.
12. Code of Ethics [Internet]. St. Louis, MO: American Optometric Association; c2019 [cited Jan 7, 2019]. Available from: <https://www.aoa.org/about-the-aoa/ethics-and-values/code-of-ethics>



Optometric Education Beyond Borders

Emiliano Terán, PhD | Optometric Education: Volume 44 Number 3 (Summer 2019)

[PDF of Article](#)

The state of Sinaloa in Northwestern Mexico, not very far from the Arizona border, is home to one of the oldest and largest universities in Mexico, the Autonomous University of Sinaloa (UAS). UAS has existed for 146 years in an area of great beauty created by rivers, beaches, mountains and forests that is also challenged by the impact of drug cartels. More than 150,000 students, from 15 to 22 years old, are enrolled at UAS. In 2011, with the goal of training competent and successful visual health professionals, the university opened the Optometry School of Sinaloa. Our strengths at the optometry school have allowed us to grow in many ways. We have, for example, a close relationship with local ophthalmologists, a teaching staff interested in carrying out scientific research, and support from the university hospital for research projects. Nevertheless, for continued progress we require support and guidance from more experienced institutions and have found the most notable support from international organizations.

About the Optometry School of Sinaloa

The Optometry School of Sinaloa is located in the capital city of Culiacán and is linked to the ophthalmology department of the UAS University Hospital. The academic staff is composed of optometrists, ophthalmologists, chemists, a psychologist and a physicist, all of whom are around 35 years old. The optometrist/teachers are certified and hold bachelor's degrees. They successfully combine teaching with private practice. The ophthalmologist/teachers specialize in various fields including retina, glaucoma and ocular plastic surgery. The remaining teachers hold either PhD or MSc degrees. With the help of our university hospital we are constantly developing multidisciplinary research projects. To establish a niche where optometrists can make a fruitful contribution, we focus our research efforts on the treatment of low vision.

Currently, the optometry school has 55 students, and with each class we typically enroll a similar number of students. As do most optometry schools in Latin America, we offer a four-year-program with the last year dedicated to clinical practice. The first two graduating classes have completed the program, resulting in 24 new professionals. Most are employed in major lens companies; only few are devoted to teaching.

Assistance from International Allies

The advancement of optometric education should transcend frontiers and borders, and we have experienced this personally. In particular, the Association of Schools and Colleges of Optometry (ASCO), Volunteer Optometric Services to Humanity (VOSH), and the Latin American Association of Optometry and Optics (ALDOO) have contributed significantly to the advancement of the Optometry School of Sinaloa. Our relationships with these organizations began when we undertook two initiatives in 2016. One was opening a student chapter of VOSH, which to our knowledge was the first in Mexico. The other was presenting our work at the annual meeting of the American Academy of Optometry (AAO) in 2016.¹ This was the first submission from an institution in Northwestern Mexico. These apparently simple and unrelated actions created a huge impact on the development of our academic optometric community.

Although it was a financial challenge for our researchers and school representatives to travel to the 2016 AAO meeting in Anaheim, Calif., it was the best investment that we could have made for the benefit of our school. We had our first meetings there with representatives from VOSH (Marcela Frazier, OD, MSPH) and ALDOO (Hector Santiago, OD, PhD). We were shocked by their willingness to help us, especially after our struggles for support to attend the conference. ALDOO offered support in three key areas: 1) implementation of our low vision department; 2) the visit of a low vision specialist to advise us on establishing this service; and 3) the opportunity for one of our professors to visit the department of low vision at the University of Houston. ALDOO, including its Education Committee and former Delegated Secretary Katerin Ortiz, OD, FAAO, has assisted us in other ways as well. They helped us to obtain resources for research projects to evaluate the visual health of our population, and they covered our lodging expenses to enable us to attend a meeting of the Latin American Optometry Schools in Panama City.

Also in 2016, by invitations from Dr. Frazier and Dr. Santiago, we were able to attend the annual meetings of VOSH and ASCO. While we witnessed ASCO's great organization and willingness for worldwide collaboration, at that first meeting we weren't quite sure what to ask or how to contribute. However, in 2017 we returned to the ASCO annual meeting with a much better idea of how their association could best assist us. We hope to continue working with the association's support and kind

guidance. The 2016 VOSH meeting was amazing, as we learned more about the organization and met J. Daniel Twelker, OD, PhD, from the University of Arizona. With his tremendous help in forging a collaboration, our students joined VOSH-Arizona on a mission trip to Hermosillo and Chihuahua in Mexico. The students had a fruitful learning opportunity and shared their experience with their classmates. This experience helped to improve our program, and Dr. Twelker is a role model for our students.

Our Progress Continues

We have continued to build on our original international collaborations to work toward our goals. More recently, we again presented research at an AAO meeting.² We also organized an optometric research workshop with Dr. Twelker and three other world-class optometrists participating: Pablo de Gracia, PhD, FAAO, Jose Vega, OD, FAAO, and Pedro Gomez, OD. This event and inspirational colleagues certainly motivated our students and allowed them to see the importance and potential of optometric research not only in our region but also across the country.

In addition, we have been involved in two other notable research projects. 1) with the assistance of Dr. Santiago, a Refractive Error Study in Children-type project to evaluate the visual status of Sinaloa's young people; and 2) through a Collaborative Research Fellowship from the ARVO Foundation, evaluation of information acquisition as a biomarker to evaluate vision impairment in glaucoma, with Russell L. Woods, PhD, from the Schepens Eye Research Institute of Massachusetts Eye and Ear.

It is incredible that the Optometry School of Sinaloa has received so much support from international organizations. Because of it, we are inspired to move forward and promote the development of optometry in our region and serve our communities by educating competent eyecare providers and fostering research careers. We hope sharing our story helps other schools to understand how they, too, can achieve their goals despite the limitations that can be found in developing countries.

References

1. Teran E, Ortega-Pereyra M, Espinoza-Castro BA, Martinez-Gaytan J, Martinez-Gaytan C, Ramirez-Jaimes R. Goodness of fit to non parametric tests of the contrast sensitivity and the visual acuity. Presented at the 2016 annual meeting of the American Academy of Optometry; Anaheim, Calif.
2. Teran E, Molina-Reyes J, DeGracia P, Martínez-Gaytan J, Martínez-Gaytan C, Ramirez-Jaimes R. Evaluation of the increased levels of UV radiation reaching the eye due to the outdoor use of smartphones. Presented at the 2017 annual meeting of the American Academy of Optometry; Chicago, Ill.



Industry News

| Optometric Education: Volume 44 Number 3 (Summer 2019)



[PDF of Article](#)

