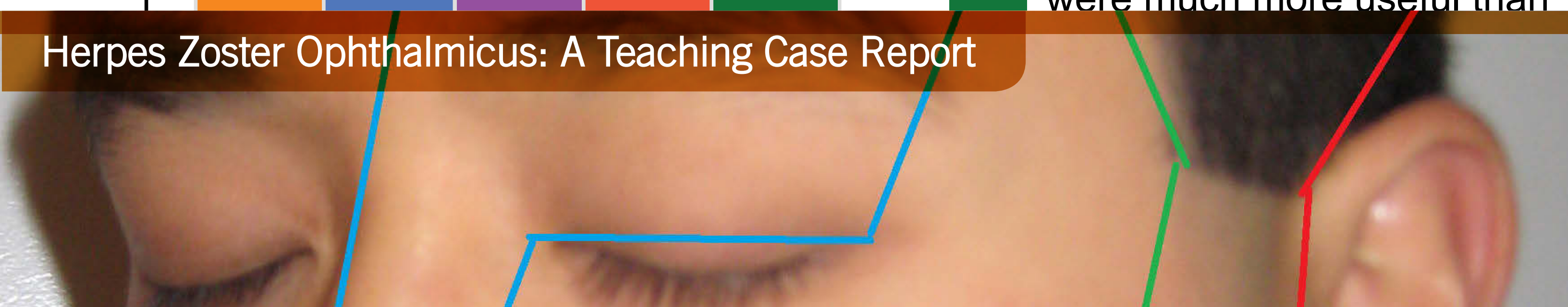
The Journal of the Association of Schools and Colleges of Optometry

OPTOMETRIC EDUCATION

Volume 39, Number 2 Winter/Spring 2014

Blended Learning in Optometric Clinical Procedures Instruction

Herpes Zoster Ophthalmicus: A Teaching Case Report



Model Approach for Incorporating Informatics in Optometric Curriculum

Use of Google as a Tool to Aid Diagnosis by Optometry Students

Anterior Eye Conditions	Students 1 to 6 used Aston e-library only						Students 7 to 12 used Aston e-library + Google						12	Aston e-Libra no. of correct ses	Aston e-Libra Google no. of correct ses
Keratoglobus													X	1	0
Marginal infiltrates													√	0	1

Also Inside:

Association of Schools and Colleges of Optometry

The Association of Schools and Colleges of Optometry (ASCO) represents the professional programs of optometric education in the United States. ASCO is a nonprofit, tax-exempt professional educational association with national headquarters in Rockville, MD.

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The Journal of the Association of Schools and Colleges of Optometry

FEATURES AND DEPARTMENTS

Now Available through Google Scholar!
Optometric Education can now be accessed using Google Scholar. Current indexing at http://scholar.google.com/ is from 2009 to the current edition, with the goal of eventually indexing back to 1998.
The current edition of the journal, as well as all past editions, can be found on the ASCO Web site at http://journal.opted.org/. Funding for the archiving was generously provided by Transitions Optical.

ARTICLES

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OPHTHALMIC

INDUSTRY NEWS

The following companies support ASCO's national programs and activities benefiting the schools and colleges of optometry in the United States and Puerto Rico.*

Patrons ($50,000 - $90,000)

Alcon Laboratories

Benefactors ($25,000 - $49,999)

Essilor of America
HOYA Free-Form Company
Luxottica / EyeMed Vision Care
Vistakon®, Division of Johnson & Johnson Vision Care
Walmart Stores, Inc.

Supporters ($15,000 - $24,999)

Allergan, Inc.
Carl Zeiss Vision / Carl Zeiss Meditec
Transitions Optical
Vision Service Plan

Friends ($10,000 - $14,999)

Abbott Medical Optics
Accutome, Inc.
Bausch + Lomb
Compulink Business Systems
Haag-Streit
HEINE
International Vision Expo
Keeler Instruments
M & S Technologies, Inc.
Marco
Oculus, Inc.
Optos North America
Volk Optical

Contributors ($5,000 – $9,999)

CooperVision
LasikPlus
Review of Optometry
Safilo Group
TLC Vision

** As of February 1, 2014*

Programs Benefit Students, New ODs

Among the professional development and networking opportunities that will be available for optometry students during International Vision Expo East in New York City (March 26-30) is a two-part education program, The Vision Expo Business Experience, which will be led by Ryan Parker, OD. The program will provide information on products needed for future practice and how to maximize vendor relations and trade shows to benefit future purchases. Students will also work in groups to build a purchasing plan to enhance a hypothetical practice and "shop" the exhibit hall.

A new event this year will be a reception for Vision Expo's Young Professionals Club, a group created for optometrists who have been out of school for five years or less. Allergan's Optometry Jumpstart program is sponsoring the reception. Young Professionals Club members will also receive six free hours of continuing education plus other benefits upon joining the group.

For information on all available programs for optometry students and new ODs, visit http://visionexpoeast.com/en/Press/Show-News/Vision-Expo-East-Promotes-Networking-Professional-Development-for-Students-and-Young-Professionals/.

2014 Brings New Products, Initiatives

Essilor of America has added to its Varilux Comfort family of progressive lenses with the launch of Varilux Comfort Enhanced Fit digital lenses. With use of the Visioffice System or the Visioffice 2 System for digital measuring, the new lenses can be personalized to each patient's frame wearing measurements. The lenses are designed to minimize the need for unnatural head movement during reading, provide comfortable transitions at all distances, and reduce peripheral distortion to expand visual fields throughout the lens. In addition, design elements can be incorporated on both sides of the lens through Varilux DualOptix digital surfacing.

Essilor also announced that it is partnering with Transitions Optical to launch Transitions Signature VII lenses, the darkest photochromic lenses with full indoor clarity. With the launch, the company introduces The Power of 3 initiative, which includes the Varilux, Crizal No-Glare and Transitions Signature VII brands. Taking advantage of all three technologies, visual performance is maximized at every distance and in every light condition, all with one lens.

For more information, visit Varilux.com and EssilorTransitions.com.

Dr. Knight to Lead Professional Affairs

Johnson & Johnson Vision Care

Millicent Knight, OD

Millicent Knight, OD, has been appointed to the role of Head of Professional Affairs, Johnson & Johnson Vision Care, North America. In this role, Dr. Knight will lead the development and deployment of the company's professional strategy across the United States and Canada. She will also direct its professional and education platform through The Vision Care Institute, LLC, and other educational outreach programs.

Dr. Knight brings to the position 25 years of comprehensive experience in multiple areas of optometry, including contact lenses, contact lens research, ocular disease management, and integrative eye and systemic care. She is a member of many organizations, including the Illinois Optometric Association, American Optometric Association, and National Optometric Association. She has served on the board of trustees of Illinois College of Optometry, the National Advisory Eye Council and the National Eye Institute. Dr. Knight is a Certified Health Coach and a Fellow in the American Academy of Anti-Aging Medicine and a Kellogg Leadership Fellow. She was named optometrist of the year by the National Optometric Association in 1999 and by the Illinois Optometric Association in 2012.

Optical Industry Veteran Retires

Safilo®

Safilo USA announced the retirement of Dick Russo, executive vice president in charge of commercial activities for North America, after 42 years of service. The new Commercial Senior Vice President of Safilo North America is Glenn Rusk, who previously led Safilo's Canadian business and will be a member of the company's Global Leadership Team.

Russo began his career in the eyewear industry in 1971 as an independent sales representative in the Safilo sales division of Starline Optical Corp., which became Safilo USA, Inc. in 1991. In addition to his career with Safilo, he has been an active member of the Vision Council, the eyewear industry's trade association, having served on the board of directors, as secretary/treasurer and as a member of the executive committee.

Dick Russo

Glenn Rusk

Also: Safilo Group was chosen "favorite frame company" by the readers of Vision Monday and 20/20 Magazine via the annual 2013 EyeVote Readers Choice Awards. Readers of the two Jobson Medical Information publications were asked to identify their favorite products in eight distinct categories in the eyewear sector.

Portable Imaging Unit Can Multi-Task

VOLK® the leader in aspheric optics®

Volk Optical's Pictor Plus handheld imager enables convenient ophthalmic imaging in any setting, in or out of the office. The portable device captures high-resolution images of the retina and anterior segment. It weighs just one pound, and fits easily with its accessories into a small briefcase. The jpeg images easily upload via Wi-Fi to a computer, are compatible with most major imaging software programs and adaptable to any patient database system. Patient ID entry assigns unique identifiers to each file, which can be used for patient records or shared for remote diagnosis and consultation.

The Pictor Plus retinal module provides a 40-degree field of view of the fundus. Nine fixation points target different regions of the retina. Using a non-mydriatic imaging method, the device can work through pupils as small as 3mm. The anterior module images the eye's surface and has a series of cobalt blue LEDs for fluorescent imaging.

For more information on the Pictor Plus, or to arrange a free three-week trial, visit www.volk.com.

Practice of the Year Award Presented

Transitions

Transitions Optical, Inc. named Clarus Optical the Transitions Eyecare Practice of the Year, recognizing the staff for their year-long efforts to promote eye health and the Transitions brand within their practice and community. Clarus Optical's administrator, Kimberly Manthe, accepted the award on behalf of the practice at an awards ceremony held in January during the 18th annual Transitions Academy in Orlando, Fla. Transitions launched the Eyecare Practice of the Year Award in 2011.


ALLERGAN
LUMIGAN 0.01% (bimatoprost ophthalmic solution) 0.01%
Alphagan P 0.1% (brimonidine tartrate ophthalmic solution) 0.1%
Combigan (brimonidine tartrate/timolol maleate ophthalmic solution) 0.2%/0.5%
Latisse (bimatoprost ophthalmic solution) 0.03%
Restasis (Cyclosporine Ophthalmic Emulsion) 0.05%
LASTACAFT (alcaftadine ophthalmic solution) 0.25%
Refresh
ZYMAXID (gatifloxacin ophthalmic solution) 0.5%

[redacted]

EDITORIAL

Interprofessional Education (IPE)

Aurora Denial, OD, FAAO

The World Health Organization (WHO) defines interprofessional education (IPE) as "the occasions when students from two or more professions learn about, from and with each other to enable effective collaboration and improve health outcomes.[1] The WHO first recognized the importance of IPE in 1978, more than 30 years ago.[2] Since that time, interprofessional educational initiatives have been slowly introduced into healthcare programs. Recent changes in healthcare policy and delivery have led to an increased awareness of the importance of IPE. Changes in accreditation in many healthcare programs have led to IPE becoming a required competency.

The Journal of Patient Safety estimates that more than 400,000 patients each year, who go to the hospital for care, suffer some type of preventable harm that contributes to their death.[3] This makes medical errors the third leading cause of death in the United States. In 2001, the Institute of Medicine recommended redesigning systems and developing effective healthcare teams to achieve care that is patient-centered and supported by evidence-based decision-making.[4] The systems would also take into account patient safety, avoidance of injury, time, efficiency and fairness.[4]

Improving the healthcare system and reducing medical errors is a goal for the future. Many organizations feel that IPE is a mechanism to achieve this goal.[5,6,7] Effective teamwork implies that all members of the team have a vested interest in the outcome of the patient's care. In the past, many healthcare professionals worked in isolated silos. Although collaboration in patient care has always been common, this may or may not imply a vested interest in the patient's outcome and still leaves room for isolation. Interprofessional education leading to interprofessional patient care will require a shift in culture. The shift reflects thinking within the framework of an autonomous professional vs. as a professional working within a team.

Culture changes are usually slow to take hold and are often met with challenges. The challenges associated with IPE include practicality in scheduling, time to bring students together, finding other professional schools to partner with, administrative support and faculty training. Information about interprofessional education is plentiful. Using the words interprofessional education in a Google search produced almost 2 million entries. There are also many journals and conferences dedicated to the topic. I recently had the opportunity to attend the 2014 Interprofessional Education Collaborative Conference in Virginia. This three-day conference provided information, resources, examples of ongoing projects, consultation with experts in the field, and an opportunity to develop curricula and projects for our students. The conference participants included faculty from multiple healthcare professions, including optometry.

Optometric education provides the knowledge, skills and role-modeling for future practitioners, but how do education and the profession of optometry fit into IPE and ultimately interprofessional practice? The profession is mainly practiced in outpatient settings, often in private or commercial practices. These practice modalities often lead to isolation. Will future changes in healthcare practice necessitate that all practitioners accept and embrace working within a team? The AOA Code of Ethics states "it should be the duty of all optometrist to keep their patient's eye, vision and general health paramount at all times."[8] The ability to accomplish this task may require the ability to work within a healthcare team. As educators, it is our job to prepare students for the future.

Optometric education has shown a strong interest in interprofessional education. In this edition of the journal (see below), I invite all faculty members to participate in a future theme edition, which will focus on all aspects of interprofessional education. The sharing of accomplishments, lessons learned and outcomes will help others striving to implement IPE into their curriculum. This is an opportunity to showcase how the profession of optometry education is moving forward and embracing a culture change.

References

1. Framework for Action on Interprofessional Education and Collaborative Practice. Geneva: World Health Organization; [cited on January 24, 2014]. Available from: http://www.who.int/hrh/resources/framework_action/en/.
2. Alma-Ata 1978: Primary Heath Care, Report of the International Conference on Primary Healthcare. World Health Organization. 6-12 September 1978: Alma-Ata, USSR.
3. James J. A new evidence based estimate of patient harms associated with hospital care. Journal of Patient Safety. 2013; Volume 9, Issue: p122-128.
4. Crossing the Quality Chiasm: A new health system for the 21st century. Washington, DC. National Institute of Health; [cited on January 25, 2014]. Available from: http://www.acmq.org/education/iomsummary.pdf.
5. Health Professions Education: A Bridge to Quality. Washington, DC. Institute of Medicine; 2003[cited January 24, 2014].Available from: http://www.iom.edu/Reports/2003/health-professions-education-a-bridge-to-quality.aspx.
6. Working Together for Health: The World Health Report, 2006. Geneva: World Health Organization; [cited on January 24, 2014]. Available from: http://www.who.int/whr/2006/en/.
7. Interprofessional Education. Prevention Education Resource Center. Washington, DC. [cited on January25, 2014]. Available from: http://www.teachprevention.org/interprofessional.php.
8. Code of Ethics. American Optometric Association, St Louis [cited on January 24, 2014]. Available from: http://www.aoa.org/about-the-aoa/ethics-and-values/code-of-ethics.

THE VISION CARE INSTITUTE™, LLC
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Special Announcement
2014 Educational Starter Grant Program

The Association of Schools and Colleges of Optometry (ASCO) and The Vision Care Institute, LLC, an affiliate of Johnson & Johnson Vision Care, Inc., are pleased to announce the offering of the 2014 Educational Starter Grants. The grants have been offered over the past three years and are dedicated to supporting educational research. This is a great opportunity for faculty to get involved in doing educational research, which can impact teaching, student learning and the profession.

Information about the grants, past successful grant proposals and the current application can be found on the ASCO website at http://www.opted.org/grant-and-award-opportunities/.

Invitation to Participate in an Upcoming Theme Edition

Optometric Education is announcing a future theme edition, which will focus on all aspects of interprofessional education. The deadline to submit articles for this theme edition is Aug. 30, 2014. For additional information on the theme edition contact Dr. Aurora Denial at deniala@neco.edu.

Optometric Technology and the Millennial Generation

Today's students gravitate toward the latest diagnostic tools, but might they and their future patients lose something in the process?

James Kundart, OD, MEd, FAAO, FCOVD-A

Dr. Kundart is the Immediate Past Chair of the Educational Technology Special Interest Group for the Association of Schools and Colleges of Optometry. He is a researcher and author and an Associate Professor at the Pacific University College of Optometry. He can be contacted at (503) 352-2759 or kundart@pacificu.edu.

As technology continues to advance at a dizzying pace, a growing list of classic optometric diagnostic devices go largely unused by the generation of students currently learning in our classrooms and clinics. As educators and clinicians we certainly welcome improvements in patient care capabilities, but I can't help but wonder whether our students' reluctance to utilize what have been some of our most useful tools might someday influence the way patients are diagnosed and treated.

Direct Ophthalmoscope

Take for example the venerable direct ophthalmoscope, which seems well on its way to becoming just a spare handle in the diagnostic kit before the end of students' first year. Perhaps that makes sense for an instrument invented more than a half century ago. However, even though features such as LED bulbs and lithium batteries have improved the direct scope, our students want to avoid it. They are hampered by its monocular views, which require alternate suppression of one eye, and its magnified views can exaggerate the optic cup-to-disc ratio. Perhaps most challenging for students is that they attempt to learn how to use the direct scope on undilated eyes. Consequently, they tend to begin early to show a preference for binocular indirect ophthalmoscopy.

The same might be said for examination of the fundus with the biomicroscope and a high-plus lens. For many, the binocular view at the slit lamp trumps the monocular view of the handheld ophthalmoscope. When a patient declines dilation and a view of the posterior segment is still necessary, most students would rather add undilated high plus to their anterior segment exam, which already necessitates a slit lamp, rather than use the direct ophthalmoscope.

Figure 1
Students seem hampered by the monocular views of the direct ophthalmoscope.

Despite its drawbacks in the minds of students, the direct scope has distinct price, portability and availability advantages over a slit lamp and 90D lens. Furthermore, there remain clinical situations in which the direct scope is advantageous. Examples include its use in the Bruckner test for detection of subtle strabismus in pediatric patients and as a quick check for media opacities prior to refraction, especially when autorefraction is done in preference to retinoscopy. Niche uses for the direct ophthalmoscope exist as well. It has been observed that its optics provide an advantage in diagnosing the distinctive reflectance of talc retinopathy.

Figure 2
Most students would rather make a trip to the dispensary to use the autolensometer than use the manual one in the exam room in front of the patient.

Figure 3
The analog knob on the manual keratometer seems to be a foreign entity to many Millennials.

Manual Lensometer

The manual lensometer is another analog instrument to which the Millennial Generation has an aversion. The wide assortment of instructional videos about it on YouTube attest to this fact. Further evidence is that most students would rather make a trip to the dispensary to use the autolensometer than use the manual one in the exam room in front of the patient. Our students' discomfort can likely be attributed to the seemingly arbitrary steps involved in manual lensometry, such as which lines to focus first, and the arithmetic required to calculate the difference between sphere and cylinder powers as well as the add. All of these things require comfort with a number line laid out on an analog knob, both of which are foreign to many Millennials. When progressive lenses and the occasional prism are added to the mix, many students feel adrift. To them, the habitual prescription is all too often an optional data point because of the perceived difficulty of obtaining it. In contrast, to seasoned optometrists it is one of the most valuable pieces of information in a refraction, and many swear by the accuracy of manual lensometry in comparison to autolensometry.[1]

Perhaps because manual lensometers cost so many times less than autolensometers they will remain in widespread use for years to come. Or maybe the ubiquitous nature of autolensometers will make the skill of manual lensometry obsolete. Yet another potential scenario is that our future optometrists will be content to keep the manual methods solely in the realm of optical technicians.

Manual Keratometer

I purchased my first optometric exam lane in 2000 and it included a manual keratometer. Working in a small solo practice without a corneal topographer or even an autorefractor, the Helmholtz-era device was useful for fitting contact lenses and diagnosing corneal ectasia. For the typical soft lens fit, getting a starting base curve was as simple as adding one to the radius of curvature from the keratometer knob. Today's students don't necessarily see the usefulness of the keratometer. Not all exam rooms have them, which reinforces the idea that keratometry is not necessary for addressing a patient's chief complaint. It's hard to convince today's students of the usefulness of knowing the toricity of the front of the cornea for determining refractive cylinder when they have access to autorefraction, on which autokeratometry is almost an afterthought.

For students, the keratometer presents challenges similar to those they perceive with the manual lensometer, primarily the analog knob. It requires a level of comfort with the number line, which they may not have been taught in elementary school. The unlabeled demarcations, to be read to the nearest 0.125D, combined with 20th century concepts in physiological optics make them unconsciously think of the keratometer as an anachronism. To them, it's a slide rule, one in which it's embarrassingly difficult to find the patient's eye. Thus, we shouldn't be surprised when we see the dust covers on these instruments even in lanes where exams are in progress. This may be unfortunate given that our students may discover keratometry skills can come in handy once they are out practicing on their own. The managed care or commercial practices where many graduates are working may give them access to auto Ks but not to topography. They may be able to fit soft contact lenses from auto Ks, but fitting RGPs or diagnosing corneal ectasia is much easier with the information a keratometer can provide about the central 3 mm of the cornea.

Cell Phone Cameras

Private practitioners are already using cell phone cameras to obtain photos at the slit lamp, and many have posted online tutorials showing how it's possible to capture high-quality images.[2] Despite the challenges this creates with HIPAA privacy laws, many student clinicians find it incredibly easy to obtain pictures from the slit lamp with their cell phones. What they lack in resolution, the images more than make up for in convenience and connectivity. It might behoove optometric educators to overcome the HIPAA concerns by having our teaching clinics own some small digital cameras with which to teach our students. We know that once they are established in their own practices, they will be able to perform ocular photography with any camera they choose.

Staying Focused on What Matters Most

The latest automated diagnostic instruments provide many advantages, including ease of use and reduced training time. They often combine multiple capabilities in a single device. They enable doctors to see more patients in a day and bolster the perception of a state-of-the-art practice. Most are digital as well, making them very appealing to tech-savvy Millennials.

On the other hand, they are costly and may not be available in every practice setting. Perhaps more importantly, they can be less accurate than tried-and-true diagnostic methods due to loss of qualitative data, making assumptions, for instance, concerning position of gaze and clarity of the ocular media.[3] Many of these new instruments also have the potential to make specific clinical skills less needed as a matter of routine. Will the erosion of such skills serve our students, or their future patients, well? Just because anterior segment OCT could potentially replace gonioscopy, or mfERG could replace threshold visual fields, doesn't necessarily mean they should.

These are issues we should not lose sight of as optometric educators. While we share our students' enthusiasm for the latest technology, we should remain vigilant in ensuring they learn and maintain the key skills that make up the diagnostic acumen necessary for delivering the highest quality of patient care.

References

1. Automated vs. Manual Lensometers. OptiBoard Discussion Forum. http://www.optiboard.com/forums/showthread.php/8523-Automated-vs-manual-lensometers. Accessed 01-28-2014.
2. Smart Phoneography - How to take slit lamp photographs with an iPhone. EyeWiki website. http://eyewiki.aao.org/Smart_Phoneography_-_How_to_take_slit_lamp_photographs_with_an_iPhone. Accessed 01-31-2014.
3. Automated Ophthalmic Equipment vs. Manual Ophthalmic Equipment. Veatch Ophthalmic Equipment website. http://www.veatchinstruments.com/info.asp?topic=Auto.%20Vs.%20Manual%20Ophthalmic%20Instruments. Accessed 01-31-2014.

Teaching with the iPad

Jamie Althoff, OD

Dr. Althoff is an Assistant Professor at Nova Southeastern University College of Optometry.

The use of iPads in education has been a popular topic of conversation since the release of the first iPad in 2010. Most of the discussion centers around the benefits of having students use iPads. However, after spending almost two years using an iPad to enhance my teaching, I am convinced that this device can be just as beneficial for the learning process when it is in the teacher's hands.

The thought of using a new and unfamiliar device may not appeal to those of us who are already teaching successfully with more comfortable, tried-and-true methods. However, if you are willing to invest a small amount of time, you will begin to see that there are many ways that using an iPad for your teaching can allow you to work efficiently, teach effectively, and have fun doing it.

I currently teach Theoretical Optics I and II lectures and laboratories for first-year optometry students at Nova Southeastern University. I began using an iPad in May 2012, and now I cannot imagine trying to teach my classes without it. I have used it in many different ways, and I have learned a lot in the process. I hope that sharing my experiences sparks new ideas for others and helps to shorten the learning curve for those who are new to the iPad. All applications discussed are available through the Apple App Store on the iPad.

Before Class

The iPad started working as a teaching tool for me before the semester even started. Optics, along with many other topics covered in optometry school, is not a subject that can be adequately understood by only attending scheduled lectures. Some concepts require additional time for the students to digest and work through at their own pace. I used the iPad to create 5- 10-minute "tutorial videos" that the students are required to watch before the related lecture. They watch the video online and take a brief online quiz before arriving at class to demonstrate that they understand the basic concept. I love that when I start talking about a new topic in class, I see heads nodding in familiarity around the room. The students love that they can refer to these videos any time outside of class while they study.

I have used two apps to create these videos. One is ShowMe (free), which is simple and easy to learn. The iPad screen becomes a whiteboard that records your voice as you write and draw. Pictures can be added and annotated, and you can set up slides and navigate between them. When a video is finished, it is available, either publicly or privately, on the showme.com website. The video can also be downloaded to a computer, and this file (.mp4) can be uploaded to YouTube or a course management system such as Blackboard. One potentially major limitation to this app is the lack of any editing tool. I eventually learned to plan on creating each video at least twice because any small mistake means starting from scratch. An example of a tutorial video made with this app is "Locating an Image With Ray Tracing." This is one of the longer yet more popular videos that I have made, and it is available on YouTube at http://youtu.be/jeN-LOKqGaew.

For several months, I used a different app, Explain Everything ($2.99), for creating videos. It also records your voice and writing on the iPad and incorporates the use of photos and slides. It also allows you to add video clips and record your annotations as the video clip is playing, or to open a web browser and record as you navigate through a web page. Explain Everything has several additional features, but its main advantage is the ability to perform basic editing. You have the option of backing up and restarting the recording from the location that you select. Clearly, this can save a lot of prep time. However, with more options and features comes a steeper learning curve, and, unfortunately, I have noticed several bugs that show up when some of the more advanced features are being used. After several months, I decided that for my uses, the simplicity of ShowMe outweighed the features of Explain Everything. "Snell's Law and Lateral Displacement" is a tutorial video that I made with Explain Everything for students to view prior to lab, and it is available at http://youtu.be/V-VtEA6yxZw.

During Class

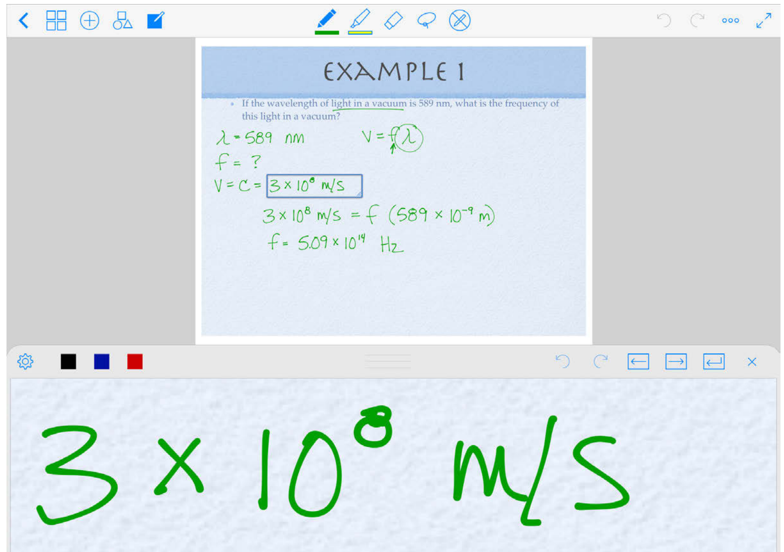
One of the main reasons I love to teach with my iPad is that I can annotate my slides while lecturing. I have not found a way to make clear, detailed annotations directly with PowerPoint or Keynote, so the main caveat is that your lecture slides must be saved as a .pdf. This takes only seconds to do, but any animations or other interactive material within the presentation will not transfer to the .pdf format. Depending on the nature of your presentation, this could mean that a few minor changes or sacrifices are made, or it could mean that you are unable to use this method of presenting.

Once my lecture slides are saved as a .pdf, I e-mail this file to myself and open it in an annotation app on the iPad. (Most annotation apps will also link directly to cloud storage services such as Dropbox and Google Drive.) The iPad is connected to the projector via a VGA ($29, apple.com) or HDMI cable ($39, apple.com), or wirelessly with AppleTV ($99, apple.com). Then, I can choose a color and pen size and start drawing. I can highlight, underline and circle text or figures on my slides. I can correct errors and write out key terms that are not included on the slide. For optics, the biggest advantage is that I can work through problems step by step along with the students and quickly sketch diagrams when questions come up. (Yes, this is similar to an overhead projector, but with many added benefits.) Side note: I provide a similar .pdf file to my students, and they also use an annotation app to take notes during class.

Several popular annotation apps are available. I currently prefer GoodNotes ($4.99) for several reasons. GoodNotes will open many file types, although it essentially converts the file into a .pdf upon opening it, which may alter the appearance of non-.pdf files. You can also start a new file with a blank page, lined paper or graph paper. These files are stored within the app and can easily be sorted into folders. While you have a file open, it is easy to open a thumbnail view and scroll through all of your slides quickly. It is easy to add an image from the iPad into any document, and it is also easy to add a page in the middle of a document, for example, if you need more space to illustrate a concept. You also might find it useful to select an area of annotations and be able to move the selection to a different area on

Figure 1

GoodNotes utilizes a zoom window, where it is possible to write quickly and naturally. When presenting, only the slide projects. The zoom window and toolbar are not visible to the audience.



the screen, or even resize it. If you want to zoom in on a portion of your slide, it is easy to do by using the pinch gesture on the iPad. In addition, a shape detector creates perfectly straight lines and geometric shapes when you draw. GoodNotes also incorporates a zoom tool, which allows you to write within a zoomed-in box, but still view the entire slide while you're writing. **(Figure 1)** This allows for much more natural and legible handwriting. When using the app to present, only the slide and your annotations will project. The toolbar, zoom box, and other elements of the interface will not be visible to the students.

I have briefly used several other annotation apps. Notability ($2.99) is very similar to GoodNotes, but the thumbnail view shows fewer slides at a time, making scrolling through long documents more cumbersome. Also, the shape detector is not as user-friendly. UPAD ($4.99) is also similar, although I stopped using this app after only a few weeks because it tended to lag when I was working with longer .pdf documents, and the thumbnail view is only single-file, similar to Notability. PDF Expert ($9.99) is another popular annotation app with a good reputation. However, I have not used PDF Expert because it is missing the ability to create a new document within the app, which is a feature I use frequently.

After Class

We all have students who, no matter how long we give them, want more time to complete their notes on a particular slide before moving on to the next slide. This tends to occur frequently in my optics courses, where many of the slides require extensive work to solve a problem. I have found that I can appease these students by offering to e-mail them a copy of the annotated slide. This can be done in just a few seconds with GoodNotes and the other annotation apps. The selected slide(s), along with any annotations that you made, are saved as a .pdf document and can be exported via e-mail or several other methods. I also use this feature when I need to correct an error in my notes. I can mark where the error is, along with any explanations and corrections, and e-mail this to my students or post it to Blackboard. In optics, it can be particularly useful to use GoodNotes to create a key for problem sets, complete with color-coded diagrams and explanations. Or, when a student e-mails me a question, I can quickly create a document that can clearly explain how to solve a problem. For particularly complicated problems that I find myself explaining over and over again, I have used ShowMe or Explain Everything to create a video.

At times it is difficult or impossible to obtain an electronic copy of a document that I want to distribute. In these cases, I use Genius Scan (free) to take a photo of the document. The app converts the photo into a .pdf document and allows it to be e-mailed or opened in other apps. I recently used this app to send a recommendation letter on behalf of a student. The organization required that the document be on letterhead and signed, but also sent via e-mail. After I printed the letter, I signed it, took a photo with Genius Scan, and attached the .pdf to my e-mail.

Transferring Files

Those who are accustomed to storing files on a flash drive for portability may feel hindered by the lack of a USB port on the iPad. The iPad does not have a traditional file storage system. Each file is stored only within the relevant app. At first, I thought it would be cumbersome to e-mail myself every file that I wanted to open on my iPad. However, the functionality of the iPad makes it simple, and I hardly even think about it now. Once I have received an e-mail, it takes less than 10 seconds to have an attached file opened in an app on my iPad. Once the file is opened within an app, it will be saved there, and the e-mail can be deleted. Similarly, each app will almost certainly have an export or share function that allows a file within that app to easily be sent via e-mail. Using e-mail to transfer files is familiar and simple, but it is limited by the attachment sizes that are allowed by your e-mail client. When I need to transfer a very large file, I connect the iPad to my computer and use iTunes to drag and drop files to and from apps.

Most apps used for reading or altering files are also compatible with various cloud storage options, such as iCloud, DropBox and Google Drive. These and many others each have a certain amount of free storage and allow extra storage for various prices. At this point I have not integrated any of these services extensively into my workflow, but many of my students and colleagues find them very convenient. They allow a file to be accessed from any computer or mobile device with an internet connection, and the file size is only limited by the amount of storage available on the account. In addition, many allow for easy collaboration with other users because a document can be shared and edited within the cloud by all who are given access.

Accessories

Several types of accessories may make the iPad more useful to a teacher. The accessory I have found to be the most essential is my stylus. I use several applications that capture handwriting on the screen. For natural, legible handwriting, and the ability to draw accurate diagrams, a stylus is much preferred to simply using my finger on the screen. Available styluses range from generic models for around $2 to specialized models for more than $100. Modern touch screens, as on the iPad, require a rather large area of contact with the screen in order for a stylus to be detected. Therefore, most styluses are made with a large rubber-like tip, and it can feel similar to using a toddler's crayon. For better precision, some models employ a clear disc to allow the user to see what and where they are writing while still maintaining enough surface area on the screen. I have used the Adonit Jot Pro ($30, Amazon) for more than a year. **(Figure 2)** Initially, it had major issues with skipping and poor conduction, but after I applied a tiny amount of thermal compound ($12, Radio Shack) between the disc and the tip, it has worked flawlessly for months. I have also borrowed a Dagi stylus ($20, www.dagi-stylus.com), which has a similar design, for a few small projects and was happy with its performance.

Depending on the exact app you're using and the type of drawing or writing you're doing, you might find it difficult to write on the iPad screen in one location without the side of your hand or wrist activating the screen in another location. Some applications have "palm rejection" settings to cut down on stray marks, and a few styluses even use a Bluetooth connection to allow you to rest your palm on the screen. The Hand Glider ($25, www.thehandglider.com) is a partial glove that blocks the side of your hand from activating the iPad screen and allows you to write naturally with a stylus. **(Figure 3)** I use this during lectures while drawing diagrams in GoodNotes and when I am creating tutorial videos with ShowMe or Explain

Figure 2
The Adonit Jot Pro uses a clear disc tip, which improves precision for writing and drawing on the iPad.

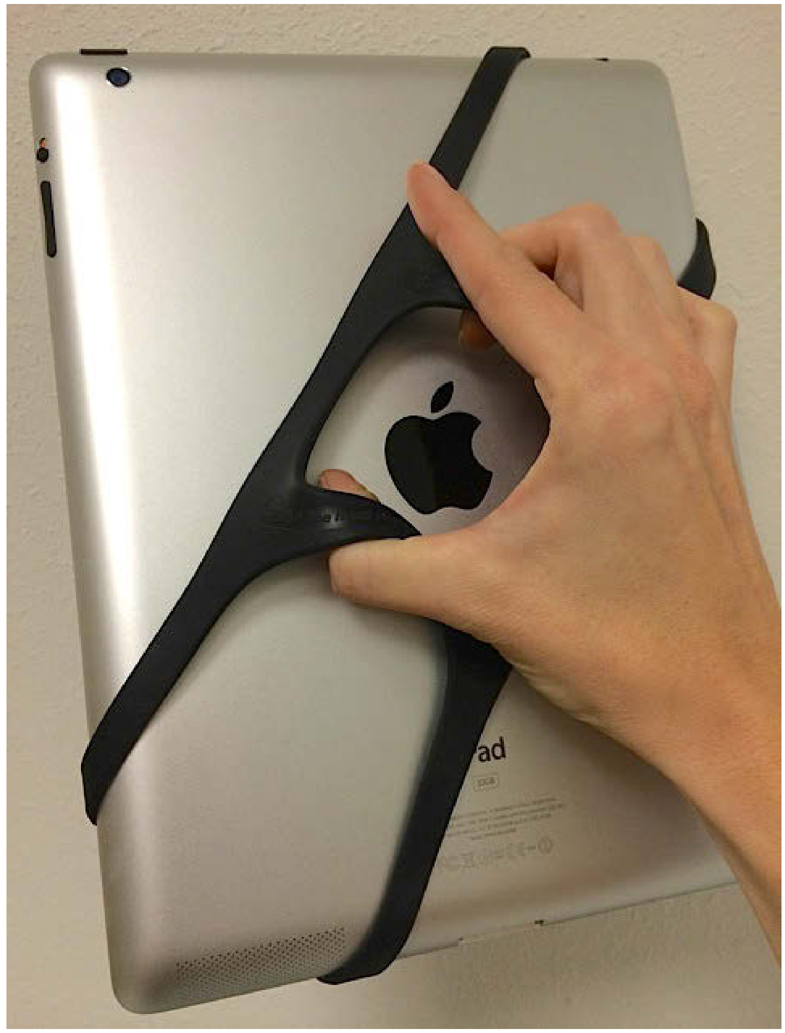
Figure 3
The Hand Glider allows your hand to rest naturally on the iPad without activating the touch screen.

Everything. Many students wonder what type of fashion statement I'm trying to make, but it has made a lot of my work on the iPad much neater and easier.

For extensive document creation or for writing numerous or lengthy e-mails, the on-screen touch keyboard may prove frustrating. Luckily, dozens of iPad keyboards are on the market. Most iPad keyboards also serve as a case to protect the iPad and as a stand to allow it to sit upright, similar to a laptop computer. They connect to the iPad via Bluetooth. While most need to be charged (very infrequently), a few are solar-powered. I personally do not use a keyboard with my iPad, so I will refer readers to an in-depth review of some of the more popular models at www.macworld.com/article/1164210/macworld_buying_guide_ipad_keyboards.html.

One last accessory I'd like to mention is the Padlette ($20, Amazon). While a benefit of lecturing with the iPad is the ability to move about the room, it can be a bit awkward to hold and use the iPad while walking around. The Padlette is essentially a very strong silicone rubber band that slips around the corners of the iPad. It forms a secure handle on the back of the iPad so that it is easy to hold with only one hand, leaving your other hand free for writing or otherwise illustrating your point. **(Figure 4)**

Figure 4
The Padlette fits around the corners of the iPad to form a secure grip on the back.



Conclusion

After almost two years of using my iPad daily inside and outside of the classroom, it has become an indispensable tool that makes instruction easier and more effective. Some features required time and practice, but for me the result has been a fun and powerful method of teaching and managing a course. I hope some of my experiences will help others to find ways to integrate the iPad into their teaching repertoire. In addition, I am always looking for new ideas from anyone who may be using other apps or methods. Please feel free to contact me with any questions, comments or suggestions at jalthoff@nova.edu.

Clinic Partners — Teaming Second-Year Scribes with Interns

Leon Nehmad, OD, MSW, FAAO

Dr. Nehmad is Associate Professor at Nova Southeastern University College of Optometry. He taught at SUNY College of Optometry for 15 years, where he was the developer and instructor of record for the second-year Integrative Seminar course.

In last issue's Educator's Podium, Dr. Weissberg outlined the Enhanced Student Training Program at New England College of Optometry, in which second-year students were assigned to perform limited patient testing under close supervision to help prepare them for third-year clinical internship. I would like to add to the discussion by describing an alternative method to meet this goal, instituted five years ago during my tenure at SUNY: the assignment of second-year students as scribes for third- and fourth-year interns.

Designing a second-year optometry student clinical experience that builds upon the first year clinic observations poses a challenge for educators. The educational value of observations leads to diminishing benefits over time with waning student interest and a desire for more meaningful participation. There is a need for increased depth of clinical experience during the second year, yet the students' rudimentary knowledge base and skills limit this. As Dr. Weissberg pointed out, second-year student participation in testing is apt to interfere with exam efficiency, and for this reason our past efforts to pair them with interns as testing assistants has led to them being pushed aside in the exam room by their senior colleagues. Finally, dividing patient testing between second-years and interns deprives the latter of needed experience.

An alternative program was instituted in 2008 when the college began a new curriculum, the hallmark of which was the Integrative Track, a three-year sequence of courses aimed at integrating classroom, clinic, and small group learning. As part of this sequence, we established clinic partners consisting of second-year scribes and third- or fourth-year interns.

A survey of students and faculty conducted prior to the start of the new program revealed overwhelmingly that the major difficulty in entering clinic in the third year was becoming comfortable with the electronic medical record (EMR). The EMR is a complex program, and brief training sessions were not sufficient to provide students with a level of competence necessary to conduct an efficient exam. Time in the exam room was spent learning to navigate the EMR at the expense of developing clinical skills. Another significant problem was a lack of familiarity with the entire exam sequence, as first-year observations were limited to an hour, permitting students to observe only fragments of the exam.

As a result, students now acquire EMR experience by scribing throughout their second year, prior to internship. EMR is taught at the start of the fall semester, and students are drilled for several weeks using sample cases and role-playing incorporating all case documentation. Once they have demonstrated competency in teaching lab, they are permitted to scribe in clinic. They are paired with an intern for one half-day clinic session per week. Seminar leaders introduce them to one another and outline their respective duties, with explicit guidelines:

- The scribe is solely responsible for entering all the information into the EMR, including the history, results, impression, plan, disposition, and billing. Under ordinary circumstances, the intern is not to enter information into the computer or interfere with the scribing. However, if a significant problem emerges that impacts the exam, the intern may take over the entry of information for a portion or the remainder of the exam.
- The scribe's job is to enter the relevant material into the EMR. In order to accomplish this it is the intern's responsibility to conduct the exam in a manner conducive for scribing. The intern needs to distill the pertinent material and dictate it at a reasonable pace, in a clear, organized, succinct fashion to achieve a well-written and professional case record. In order to accomplish this, the intern needs to know where the scribe is at all times in the EMR templates.
- Neither the scribe nor the intern is to use pen and paper to "transcribe" information. It is to be entered directly into the EMR.
- The two work together as a team with ongoing communication and clarification as necessary to address any problems.
- The primary purpose of the partnership is not for the intern to

- teach the scribe (though such teaching will occur), but to provide an excellent patient examination and case record.
- Both the intern and scribe sign the chart.
- Seminar leaders monitor the clinic partners for the initial portion of the session to assure that the process is going smoothly and that the above goals are being met.

Through the process of scribing, the student obtains an understanding of how to construct a professional record, the overall flow of the exam, clinic protocols, and intern supervision. As opposed to being pushed aside by interns when assigned to sharing with testing, scribing gives the student "real estate " in the exam room that is solely his or her domain. Scribes develop a responsibility for the case through their contribution and keep a log, including the important aspects of the case.

One valuable by-product that develops from the partnership is a mentorship between the intern and scribe. The scribe learns about the role of an intern in patient care from the perspective of an upper classman. This teamwork serves as an early model for intraprofessional collaboration. As part of their course grade, scribes are evaluated by group leaders with input from the intern.

The students are assigned to scribe every other week throughout the year. On alternating weeks, they meet in small groups conducted by seminar leaders. Discussions focus on integrative concepts drawn from cases seen in the prior week. Scribes have the opportunity to digest and research their cases as well as discuss last week's scribing. Over the course of the semester, the scribe must print out and critique at least two case records highlighting strengths, weaknesses, gaps, and suggestions for improvement. This exercise fosters student self-directed learning and is incorporated into the course grade.

Choosing with whom and in what setting to assign the scribes is important. Having to work within pre-existing course schedules requires that scribes be paired with both third- and fourth-year interns. Scribing for a fourth-year student tends to be more challenging due to the need to keep pace with a relatively faster exam. On the other hand, it also permits the student to participate in one that is more efficient and informed. Scribes are assigned between two and five interns over the course of the semester, again, based on pre-existing schedules and the decision of the course instructor. Working with the same partner each session can provide a familiarity to facilitate the tasks, while working with different partners provides diversity to enhance learning.

The scribing program is designed for primary care clinic, as a natural entry point for the second-year student. In the second half of the year when knowledge base and level of performance increases, stronger students may be placed in specialty clinics, such as glaucoma, retina, or vision therapy.

The clinic partners program has been in existence for five years and student and faculty feedback has been excellent. Like any new program that created significant changes it took some time to be accepted. During the first year some of the interns and faculty were concerned that second-year students could not perform well enough to participate in an important aspect of the patient encounter. However, supported by a strong training base, in a short period of time they proved themselves well and were readily accepted. From the program's second year forward, new third-year interns had the benefit of knowing what it was like to scribe and from this perspective embraced their new role as partner and mentor.

Most importantly, students entering clinic at the beginning of their third year were now able to achieve a faster start by already being competent in using the EMR. This allowed the intern to progress from focusing on the mechanical aspects of the exam, such as navigating the EMR, to higher-level tasks such as testing, case analysis and clinical decision-making.

The biggest challenge for the scribe is documenting the case history. This makes it incumbent upon the intern to learn to control the pace, direction and relevance of the patient interaction. Entering the exam results is a fairly straightforward process, though the intern is required to clarify when unfamiliar terminology is used. The intern also frequently needs to help the scribe with the composition of the impression and plan. Again, this process benefits both students.

Other challenges that emerged were occasional difficulties in working with the partner. Despite having gone through the scribing experience in previous years, some interns had difficulty accepting scribes, who complained that they did not treat them well. In other instances, interns complained about the skills of the scribe and impact upon the exam. Scribes and interns were asked to report problems such as these to the course instructor, who intervened to resolve them or assign the scribes and interns to different clinic partners. As might be expected, such problems are not always reported. Seminar leaders monitor the work to the best extent by direct observation, soliciting feedback and evaluating the scribe's printouts.

The scribing program has been well-established within the Integrative Seminar sequence at SUNY College of Optometry. It has strengthened the clinical development of second-year students and facilitated their entry into clinic. It has provided an enthusiastic and more active learning experience, fostered critical thinking and allowed for more productive student collaboration within the clinic setting. It has become a valuable and integral part of optometric education at the college.

Educator's Podium Submission Guidelines

Educator's Podium is an opinion-based, nonpeer-reviewed forum for optometric educators to share, think and question within any area related to the educational process or improving patient care. Send submissions (500-1,500 words) and a 150-word synopsis for Facebook to journal Editor Dr. Aurora Denial at deniala@neco.edu.

Blended Learning in Optometric Clinical Procedures Instruction

Denise Goodwin, OD, FAAO
Len V. Hua, OD, PhD, FAAO
John R. Hayes, PhD

Abstract

Blended learning combines online and face-to-face teaching. One-third of a refraction course in the second year of optometry school was offered in a blended format. We evaluated student understanding, preparation for laboratory sessions and satisfaction. The final exam scores comparing online and in-class topics were not significantly different from 2011 to 2012. No difference was noted in laboratory skills. Students were satisfied with the online activities. Blended learning did not affect learning or laboratory performance. However, students appreciated its flexibility and ability to keep them engaged. Blended learning may be an effective way of delivering material.

Key Words: *optometric education, blended learning, refraction*

Dr. Goodwin is a Professor at Pacific University College of Optometry.
Dr. Hua is an Associate Professor at Pacific University College of Optometry.
Dr. Hayes is a Professor at Pacific University College of Optometry.

Introduction

Blended learning is a hybrid of online and face-to-face teaching. It uses technology to enhance teaching and can increase interaction between faculty and students. Technology can allow flexibility in both teaching and learning. Online learning allows for a greater variety of teaching and learning styles.[1] Different techniques can be used in order to meet the needs of different types of learners. The learner can also adjust the pace of the learning to meet his/her needs. There is improved access to the information and greater convenience because the students are able to view the information multiple times and at any time.[1] In addition, multiple assessment methods are available through the use of technology. This helps to assure that students understand the topic areas. Finally, technology allows ease of communication between students and between student and professor.[1]

Learning styles of students have changed over the years. Technology has become an integral part in the lives of the students we teach. Many larger educational institutions now use online instruction.[2] Evaluations of blended learning in the areas of orthopedics,[3] physiotherapy,[4] nursing,[5-7] dentistry,[8] geriatric medicine[9] and pediatric medicine[10,11] have shown that students have a high satisfaction with online learning, including better contact with tutors, more timely feedback and improved flexibility. There are conflicting results from studies that attempt to objectively compare test results from traditional vs. online learning.[4,8,12,13] While blended learning approaches have been demonstrated to be effective in many disciplines, these approaches have not been studied in optometry.

Clinical Procedures III occurs during the fall semester of the second year at Pacific University College of Optometry. In the course, students are taught how to perform distance and near phorometry. Students traditionally meet for one hour of lecture per week and participate in a two-hour hands-on lab each week. Two multiple-choice examinations are given through the semester to assess knowledge, and students are required to demonstrate proficiency of the skills they have learned with a hands-on assessment. Due to the combination of lecture and laboratory time, it was felt that this class was an ideal place to implement blended learning in the optometry curriculum. Here, the traditional lecture time is replaced by computer modules, and the face-to-face teaching is done in the laboratory setting.

After integration of blended learning in the Clinical Procedures III course, we evaluated three general areas to determine the benefits and challenges of the blended learning program: the understanding of material presented, student preparation for laboratory sessions, and student satisfaction. The results of our study will aid optometric educators in integrating this technology in their curriculum.

Methods

Clinical Procedures III includes 12 topics presented through the semester. **(Table 1)** In fall 2012 we offered four of the 12 topics in a blended format. The other eight lectures were done using the traditional format. The traditional lectures were kept as similar to the previous year as possible so we could compare student performance.

An example of the blended learning on a Moodle page is seen in **Figure 1**. Each blended learning session included three to four, 3- 8-minute video segments. Each video segment was followed by a quiz to assure students understood the content. Students were required to watch the videos and receive a perfect score on all quizzes prior to the start of their lab time. Students received a quiz grade based on their first attempt. However, they were required to retake the quiz until they got 100%, otherwise no credit was given. The students were not required to attend class the weeks that they participated in the blended learning, but they were required to attend lab every week. Two in-class multiple-choice tests occurred through the semester, as well as the hands-on proficiency assessment. To assess understanding and compare performance with online vs. classroom-related topics, we compared the results of the cumulative final examination from 2012 with the same examination given in 2011.

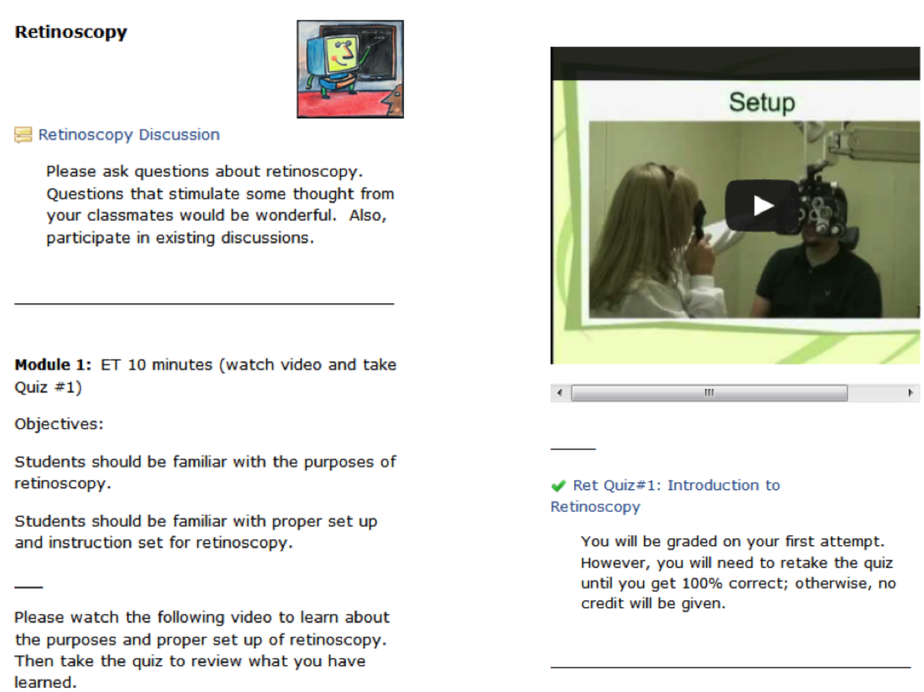
Table 1
Clinical Procedures III Topics and Rankings by TAs

Topics covered in Clinical Procedures III and ranking of the topics the teaching assistants (TAs) thought were presented online. (See text for further information.) Topics presented in a blended format are denoted with an asterisk. Topics that the majority of TAs thought were taught online are indicated with a “+”.

Topic	TA ranking
Week 1: Orientation	0
Week 2: Static Retinoscopy*	0
Week 3: Keratometry+	4
Week 4: Radial Line	2
Week 5: Monocular Distance Sphere	0
Week 6: Jackson Cross Cylinder+	3
Week 7: Distance Equalization and Binocular Distance Sphere*	0
Week 8: Forced Accommodation+	5
Week 9: Accommodative Posture*	2
Week 10: Phorias*	2
Week 11: Vertical and Horizontal Vergences	1
Week 12: Sequencing and Clinical Thinking	0

Figure 1
Example from the Moodle Website

The first of three retinoscopy modules is shown. The computer icon indicates that this activity will be done online. Each online topic during the semester starts with an area where the students can discuss the topic (Retinoscopy Discussion). Each topic is then broken down into three or four modules. The estimated time (ET) that it is expected that the student will take to complete each module and what tasks the student needs to complete are listed. The total estimated time for each topic can be determined by adding the estimated times for each module. The objectives are then stated. Finally, the video is available by clicking the play button, followed by a link to the quiz.



In addition to completing the blended learning modules, the students were required to meaningfully participate in discussion boards. No quota or required topics were given. Students were encouraged to post questions that stimulated a meaningful conversation, participate in the conversations, and read the posts. The instructor posted questions and responded to discussion questions intermittently when it was necessary to clarify or correct information given by other students or to stimulate further discussion.

No pre-written notes were given to the students for the online lectures. Students were neither encouraged nor discouraged from taking their own notes. As was done in previous years, for all in-class topics a pre-written outline was given to students explaining details of how to perform the procedures.

We used three methods to evaluate the efficacy of the blended learning model. First, we compared performance on the final exam from previous years when no blended learning took place. Additionally, we gathered feedback from the instructors and teaching assistants (TAs) in an attempt to determine if the blended learning activities affected laboratory performance. Finally, students were given extra credit to participate in a survey to determine their thoughts regarding the blended learning experience.

Results

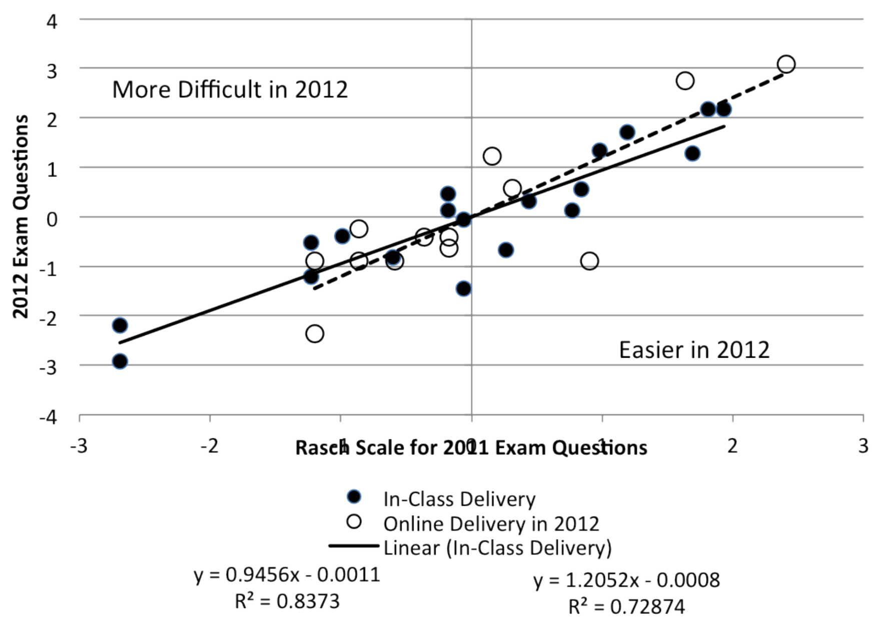
Final exam comparison

We compared the final exam results to the results of the same final exam given the previous year. Ninety-two students completed the Clinical Procedures III final examination in 2012 and 88 students completed the exam in 2011. The final exam was comprised of 40 multiple-choice questions. Of these, 30 questions covered topics from week eight to week 12, and the remaining 10 questions covered topics from week one to week seven. **(Table 1)** Thirteen exam questions pertained to information delivered online. Nineteen questions pertained to material covered in class. Eight questions were not included in the analysis either because the question covered material that was presented both in class and online or because the lecture was delivered by a different instructor than the person that delivered the information the previous year.

Table 2
Test Results of the 2011 and 2012 Final Exam for In-Class and Online Delivery

	Median	Mean	SD	n	t	p
2011 Class questions	0.824	0.828	0.124	88	0.79	0.43
2012 Class questions	0.824	0.813	0.128	92		
2011 Online questions	0.923	0.887	0.122	88	0.93	0.35
2012 Online questions	0.923	0.865	0.112	92		
2011 Diff between online - class	0.05	0.060	0.141	88	3.97	0.00
2012 Diff between online - class	0.04	0.053	0.133	92	3.79	0.00
Differences between online/class 2012-2011					0.34	0.73

Figure 2
Rasch Item Scale for Values for 2012 Plotted on 2011 Values for In-Class and Online Delivered Content



The mean score for questions that pertained to information given in class was 82.8% in 2011 and 81.3% in 2012. The mean score for questions that pertained to information presented online was 88.7% in 2011 and 86.5% in 2012. The median scores were identical for both online and in-class topics. **(Table 2)** These differences were not statistically different (p=0.43 for in-class questions and p=0.35 for online questions). A Rasch analysis was conducted to provide information on the level of difficulty for each exam question. Generally, this demonstrated that the questions that were easy in 2011 were easy in 2012, and the questions that were difficult in 2011 were difficult in 2012. **(Figure 2)**

Impressions from instructors and TAs

At the end of the semester, laboratory instructors and TAs were questioned to determine whether they thought the blended learning activities affected laboratory performance. First we determined whether the lab instructors and TAs had knowledge of which lectures had been given online. Four instructors were involved in the laboratory sessions. We received responses from two instructors. One of the two respondents was aware of which topics had been presented online. None of the

TAs who responded to the survey knew which topics had been taught online.

All lab instructors and TAs who were unaware of which lectures were given online were given a list of the topics delivered in Clinical Procedures III and were asked, "If you are unsure which lectures were put online, which four lectures do you think were online, and why?" If the instructors or TAs knew which lectures were online they were asked what differences they had noted when comparing labs where information was presented online vs. those where information was presented in class. Additionally, all instructors were asked to compare performance of the students from this year to students who took the course in previous years.

The instructor who was unaware of which topic had been presented online reported that he had not noted a difference in student performance compared to performance in previous years. The instructor who was aware of which topics were online noted that students did not rely as much on their notes when performing the online-taught procedures for the first time. However, no difference in skill level was noted when comparing the online-related labs and the in-class labs from previous years.

All TAs were third-year students who had taken and passed the course the previous year. Seven TAs were involved in the laboratory sessions. We received responses from six TAs. When TAs were asked what lectures they thought were online, and why, one TA chose the lectures he/she thought were online because he/she thought they would be easy to show in a video format. Five of the six TAs chose the topics they thought were presented online based on the feeling that the students would do poorer in labs associated with the online presentation. The following were the reasons why the five TAs chose the labs they thought were online:

"The students were less prepared for those labs."

"These labs were most challenging for the students."

"They had a few more questions about those tests than others."

"These labs seemed to be the most confusing labs for the students."

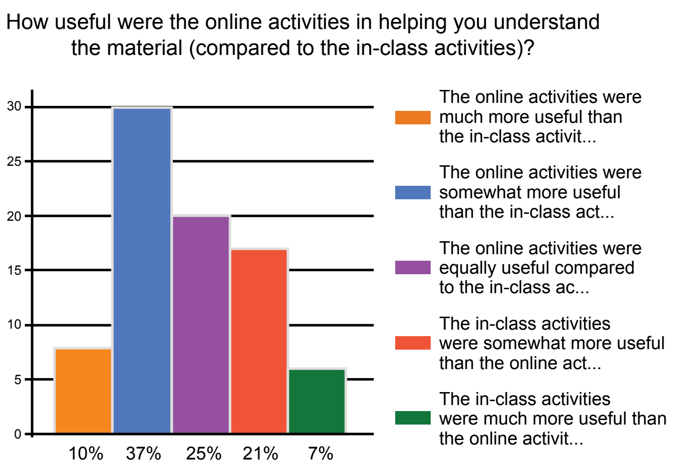
"The students were not very prepared for these topics and required a lot more in-lab instruction."

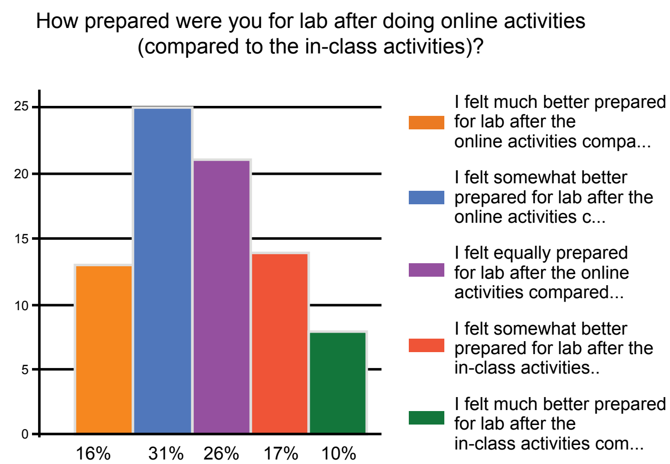
Four of these five TAs picked four courses they thought were taught online, and one picked only three courses he/she thought were taught online. **(Table 1)**

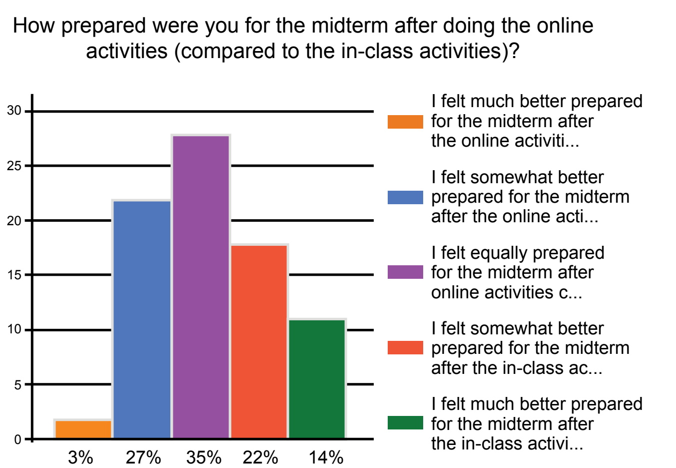
Student impressions

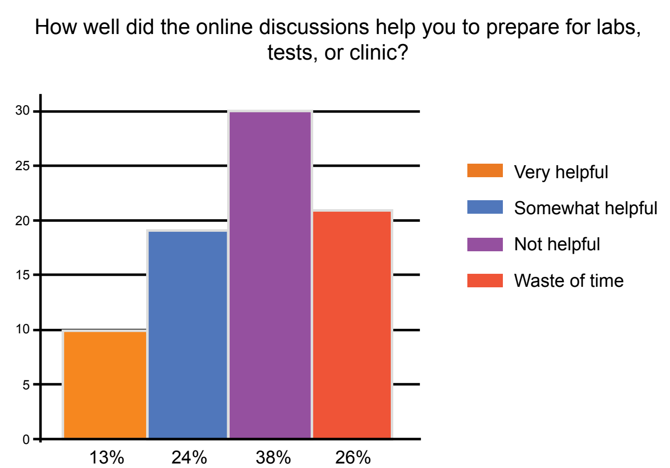
Despite that extra credit was given for completing a survey regarding their satisfaction with the blended learning, only 81 of the 92 students completed the survey. These questions and responses are seen in **Figure 3**. In general, students were satisfied with the online

Figure 3
Select Results from the Student Survey









activities (56% satisfied, 26% neither satisfied or dissatisfied, 19% dissatisfied) and felt the videos (95% very or somewhat helpful) and quizzes (95% very or somewhat helpful) helped them prepare for the labs, tests or clinic. They did not feel as if the discussion topics were helpful. Sixty-four percent felt the discussions were a waste of time or not helpful.

In the survey, students were given a chance to state what they liked and did not like about the blended learning. Because the responses were from individuals, some appreciated things that others did not. For example, many stated that they liked the immediate feedback from the quizzes, but some students felt that they did not receive immediate feedback. In this instance the students may have been referring to a different aspect of the online learning experience, such as not being able to ask questions immediately as you would during a lecture. However, the comments given were not specific.

Student responses to the question of what they liked are summarized below, in order of the most common sentiment:

- Videos helped with understanding
- Liked quizzes/quizzes helped to keep them focused and engaged/ liked immediate feedback from quizzes
- Ability to watch repeatedly
- Ability to do it on their own time or anywhere/ability to do it right before lab
- Ability to go at their own pace
- Liked the discussions

Student responses to the question of what they did not like are summarized below, in order of most common sentiment:

- Being graded on discussions
- Didn't have pre-written notes
- Discussions were not helpful/ would rather ask or interact in person
- Quiz grading too hard
- Make quiz questions harder/worth more
- Hard to study from videos
- No immediate feedback

Discussion

Advances in computer technology and software over the past decade have offered new ways for teaching and training. More and more students are taking courses fully online or in a blended/hybrid format.[14] Studies have shown that when online learning experiences are well organized and delivered (keeping the focus on outcomes and learning), they significantly enhance learning and retention of complex topics related to health sciences.[15,16] This project aimed to determine if applying blended learning methodology in an optometric clinical procedures course would enhance student learning, as well as increase student satisfaction.

The current focus of health education research aims to determine how instructional technology can be used effectively and efficiently to achieve learning objectives. A recent study in exercise physiology found that students who took a hybrid course performed significantly better and got higher letter grades than students in a traditional lecture-based course.[15] Likewise, blended learning resulted in improved grades in an undergraduate human anatomy course[12] and in a dentistry program.[8] A study with physiotherapy students showed improvement in some, but not all, areas.[4] When evaluating punctuation, those participating in traditional learning performed 24% better than those who participated in online activities.[13] Nevertheless, blended learning has been proposed to promote lifelong learning in larger educational institutions.[17] It may not be effective for all disciplines and has not been studied in optometry. The only report about online learning activity and optometry was a survey given to a group of second- and third-year students from the School of Optometry and Vision Science at the University of New South Wales to assess the usefulness and the frequency of use of a learning management system (WebCT).[18] The authors concluded that the web-based learning tool can serve as a platform to facilitate independent deeper learning and foster learning communities amongst optometry students.

Moving the Clinical Procedures III (phorometry) material online did not appear to affect learning as defined by multiple-choice exam performance. There was no statistically significant difference in scores on online-related questions or on in class-related questions when comparing identical final examinations given in 2011 and 2012. The medians were identical. The questions remained the same difficulty, and exam performance was the same both years. Generally, the difficult questions in 2011 were difficult in 2012 regardless of the method of delivery. This lack of difference in test scores correlates with the large number of students reporting on the end-of-the-course survey that they felt equally prepared for the midterm after the online activities compared to the in-class activities. **(Figure 3)** Likewise, Amin and Saqr[3] reported that only a little more than half (54.1%) of students in an orthopedic course said that e-learning helped them understand surgery better. From our study design we are unable to determine if blended learning has long-term learning implications.

Whether presented online (in 2012) or in the classroom (in 2011), topics that were chosen to be presented online were easier for students on the multiple-choice examination compared to the information presented in class. There was a median score of 92.3% in both 2011 and 2012 for the questions related to material presented online in 2012. This was a higher percentage than the score pertaining to information that was taught in the classroom in 2012 (median of 82.4% in 2011 and 2012). This may have been due to the instructor inadvertently choosing the online topics because they were easier for the students.

The lectures given online did not correspond with the top three lectures that the TAs thought had been presented online. It was very interesting that all but one of the TAs who responded to the survey chose the labs they thought were associated with online teaching because they felt they were the most challenging labs for the students. The TAs may have assumed that because the information was presented online the students would not take the initiative to complete the assignment. None of the details about the content or structure of the online lectures were given to the TAs. They did not know that there were quizzes or that there were consequences for the students not completing the quizzes prior to lab.

Lab instructors did not note a difference in skill level when comparing 2012 students to previous years. It makes sense that because no written notes were distributed, students were not relying on their notes as much to do the online labs. A number of students had organized details of the refraction into tables. It can be argued that the same thing would happen if the written notes were not distributed prior to an in-class lecture.

The majority of students were satisfied with the online activities. Generally, they liked the videos and the quizzes. No one felt the videos were a waste of time, and only one student felt the quizzes were a waste of time. Comments indicated that students liked to do the online activities on their own time (some liked to sleep in and do it in their beds). They also liked that they could watch the videos at their own pace. They were able to pause the videos to contemplate the information. However, they did find it difficult to study from videos. This was because it was challenging to find specific details when reviewing the video.

At least three quizzes were given throughout the online modules. The questions included multiple-choice, short-answer, true/false and matching questions. This assured that students were actively watching the videos. It also helped the instructor and student to discern whether participants understood pertinent principles. On the survey, many students commented that the quizzes helped them to stay focused and engaged. They also liked immediate feedback from quizzes.

A couple of students stated that it was difficult to remember to do the online activities. Only two students did not complete one quiz with 100% prior to the lab. Both instances occurred with the online activities associated with the first lab. All students completed all online activities prior to their lab session after the first week.

In general, the students did not like the discussions. They did not like that the discussions were mandatory and graded. In order to keep track of the quality of discussions in Moodle, the instructor needed to put some sort of rating system on the questions. This showed up automatically on the student grades. Despite the students being told multiple times that there was no requirement on the number of posts – they just needed to meaningfully participate – many felt that they needed to post the number of times that was implied by the rating system. Some students got together and planned to post a question so that another student could post a response. This made it more difficult to find the meaningful discussion topics on the website. Some students said that if they had a real question they would just ask it on their Facebook page. However, faculty do not have access to this Facebook page so the instructor would not be able to see what was being written. Students did not seem to want to participate in what the instructor viewed as more thoughtful questions. Many preferred to have an immediate answer from the "professor" rather than discussing topics with their classmates.

The discussions were very useful to the instructor in determining what the students were and were not understanding. The students answered each other's questions, but the discussions allowed the instructor to see and correct misconceptions when appropriate. Also, inconsistencies or misunderstandings that were presented in lab could be addressed immediately.

We will be rethinking how we organize the online discussions. Although students preferred the discussions to be non-mandatory, the author (DG) put a non-graded discussion section in the Clinical Procedures IV (spring 2013) course. This course involved the same students who participated in Clinical Procedures III in 2012. Students were told that they could post and should check the discussion board. However, by the last week of class, only six students had made a post (one student made three posts), and only 60 students even viewed the discussion more than once through the semester. Suggestions for a more meaningful discussion include having the students teach certain topics online, requiring citations for responses, or requiring them to respond only to prompts by the instructor. In addition, some classes may be able to have students work in small groups, have peers edit papers, perform case analysis, discuss assigned readings, or develop an area where students contribute links to certain research topics. It is recommended that the participation in the discussion is included in the course grade.[19] Alternatively, the traditional lecture time can be used for a discussion. The instructor chose not to do this, as she wanted the blended learning experience to be time-neutral for the students. She did not want to add activities to the students' already busy schedule without removing something.

In the future, the instructor will consider distributing the pre-written notes to the students. Additionally, more guidance will be given regarding what is expected in the discussions. There were a total of five discussion boards on which students could post (General Discussion, Retinoscopy, Distance Equalization and Binocular Distance Sphere, Accommodative Posture, and Phorias). This became unwieldy. Rather than having multiple areas for the discussion, the author would suggest only having one discussion board.

No major technology difficulties occurred. One facet that may have contributed to the lack of technology difficulties was that although the orientation on the first day of class was done in the classroom, the students were required to watch a 2- 3-minute video to ensure everyone had their technical difficulties worked out the first week. They were instructed to contact Technology Information Services immediately if they had difficulties and were told that this would not be accepted as an excuse for not completing the assignment prior to the due date.

Conclusion

Blended learning involves blending the classroom activities with online activities. Although there was no difference in examination or laboratory performance, putting the lectures online allowed the students to listen to or watch the lectures as many times as they desired. It allowed for more flexibility in that the students could do the assignments at any time of the day. It allowed more active student involvement. Optometric faculty need to meet the expectations of the students while delivering difficult material in an effective way. Blended learning may be an effective way to achieve this goal.

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References

1. Dabbagh N, Nanna-Ritland B. Online learning: Concepts, strategies and application. New Jersey, NJ: Upper Saddle River. 2005.
2. Dykman CA, Davis CK. Online education forum part one – the shift toward online education. Journal of Information Systems Education. 2008;19:11-16.
3. Amin OA, Saqr M. Blended learning in orthopedics course: An evaluation study. International Journal of Health Sciences. 2011;5(2 Suppl 1):40-1.
4. Arroyo-Morales M, Cantarero-Villanueva I, Fernandez-Lao C, et al. A blended learning approach to palpation and ultrasound imaging skills through supplementation of traditional classroom teaching with an e-learning package. Man Ther. 2012;17(5):474-8.
5. Bradley C, Erice M, Halfer D, et al. The impact of a blended learning approach on instructor and learner satisfaction with preceptor education. Journal for Nurses in Staff Development – JNSD. 2007;23(4):164-70.
6. Hsu LL. Qualitative assessment of a blended learning intervention in an undergraduate nursing course. Journal of Nursing Research. 2012;20(4):291-9.
7. Ireland J, Johnson N, Adams D, et al. Blended learning in education: Effects on knowledge and attitude. British Journal of Nursing. 2009;18(2):124-30.
8. Faraone KL, Garrett PH, Romberg E. A blended learning approach to teaching pre-clinical complete denture prosthodontics. European Journal of Dental Education. 2013;17(1):e22-7.
9. Duque G, Demontiero O, Whereat S, et al. Evaluation of a blended learning model in geriatric medicine: A successful learning experience for medical students. Australasian Journal on Ageing. 2013;32(2):103-9.
10. Karamizadeh Z, Zarifsanayei N, Faghihi AA, et al. The study of effectiveness of blended learning approach for medical training courses. Iranian Red Crescent Medical Journal. 2012;14(1):41-4.
11. Lehmann R, Bosse HM, Simon A, et al. An innovative blended learning approach using virtual patients as preparation for skills laboratory training: perceptions of students and tutors. BMC Medical Education. 2013;13:23.
12. Pereira JA, Pleguezuelos E, Meri A, et al. Effectiveness of using blended learning strategies for teaching and learning human anatomy. Med Educ. 2007;41(2):189-95.
13. Emerson L, MacKay B. A comparison between paper-based and online learning in higher education. British Journal of Education Technology. 2011; 42(5):727-735.
14. Allen IE, Seaman J. Staying the Course: Online Education in the United States. Needham MA: Sloan Center for Online Education. 2008.
15. McFarlin BK. Hybrid lecture-online format increases student grades in an undergraduate exercise physiology course at a large urban university. Adv Physiol Educ. 2008;32(1):86-91.
16. Gallagher JE, Dobrosielski-Vergona KA, Wingard RG, et al. Web-based vs. traditional classroom instruction in gerontology: A pilot study. Journal of Dental Hygiene. 2005;79(3):7.
17. United States Department of Education, Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies, Washington, D.C.: Office of Planning, Evaluation, and Policy Development, 2010.
18. Herse P, Lee A. Optometry and WebCT: A student survey of the value of web-based learning environments in optometric education. Clinical & Experimental Optometry. 2005;88(1):46-52.
19. Teaching Effectiveness Program: Discussion Board [Internet]. Eugene (OR): University of Oregon [cited 2013]. Available from: http://tep.uoregon.edu/technology/blackboard/docs/discussionboard.pdf.

Herpes Zoster Ophthalmicus: A Teaching Case Report

Kent Nguyen, OD
Joseph Gallagher, OD, FAAO
Dorothy Hitchmoth, OD, FAAO, Diplom

Abstract

Herpes zoster ophthalmicus (HZO) is a disease that occurs when the ophthalmic division of the trigeminal nerve is impaired as a result of reactivation of the varicella-zoster virus. HZO develops in 10-20% of patients who experience reactivation of zoster in the fifth cranial nerve dermatome. The patient in this teaching case report developed neurotrophic keratitis as a result of both HZO and diabetic neuropathy of V1. This teaching case illustrates many of the classic signs and symptoms of HZO and discusses appropriate treatment, management and patient education.

Key Words: *herpes zoster ophthalmicus, neurotrophic keratitis, diabetes mellitus, antiviral, Hutchinson's sign, Zostavax*

Dr. Nguyen is a 2012 graduate of the Southern California College of Optometry and a former Optometry Resident at the Department of Veterans Affairs in White River Junction, Vt.

Dr. Gallagher is an Attending Optometrist at the Department of Veterans Affairs in White River Junction, Vt.

Dr. Hitchmoth is Chief of Optometry at the Department of Veterans Affairs in White River Junction, Vt.

Background

The following case report on the diagnosis and management of herpes zoster ophthalmicus (HZO) is appropriate as a teaching guide for third- and fourth-year optometry students as well as optometry residents. The case report explores important clinical findings and considerations in the treatment of HZO in a patient with HZO, ocular manifestations of diabetes and atrophic age-related macular degeneration. This case emphasizes the need for a list of differentials when a patient presents with comorbid disease. Thus, it also teaches students to learn to manage multiple conditions in the same patient, all of which may contribute to a patient's decreased vision and may be important in the determination of treatment and prognosis.

Learning Objectives

At the conclusion of this case discussion, participants should be able to:

1. Describe the signs and symptoms of HZO
2. List the differential diagnoses of neurotrophic keratitis
3. Describe the stages of the Mackie Classification
4. Understand treatment and management of HZO and neurotrophic keratitis
5. Describe the pathophysiology and demographics of herpes zoster (HZ)
6. Understand common morphologic changes that occur in corneas of patients with diabetes

Key Concepts

1. Systemic, ocular and neurologic causes of neurotrophic keratitis
2. Pathophysiology of HZO
3. Ocular manifestations of HZ
4. Treatment considerations in comorbid presentations

Discussion Questions

1. What is the pathophysiology of herpes zoster?
2. What are the demographics of herpes zoster and HZO?

3. What are classic signs and symptoms of herpes zoster?
4. What are some of the acute and chronic signs of HZO?
5. Why might a HZO patient not complain of symptoms?
6. What are the common signs and symptoms of neurotrophic keratitis?
7. What are treatments for mild vs. severe forms of neurotrophic keratitis?
8. What neural factors are used in treatment of neurotrophic keratitis?
9. How is the diabetic cornea different from the non-diabetic cornea?
10. What are some of the systemic, ocular and neurologic causes of neurotrophic keratitis?
11. What are the stages of neurotrophic keratitis?
12. What are some differentials for red eye?

Case Description

Patient RT, a 76-year-old Caucasian male, was referred to the White River Junction Veterans Affairs Medical Center eye clinic on Aug. 8, 2012 for a red left eye that started two days prior. The patient was seen by an optometrist in the private sector who diagnosed the patient with bacterial conjunctivitis OS and prescribed ofloxacin QID OU. The patient reported feeling pressure in his left eye, as well as pain radiating down the left side of his face. He also had small erythematous, vesicular lesions on the left side of his face that also started two days prior.

RT's medical history was positive for diabetes mellitus type 2 for 18 years with associated complications of peripheral neuropathy, foot ulcers, dystrophic toenails, polyneuropathy, chronic urinary tract infections and kidney failure. The patient also had erectile dysfunction, arthralgia, stenosis of the carotid artery, spinal stenosis, colonic polyps, dysphagia, drop foot, hammer toe, hyperkeratosis, hypertension, suspect gout, and pulmonary embolism from unknown cause. The patient had a remote surgical history of lumbar discectomy.

RT's last visit to the eye clinic was March 29, 2006. His ocular history was positive for retinal Hollenhorst plaque OD, involutional proliferative diabetic retinopathy with panretinal photocoagulation (PRP) OU, corneal epitheliopathy (likely diabetic neurotrophic cornea) OU, dry eye syndrome OU, pseudophakia OU and early dry macular degeneration OS.

His current medications included baclofen, camphor/menthol lotion, carbamazepine, clobetasol proprionate ointment, colchicine, docusate, hydroxyzine, insulin (aspart and glargine), lisinopril, loperamide, metformin, naproxen, permethrin cream, psyllium, and triamcinolone cream. His fasting blood glucose measured at home the morning of his appointment was 127 mg/dl. He was not a smoker. His allergies included contrast media, terazosin and Augmentin.

Entering unaided visual acuities were OD 20/60-2 and OS 20/200-1 without improvement on pinhole. Notation was made that the patient was possibly viewing eccentrically with his left eye. Pupils were equally round and minimally reactive to light, without an afferent pupillary defect. During pupil testing, the patient reported that the trans-illuminator appeared dimmer in his left eye. Red cap desaturation testing revealed 40% desaturation OS.

Anterior segment evaluation revealed meibomian gland stasis OU, mild mucous discharge OS, and trace conjunctival hypermia OS. Fluorescein dye evaluation of the corneas revealed 4+ diffuse punctate staining OS and trace punctate staining OD. There were no ulcerations, edema or dendrites in the cornea OU. The anterior chamber was deep and quiet OD but was difficult to assess OS through the corneal epithelial defects. Intraocular pressures were 11 mmHg OU by non-contact tonometry (NCT).

Dilated fundus examination revealed posterior chamber IOLs with peripheral fibrosis OU. The vitreous was clear and quiet OU. The optic nerves had distinct margins but there was moderate pallor of the rims. The C/D ratios were 0.35 round OU. The maculae had nearly complete geographic atrophy OU with a small central island of retinal pigmented epithelium remaining, which was greater in size OD than OS. The peripheral retina had extensive PRP OU that encroached on the posterior pole. No hemorrhages were present OU.

The patient was diagnosed with HZ with V1 branch involvement. He was also diagnosed with chronic blepharitis-associated evaporative dry eye syndrome. He was prescribed oral famciclovir 500 mg Q8H and preservative-free artificial tears (carboxymethylcellulose 0.5%) Q1H OU, and was instructed to discontinue ofloxacin ophthalmic solution. Other diagnoses from the examination were diabetic optic atrophy OU and atrophic age-related macular degeneration OU, each contributing to and consistent with the decreased visual acuity. The patient was scheduled to return in one week to monitor the HZ and other conditions as needed

Follow-up and management (Table 1)

Visit #2 (8/15/12): The small erythematous, vesicular lesions on the left side of the patient's face decreased in size. His pain also slightly improved. Visual acuity remained reduced at OD 20/70 and OS 20/400 uncorrected. Corneal staining was graded as 2+ diffuse SPK OD and 3+ diffuse SPK OS, without edema or dendrites OU. OCT imaging of the optic nerves and maculae were attempted to further evaluate the optic atrophy and atrophic macular degeneration. However, image quality was poor secondary to corneal staining and keratitis. The plan was to continue with oral famciclovir Q8H for three more days and change the artificial tears from carboxymethylcellulose 0.5% to 1.0% Q1H OU for additional viscosity.

Visit #3 (8/23/12): Visual acuity was OD 20/80+2 and OS 20/150-1 uncorrected. The skin lesions continued to reduce in size. Dermatomal facial pain symptoms were intermittent and not as severe as before. Corneal staining was noted to be 2+ diffuse OD and 3++ diffuse OS. There were also two new anterior stromal infiltrates near the superior limbus OS. One infiltrate was 1 mm in size and stained superficially; the other infiltrate was 1/3 mm in size and did not stain. The patient was diagnosed with stromal keratitis OS and was prescribed prednisolone acetate 1% ophthalmic solution QID OS. Polysporin ophthalmic ointment BID OS and ciprofloxacin 0.3% ophthalmic solution QID OS were also prescribed for bacterial coverage. Carboxymethylcellulose 1.0% was continued Q1H to Q1.5H OU.

Visit #4 (8/27/12): Visual acuity was OD 20/70-1 and OD 20/150-1 uncorrected. Facial pain was reported to be less frequent and less severe. Corneal staining reduced to trace OD but increased to 4+ diffuse OS. The two stromal infiltrates OS reduced in size to 1/3 mm and 1/4 mm, with only the larger one staining. Only ciprofloxacin 0.3% ophthalmic solution was discontinued due to reduction of infiltrate sizes. The rest of the topical medications and artificial tears were continued as prescribed.

Visit #5 (8/29/12) and #6 (9/5/12): Visual acuities at these two visits were stable at about OD 20/70 and OS 20/150 uncorrected. Facial pain was also stable without increase. The degree of corneal staining improved to trace OD and 3+ diffuse OS. The stromal infiltrates OS had greatly reduced in size and appeared more faint. Follow-up was scheduled for two weeks. Polysporin ophthalmic ointment was discontinued and prednisolone acetate 1% ophthalmic solution was tapered to TID OS for one week, then BID OS for one week. Artificial tears were continued as before.

Visit #7 (9/19/12): Visual acuity was OD 20/70+2 and OS 20/150-1 uncorrected. Pain symptoms remained stable but the skin lesions were almost fully resolved. Corneal staining decreased to 2+ diffuse OS but increased to 1+ diffuse OD. The stromal infiltrates OS had completely resolved. The patient was dilated to obtain OCT images of the maculae and optic nerves. Preservative-free artificial tears were instilled every 5-10 minutes as the patient was dilating to prevent additional keratitis from the dilating drops. Fundoscopy revealed no changes OU.

OCT of the macula revealed thinning of the retinal tissue, mild disruption of the retinal pigmented epithelium, and no edema OU. However, the signal strength and image quality were much lower OS and an accurate assessment was difficult to make. OCT of the optic nerve fiber layers revealed OD borderline thinning of the superior quadrant, and OS thinning of the superior and inferior quadrants and borderline thinning of the nasal quadrant. Again, the signal strength was much lower OS because of signal interference from poor optics in the cornea.

Prednisolone acetate 1% ophthalmic solution was discontinued. Artificial tears were to be continued every 1.5 hours. Additionally, a bland lubricating ointment was prescribed QHS OU. The patient did not have any complaints about his vision and wished to lengthen the time until his next follow-up visit. A follow-up was scheduled for one month to check the anterior segments, corneal sensitivities, and follow-up on blood sugar control. Careful patient education was provided at this time as well. The patient was told that the eye was not entirely healed and he may not be able to feel disruption to his cornea because of nerve damage.

Visit #8 (10/17/12): The patient reported better blood sugar control. His fasting blood sugar that morning was 112 mg/dl. A left facial "ache" was still present, but improving. The facial skin lesions had resolved. Visual acuity remained stable at OD 20/70-2 and OS 20/150+2 uncorrected. Corneal staining decreased to 1-2+ diffuse OU, with three superior stromal scars OS where the previous infiltrates were. Corneal sensitivity testing with a cotton wisp was noted to be equal and normal OU. The patient was instructed to continue artificial tears 4-6 times per day or as needed, and to return in 4-6 months for a dilated exam. Unfortunately, RT passed away on Jan. 9, 2013. The cause of death was unknown.

Table 1
Summary of Follow-Up Visits

Visit	Visual Acuity	Cornea	Other Signs/ Symptoms	Treatment
8/8/12	OD: 20/60-2 OS: 20/200-1	Diffuse inferior SPK OD>OS	Pain/pressure left face Scattered lesions V1	Famciclovir Q8H Refresh Q1H OU
8/15/12	OD: 20/70 OS: 20/400	OD: 2+ diffuse staining OS: 3+ diffuse staining	Dec pain/pressure Dec lesion size	Famciclovir Q8H Celluvisc Q1H OU
8/23/12	OD: 20/80+2 OS: 20/150-1	OD: 2+ diffuse staining OS: 3++ diffuse staining 2 infiltrates 1 & 1/3 mm	Dec pain/pressure Dec lesion size	Celluvisc Q1H OU Pred F QID OS Polyspor BID OS Cipro QID OS
8/27/12	OD: 20/70-1 OS: 20/150-2	OD: trace staining OS: 4+ diffuse staining 2 infiltrates 1/3 & 1/4 mm	Dec pain/pressure Dec lesion size	Celluvisc Q1H OU Pred F QID OS Polyspor BID OS
8/29/12	OD: 20/70 OS: 20/150	OD: trace staining OS: 4+ diffuse staining 2 fainter infiltrates 1/3 & 1/4 mm	Stable pain/pressure Dec lesion size	Celluvisc Q1H OU Pred F QID OS Polyspor BID OS
9/5/12	OD: 20/70+2 OS: 20/150-1	OD: trace staining OS: 3+ diffuse staining; 2 fainter infiltrates 1/3 & 1/8 mm	Stable pain/pressure Dec lesion size	Celluvisc Q1H OU Pred F TID 1 wk then BID 1 wk OS
9/19/12	OD: 20/70+2 OS: 20/150-1	OD: 1+ diffuse staining OS: 2+ diffuse staining Infiltrates resolved	Dec pain/pressure Dec lesion size	Celluvisc Q1H OU Bland lubricating ointment BID OU
10/17/12	OD: 20/70-2 OS: 0/150+2	OU: 1-2+ diffuse SPK in scattered patches OS: 3 stromal scars all 1/4 mm	Intermittent face ache Skin lesions resolved	Celluvisc 4-6x per day OU

Literature Review

Herpes zoster ophthalmicus

The varicella-zoster virus (VZV), which belongs to the same herpes subfamily as herpes simplex, is responsible for causing both chickenpox (varicella) and shingles (herpes zoster).[1] After an initial infection of chickenpox, the VZV lays dormant in the dorsal root ganglia of a variety of nerves throughout the body, including the trigeminal nerve, which is affected in herpes zoster ophthalmicus. The most commonly affected dermatomes are in the thoracic region of the body, followed by the lumbar and cervical regions.[2] HZ can remain dormant for decades before reactivation results from a decline in cell-mediated immunity.[3] This decline in immunity can result from increasing age, immunosuppressive conditions or medications.[4] Viral replication spreads along the dermatome of the affected ganglia, commonly presenting as a unilateral vesicular rash that does not cross the midline of the body.[5,6] The rash may affect one or two adjacent dermatomes (localized zoster) or be more widespread and affect three or more dermatomes (disseminated zoster).[4] Associated prodromal symptoms may include fever, headache, malaise or unilateral pain. Prodromal symptoms may occur days to weeks before the rash. It is common for individuals to have one episode of HZ in their lifetime. However, periodic episodes of reactivation may occur.[4,6]

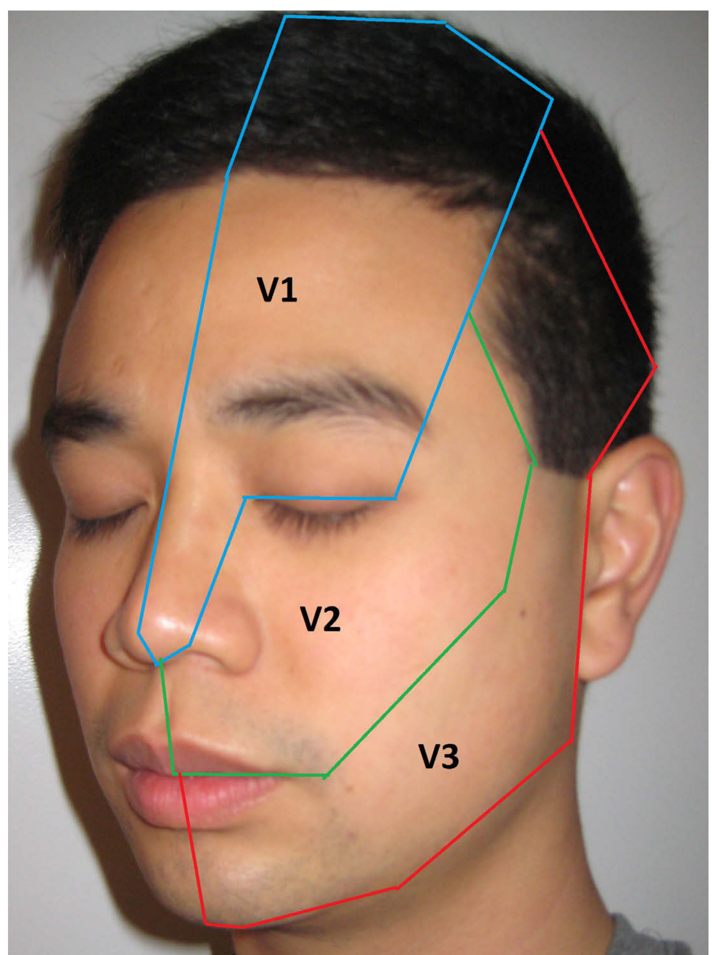
In the United States, the incidence of HZ is 3.2 per 1,000 person-years. The incidence increases with age, with the highest rate in individuals over 80 years old. The incidence is also higher in patients with recent care for cancer, HIV infection, or transplantation compared to patients without these conditions.[7] HZ is uncommon in adults younger than 40 years old who are not immunocompromised. Younger patients tend to develop less severe forms of the disease and have better response to treatment.[8]

HZO occurs when reactivation of the VZV involves the ophthalmic division (V1) of the trigeminal nerve and may be associated with ocular involvement. **(Figure 1)** The other two main divisions of the trigeminal nerve are the maxillary (V2) and mandibular (V3). **(Figure 2)** The ophthalmic division further divides into the frontal, lacrimal and nasociliary branches. These branches innervate the forehead, upper eyelid, cornea, uvea, conjunctiva, sclera and the nose. The most common decade of onset of HZO is between 50 and 59 years of age.[9] Current standard of care recommendations for patients with HZ affecting the fifth cranial nerve include referral to an eyecare practitioner to rule out vision-threatening complications. Most patients with HZ affecting V1 experience very little ocular involvement.[10] Only 10-20% of HZ cases involving the fifth cranial nerve will have HZO.[2]

Ocular manifestations of HZO in the anterior segment may be acute or chronic, and the cornea is commonly

Figure 1
Unilateral Vesicular Rash Along V1 Dermatome in Herpes Zoster Ophthalmicus
(Photo by Robert E. Sumpter, Image ID#12621, Centers for Disease Control and Prevention, Public Health Image Library.[43])

Figure 2
Three Main Divisions of the Trigeminal Nerve
(Original image created by author)



involved. Acute ophthalmic complications include acute epithelial keratitis, conjunctivitis, episcleritis, scleritis, nummular keratitis, stromal (interstitial) keratitis, disciform keratitis and anterior uveitis. Chronic complications include neurotrophic keratitis, scleritis, mucous plaque keratitis, lipid degeneration, lipid-filled granuloma and eyelid scarring.[1,8] Immunocompromised patients are more likely to have bacterial keratitis and poor visual outcome compared to immunocompetent patients.[8] Posterior segment manifestations are uncommon, and may include retinal perivasculitis, ischemic optic neuritis and necrotizing retinopathy.[6]

Acute epithelial keratitis, which develops in more than 50% of cases within two days of rash onset, may be characterized by dendritic lesions known as "pseudodendrites." Pseudodendrites are elevated, opaque, white, fine branching or stellate plaque-like lesions that have tapered ends without terminal end bulbs. Pseudodendrites stain better with rose bengal than with fluorescein. These lesions are more likely to form in younger HZO patients. Pseudodendrites are treated with a topical antiviral, while the other forms of keratitis are treated with topical steroids, such as prednisolone acetate 1%.[1,9]

Decreased visual acuity and corneal sensation are common symptoms, and patients may complain of foreign body sensation, irritation, burning and dry eye symptoms.[8] In some patients with decreased corneal sensitivity there may be no symptoms of discomfort at all[5] due to neurotrophic corneal nerves branching from CN V1. Loss of corneal sensitivity can lead to breakdown of epithelium, which can in turn create inflammation (uveitis), secondary infection, corneal thinning, ulcers, corneal perforations and scarring.[5,8] Edema of the eyelids, ptosis, lagophthalmos or eyelid scarring may also lead to tear evaporation and corneal desiccation that ultimately results in damage to the corneal nerves.[5,6]

Oral antivirals are widely used to treat HZ. The most common oral antivirals used are acyclovir 800 mg five times a day, valacyclovir 1 g TID, and famciclovir 500 mg TID for 7-10 days.[1] These three antivirals have been shown to reduce pain, virus shedding and anterior segment complications when started within 72 hours of onset.[11] The less frequent dosing of valacyclovir and famciclovir compared to acyclovir increases the potential for patient compliance. Valacyclovir is a prodrug of acyclovir, and has been found to be equally effective in reducing ocular complications, zoster-associated pain and skin lesions.[12] A study of 86 immunocompetent HZ patients revealed that famciclovir may provide earlier reduction in zoster-associated pain compared to valacyclovir.[13]

In a study surveying 100 eyecare practitioners, the majority of them being corneal specialists, on treatment options for stromal keratitis and anterior uveitis associated with HZO, the most common treatment reported was a combination of oral antivirals and topical corticosteroids, with variability in the dosage and duration. The second most common treatment was topical corticosteroids alone. Oral antivirals are typically administered for 7-14 days, but there is no established guideline for the duration of antiviral treatment. The most common corticosteroid used to treat was prednisolone acetate 1% QID.[14]

Vaccination has been important in preventing the reactivation of VZV. The Shingles Prevention Study in 2005 found that the use of the Oka/Merck VZV vaccine ("zoster vaccine") reduced the incidence of HZ by 51% and the incidence of post-herpetic neuralgia by 66% in immunocompetent individuals 60 years of age and older.[15] The U.S. Food and Drug Administration (FDA) approved Zostavax (Zoster vaccine live) in 2006, for individuals 60 years of age and older.[16]

In 2011, the FDA approved Zostavax for individuals 50-59 years of age.[17] However, the U.S. Centers for Disease Control and Prevention (CDC) still recommends the vaccine for 60 years of age and older despite the FDA approval.[18] Furthermore, vaccination rates are low for the 50- to 59-year-old age group due to lack of awareness or understanding of the vaccine. The rate increases for older age groups.[19]

Neurotrophic keratitis

Neurotrophic keratitis is a corneal disease caused by an impairment of corneal branches of trigeminal nerve V1.[20,21] Loss or reduction of corneal innervation leads to compromised corneal integrity, tear dysfunction and decreased corneal sensation.[6] Dry eye syndrome often results because the tear reflex can be impaired.[22] Neurotrophic keratitis can lead to defective differentiation and delayed wound healing of epithelial cells, which in turn can result in corneal ulceration and even perforation without the patient feeling discomfort.[9,22] Neurotrophic keratitis occurs at a higher frequency with increasing age, and develops in about 20% of cases of HZO. Older individuals are also at increased risk for secondary corneal infections.[9]

A number of ocular, systemic and neurologic conditions can cause corneal hypoesthesia that leads to neurotrophic keratitis.[23] **(Table 2)** These include ocular surgery, trauma, topical medications, diabetes mellitus, contact lens wear, trigeminal neuralgia and others. Neurotrophic keratitis is divided into three stages known as the Mackie Classification.[23] **(Table 3)** Stage 1 is characterized by decreased tear breakup time and punctate epithelial staining. Stage 2 is characterized by stromal edema and loss of epithelium. Stage 3 is characterized by stromal lysis and corneal perforation.

Standard treatments for milder cases of neurotrophic keratitis include preservative-free artificial tears, punctal occlusion and bandage contact lenses. Antibiotic ointments may be used prophylactically to prevent infectious corneal ulcers. Steroids may be needed if the patient develops keratouveitis but should be used with caution due to the known side effect of reduction in would healing. More severe cases may require surgery, such as tarsorraphy or conjunctival flap construction.[20,22,24] Large corneal defects may require penetrating keratoplasty; however, any surgical corneal intervention should be avoided due to further risks of corneal ulcers, melting and perforations after surgery.[20] Discontinuation of other non-essential topical drugs is necessary to reduce toxicity.[20,24]

Impairment of the trigeminal nerve causes an insufficient supply of neural factors, which leads to corneal epithelial disorder. These neural factors include substance P (SP) and insulin-like growth factor-1 (IGF-1).[22] Eye drops containing SP and IGF-1 have been shown to synergistically stimulate epithelial wound closure.[25] Derivatives of these neural factors (FGLM-amide and SSSR, respectively) have also been shown to promote resurfacing of persistent epithelial defects in neurotrophic corneas.[26] Autologous serum (AS) has also been shown to stimulate epithelial healing, improve corneal sensitivity, improve visual acuity and increase levels of SP and IGF-1 in individuals with neurotrophic keratitis.[27]

Diabetes mellitus and neurotrophic keratitis

Neurotrophic keratitis may occur in patients with diabetes mellitus. Diabetic patients have reduced basal tear production and corneal sensitivity.[28] Neurotrophic keratitis should be a differential when a diabetic patient develops unexplained corneal epithelial disease.[21] Epithelial dysfunction puts diabetic patients at greater risk for corneal disorders such as recurrent corneal erosions, decreased sensitivity, delayed re-epithelialization, abnormal wound repair and ulcerations.[29] A study of corneal structure and sensitivity in type 1 diabetics found that corneal sensitivity is positively correlated with the number of long nerve fiber bundles in the cornea, and inversely correlated to the duration of diabetes. A significant decrease in long nerve fiber bundles was observed in patients with even mild neuropathy. However, corneal sensitivity may remain normal in patients with mild to moderate neuropathy. Epithelial thickness and corneal sensitivity are significantly decreased in patients with severe corneal neuropathy.[30]

Discussion

The patient in this teaching case report presented with a red painful eye that was previously diagnosed as bacterial conjunctivitis and treated with a topical antibiotic. It is important for a clinician to consider the referring diagnosis; however, it is imperative that he/she differentiate the causes of red eye by careful clinical history and exam. Clinical history should include a careful detailed ocular and medical history. Older patients and other immunocompromised patients are more likely to have a number of medical conditions and may be taking numerous medications that can broaden or change the differential significantly. The astute clinician pays attention to the systemic conditions that may have ocular manifestations and the systemic medications that may have ocular side effects and adjusts the differential and the physical exam accordingly.

A thorough case history was key in diagnosing this case. The patient had classic signs and symptoms of HZ, most notably a unilateral vesicular rash with ipsilateral facial pain following the V1 dermatome. The patient had acute manifestations of HZO in the form of epithelial keratitis and stromal keratitis. The patient's reduced acuity was not consistent with his presenting

Table 2
Causes of Neurotrophic Keratitis/Corneal Hypoesthesia

Cause
Infection
Herpes zoster Herpes simplex Leprosy
Fifth Nerve Palsy
Surgery (such as for trigeminal neuralgia) Neoplasia (such as acoustic neuroma) Aneurysms Facial trauma Congenital Familial dysautonomia (Riley-Day syndrome) Goldenhar-Gorlin syndrome Mobius syndrome Familial corneal hypesthesia Congential insensitivity to pain with anhidrosis
Topical Medications
Anesthetics Timolol Betaxolol Sulfacetamide 30% Diclofenac sodium
Corneal Dystrophies
Lattice Granular (rare)
Systemic Disease
Diabetes mellitus Vitamin A deficiency
Iatrogenic
Contact lens wear Trauma to ciliary nerves by laser and surgery Corneal incisions LASIK
Toxic
Chemical burns Carbon disulfide exposure Hydrogen sulfide exposure

Table 3
The Mackie Classification

Stage
Stage 1
Rose bengal staining of the palpebral conjunctiva Decreased tear breakup time Increased viscosity of tear mucus Punctate epithelial staining with fluorescein Scattered small facets of dried epithelium (Gaule spots)
Stage 2
Acute loss of epithelium, usually under the upper lid Surrounding rim of loose epithelium Stromal edema Aqueous cells and flare Edges of the defect become smooth and rolled with time
Stage 3
Stromal lysis, sometimes resulting in corneal perforation

Adapted from: Groos EB. Neurotrophic keratitis. In: Krachmer JH, Mannis MJ, Holland EJ (eds.) Cornea 2nd Ed: Fundamentals, Diagnosis and Management. Mosby: Philadelphia, 2005, p 1191.

corneal condition, which required additional testing. A clinician should be aware that there may be multiple causes of a patient's reduced visual acuity. The patient in this teaching case report had vision loss from a combination of neurotrophic keratitis secondary to HZO and diabetes, and atrophic macular degeneration. A good method for students to practice is to use the 'axis approach', where the major structures going from the front to the back of the eye along the visual axis are considered. This includes the cornea, the lens and the retina. A clinician should know how to address each cause and decide which ones can be treated and which ones should be monitored.

Additionally, HZ skin lesions typically appear as a vesicular rash covering a large area that respects the dermatome vertical midline. However, skin lesions can be widely scattered and difficult to identify if they are beyond the hairline. The patient in this case had several small, red lesions following the dermatome and respecting the midline but they were few in number and widely scattered. A clinician should be aware of the different presentations of the skin lesions that appear as erythema, macules, papules or vesicles.[6] **(Figure 3)** The presence of the rash in younger patients may be mistaken for other diseases, such as herpes simplex dermatitis, insect bites or poison ivy, which leads to incorrect management.[9]

Figure 3
Vesicular Rash Due to the Varicella-Zoster Virus
(Photo by Joe Miller, Image ID#5409, Centers for Disease Control and Prevention, Public Health Image Library.[43])

Interestingly, the patient in this case was at first in disbelief that he had HZ simply because he had been vaccinated for it. The patient was educated that vaccinations do not work 100% of the time. However, in a study examining the incidence of recurrence of HZ in immunocompetent individuals less than 70 years of age, the incidence of recurrence was 0.99 and 2.20 cases per 1,000 person-years in vaccinated and unvaccinated individuals, respectively. Thus, regardless of vaccination status, there is still a low risk of recurrence of HZ.[31] The efficacy of the vaccine decreases one year after administration and continues to decline afterward. The efficacy of the vaccine is uncertain after five years.[32] Vaccinated individuals who developed HZ developed a milder form of the disease compared to unvaccinated individuals in one study.[3] Unvaccinated individuals with a history of HZO must exercise caution if they decide to get vaccinated. Hwang et al. described the case of a 63-year-old male with a history of HZ keratouveitis and neurotrophic keratopathy who had been quiescent for 3.5 years, but developed keratouveitis two weeks after vaccination. Patients with a history of HZO may have persistent viral antigens. The live attenuated vaccine may induce recurrence of keratouveitis.[33]

Also, Hutchinson's sign was not evaluated in this patient. However, this sign can help predict the clinical outcome for the patient. Hutchinson's sign is positive if the patient reports pain or discomfort on the very tip of the nose on palpation. There may or may not be a rash in the cutaneous region of the terminal branches of the nasociliary nerve, which are at the tip, side and root of the nose.[10] Several studies have found that Hutchinson's sign is a strong predictor of ocular involvement and poor visual outcome in HZ patients.[34,35,36] Nithyanandam et al. found that other factors significantly associated with visual loss in HZO are anterior uveitis, acute epithelial lesions, neurotrophic keratitis and increasing age.[34] A positive Hutchinson's sign predicts about a 76% chance of ocular involvement, while a negative Hutchinson's sign still has about a 34% chance of ocular involvement.[37] However, not all studies agree on the predictive value of Hutchinson's sign. Adam et al. 2010 instead found that blepharitis, eye redness and a rash in the supratrochlear nerve distribution (forehead above nasal bridge) were statistically significant associations with moderate to severe eye disease in HZ patients.[10]

The epithelial disease and neurotrophic keratitis that developed in the patient in this case required regular use of artificial tears in addition to pharmacological therapy. The artificial tears were a first-line defense in protecting the cornea and allowing it to heal. Another treatment consideration for this patient was bandage contact lenses. Soft contact lenses are used in the management of many corneal conditions to provide pain relief and mechanical protection, facilitate epithelial healing and maintain corneal hydration.[38] Silicone hydrogel lenses work as effective bandage contact lenses due to high oxygen permeability, low water content, good wetting properties and good patient comfort.[39] However, use of contact lenses is not without risks, such as increased risk of infections. The management of this patient was more cautious in order to avoid introducing another potential complication. Furthermore, the patient was already very compliant with all his medications and his condition was improving.

It is important to note that the patient in this case had persistent pain along the affected dermatome that slowly resolved over the course of follow-up but not entirely. Two months after initial presentation, the patient continued to report an "ache" on the left side of his face. This was diagnosed as post-herpetic neuralgia (PHN), a pain that can persist throughout the acute phase of HZO and for many months afterwards. The pain can be severe and has been associated with depression and suicidal ideation if not controlled. PHN is the most common lingering symptom and most debilitating complication of HZ,6 occurring in about 75% of patients over 70 years old.[1] A possible mechanism is inflammation and destruction of nerve roots. PHN is treated with opioids, topical analgesics, antidepressants and anticonvulsants according to the patient's individual needs.[40] Oral famciclovir and valacyclovir are more effective than acyclovir in treating PHN. These oral antivirals can reduce the severity of PHN, but they do not prevent it.[11] Studies have shown that the use of cimetidine, an H2 antihistamine receptor antagonist, shortened the time to heal pain and skin lesions in HZ patients, although the mechanism for immunomodulation is not completely understood.[41,42]

In general, the patient in this case was followed very closely at first. As his condition became more controlled, the interval between follow-ups became longer. The patient did become frustrated with the number of follow-up visits required because of the lack of acute pain and improved acuity over time. After several visits, the patient did not have any complaints about his vision and wanted to be seen much later for his next follow-up, despite the fact that there were persistent signs of inflammation and neurotrophia. Patients are often aware of their reduced vision; however, the corneal esthesia associated with an HZO infection may elude the patient and lead to a false understanding of the resolution of the disease process. The patient in this case did not initially understand why he needed to continue to come back for follow-up. Careful patient education was key in managing the patient's corneal disease. Pseudodendrites, keratitis, inflammation or loss of stromal clarity are often present with few symptoms, so it is important to understand the course of neurotrophic keratitis.[5]

Conclusion

Any HZ patient with V1 branch involvement should be referred for an eye exam. HZO affects up to 20% of HZ cases involving the fifth cranial nerve dermatome. It can lead to a host of acute or chronic ocular conditions, many of which involve the cornea. Thus, timely and accurate management is important in preventing further damage and vision loss. Still, the most debilitating complication of HZ is PHN. Older patients should be monitored more carefully and treatment should be more aggressive, as the incidence and severity of the disease increase with age. Vaccination is helpful is reducing the incidence of HZ and PHN, but recurrence is possible and the long-term efficacy of the vaccine is uncertain. Neurotrophic keratitis may complicate treatment, exacerbating the corneal damage and prolonging therapy. Patients may complain of various ocular symptoms or have no symptoms at all. Good patient history, careful observation and aggressive treatment are imperative in managing patients with HZO.

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References

1. Kanski JJ, Bowling B. Clinical Ophthalmology: A Systemic Approach 7th Edition. Elsevier: New York, 2011, pp 187-191.
2. Ragozzino MW, Melton LJ 3rd, Kurland LT, Chu CP, Perry HO. Population-based study of herpes zoster and its sequelae. Medicine (Baltimore). 1982 Sep;61(5):310-6.
3. Gelb LD. Preventing Herpes Zoster Through Vaccination. Ophthalmology. 2008 Feb;115(2 Suppl):S35-8.
4. The United States Centers for Disease Control and Prevention. Shingles (Herpes Zoster) Clinical Overview. http://www.cdc.gov/shingles/hcp/clinical-overview.html. Accessed: March 6, 2013.
5. Kaufman SC. Anterior segment complications of herpes zoster ophthalmicus. Ophthalmology. 2008 Feb;115(2 Suppl):S24-32.
6. Liesegang TJ. Herpes zoster ophthalmicus natural history, risk factors, clinical presentation, and morbidity. Ophthalmology. 2008 Feb;115(2 Suppl):S3-12.
7. Insinga RP, Itzler RF, Pellissier JM, Saddier P, Nikas AA. The incidence of herpes zoster in a United States administrative database. J Gen Intern Med. 2005 Aug;20(8):748-53.
8. Gupta N, Sachdev R, Sinha R, Titiyal JS, Tandon R. Herpes zoster ophthalmicus: disease spectrum in young adults. Middle East Afr J Ophthalmol. 2011 Apr;18(2):178-82.
9. Ghaznawi N, Virdi A, Dayan A, et al. Herpes zoster ophthalmicus: comparison of disease in patients 60 years and older versus younger than 60 years. Ophthalmology. 2011 Nov;118(11):2242-50.
10. Adam RS, Vale N, Bona MD, Hasanee K, Farrokhyar F. Triaging herpes zoster ophthalmicus patients in the emergency department: do all patients require referral? Acad Emerg Med. 2010 Nov;17(11):1183-8.
11. Pavan-Langston D. Herpes zoster antivirals and pain management. Ophthalmology. 2008 Feb;115(2 Suppl):S13-20.
12. Colin J, Prisant O, Cochener B, et al. Comparison of the efficacy and safety of valaciclovir and acyclovir for the treatment of herpes zoster ophthalmicus. Ophthalmology. 2000 Aug;107(8):1507-11.
13. Ono F, Yasumoto S, Furumura M, et al. Comparison between famciclovir and valacyclovir for acute pain in adult Japanese immunocompetent patients with herpes zoster. J Dermatol. 2012 Nov;39(11):902-8.
14. Sy A, McLeod SD, Cohen EJ, et al. Practice patterns and opinions in the management of recurrent or chronic herpes zoster ophthalmic-

us. Cornea. 2012 Jul;31(7):786-90.
15. Oxman MN, Levin MJ, Johnson GR, et al. A vaccine to prevent herpes zoster and postherpetic neuralgia in older adults. N Engl J Med 2005;352:2271-84.
16. Baylor NW, US Food and Drug Administration. Approval letter – Zostavax [letter online]. May 25, 2006. Available at: http://www.fda.gov/BiologicsBloodVaccines/Vaccines/Approve Products/ucm132873.htm. Accessed: January 22, 2013.
17. Sun W, US Food and Drug Administration. Approval letter – Zostavax [letter online]. March 24, 2011. Available at: http://www.fda.gov/BiologicsBloodVaccines/Vaccines/ApprovedProducts/ucm248608.htm. Accessed: January 21, 2013.
18. The United States Centers for Disease Control and Prevention. Shingles (Herpes Zoster) Vaccination. http://www.cdc.gov/shingles/vaccination.html. Accessed: March 9, 2013.
19. Javed S, Javed F, Mays RM, Tyring SK. Herpes zoster vaccine awareness among people ≥ 50 years of age and its implications on immunization. Dermatol Online J. 2012 Aug 15;18(8):2.
20. Bonini S, Rama P, Olzi D, Lambiase A. Neurotrophic keratitis. Eye (Lond). 2003 Nov;17(8):989-95.
21. Lockwood A, Hope-Ross M, Chell P. Neurotrophic keratopathy and diabetes mellitus. Eye (Lond). 2006 Jul;20(7):837-9.
22. Nishida T, Yanai R. Advances in treatment for neurotrophic keratopathy. Curr Opin Ophthalmol. 2009 Jul;20(4):276-81.
23. Groos EB. Neurotrophic keratitis. In: Krachmer JH, Mannis MJ, Holland EJ (eds.) Cornea 2nd Ed: Fundamentals, Diagnosis and Management. Mosby: Philadelphia, 2005, pp 1190-91.
24. Reynolds SA, Kabat AG. Therapeutic options for the management of early neurotrophic keratopathy: a case report and review. Optometry. 2006 Oct;77(10):503-7.
25. Nakamura M, Ofuji K, Chikama T, Nishida T. Combined effects of substance P and insulin-like growth factor-1 on corneal epithelial wound closure of rabbit in vivo. Curr Eye Res. 1997 Mar;16(3):275-8.
26. Yamada N, Matsuda R, Morishige N, et al. Open clinical study of eye-drops containing tetrapeptides derived from substance P and insulin-like growth factor-1 for treatment of persistent corneal epithelial defects associated with neurotrophic keratopathy. Br J Ophthalmol. 2008 Jul;92(7):896-900.
27. Matsumoto Y, Dogru M, Goto E, et al. Autologous serum application in the treatment of neurotrophic keratopathy. Ophthalmology. 2004 Jun;111(6):1115-20.
28. Cousen P, Cackett P, Bennett H, Swa K, Dhillon B. Tear production and corneal sensitivity in diabetes. J Diabetes Complications. 2007 Nov-Dec;21(6):371-3.
29. Bikbova G, Oshitari T, Tawada A, Yamamoto S. Corneal changes in diabetes mellitus. Curr Diabetes Rev. 2012 Jul 1;8(4):294-302.
30. Rosenberg ME, Tervo TM, Immonen IJ, et al. Corneal structure and sensitivity in type 1 diabetes mellitus. Invest Ophthalmol Vis Sci. 2000 Sep;41(10):2915-21.
31. Tseng HF, Chi M, Smith N, et al. Herpes zoster vaccine and the incidence of recurrent herpes zoster in an immunocompetent elderly population. J Infect Dis. 2012 Jul 15;206(2):190-6.
32. Schmader KE, Oxman MN, Levin MJ, et al. Shingles Prevention Study Group. Persistence of the efficacy of zoster vaccine in the shingles prevention study and the short-term persistence substudy. Clin Infect Dis. 2012 Nov 15;55(10):1320-8.
33. Hwang CW Jr, Steigleman WA, Saucedo-Sanchez E, Tuli SS. Reactivation of Herpes Zoster Keratitis in an Adult After Varicella Zoster Vaccination. Cornea. 2013 Apr;32(4):508-9.
34. Nithyanandam S, Stephen J, Joseph M, Dabir S. Factors affecting visual outcome in herpes zoster ophthalmicus: a prospective study. Clin Experiment Ophthalmol. 2010 Dec;38(9):845-50.
35. Van Dyk M, Meyer D. Hutchinson's sign as a marker of ocular involvement in HIV-positive patients with herpes zoster ophthalmicus. S Afr Med J. 2010 Mar 8;100(3):172-4.
36. Zaal MJ, Völker-Dieben HJ, D'Amaro J. Prognostic value of Hutchinson's sign in acute herpes zoster ophthalmicus. Graefes Arch Clin Exp Ophthalmol. 2003 Mar;241(3):187-91.
37. Harding SP, Lipton JR, Wells JC. Natural history of herpes zoster ophthalmicus: predictors of postherpetic neuralgia and ocular involvement. Br J Ophthalmol. 1987 May;71(5):353-8.
38. Arora R, Jain S, Monga S, Narayanan R, Raina UK, Mehta DK. Efficacy of continuous wear PureVision contact lenses for therapeutic use. Cont Lens Anterior Eye. 2004 Mar;27(1):39-43.
39. Ambroziak AM, Szaflik JP, Szaflik J. Therapeutic use of a silicone hydrogel contact lens in selected clinical cases. Eye Contact Lens. 2004 Jan;30(1):63-7.
40. Sanjay S, Huang P, Lavanya R. Herpes zoster ophthalmicus. Curr Treat Options Neurol. 2011 Feb;13(1):79-91.
41. Komlos L, Notmann J, Arieli J, et al. IN vitro cell-mediated immune reactions in herpes zoster patients treated with cimetidine. Asian Pac J Allergy Immunol. 1994 Jun;12(1):51-8.
42. Miller A, Harel D, Laor A, Lahat N. Cimetidine as an immunomodulator in the treatment of herpes zoster. J Neuroimmunol. 1989 Mar;22(1):69-76.
43. The United States Centers for Disease Control and Prevention. Public Health Image Library (PHIL). http://phil.cdc.gov/phil/home.asp. Accessed: July 9, 2013.

Model Approach for Incorporating Informatics in Optometric Curriculum

Sajeesh Kumar, PhD

James E. Venable, OD, FCOVD

Abstract

The digital revolution is transforming the profession of optometry. Increasingly, optometric information is being recorded, stored and analyzed using computerized tools. This concept paper discusses the integration of informatics into clinical optometry training and, specifically, a framework for an optometric informatics curriculum. Within this framework, the objectives, course sections and a model curriculum are described. Optometry informatics curriculum aims to equip students with the knowledge and tools they will need in their future role as decision-makers to use, design, implement, maintain or evaluate an optometric informatics application.

Key Words: *education, informatics, optometry*

Dr. Kumar is an Associate Professor in the Department of Health Informatics & Information Management at the University of Tennessee Health Science Center in Memphis. His research focuses on design and development of optometry informatics, teleophthalmology technology, education technologies and technology evaluation.

Dr. Venable is an Assistant Professor and Vice President for Clinical Programs at Southern College of Optometry in Memphis, Tenn. He teaches both didactic and clinical courses and is the instructor of record for Practice of Optometry I & II.

Introduction

Rapid innovation in information technology is having a significant impact on the profession of optometry. Innovations include technologies such as high-capacity digital networks, powerful computer hardware and software, high-resolution digital image compression, the Internet, very high data speeds and the capability for faster and lossless image transmission.[1] By embracing these innovations in ways such as tying in digital devices to the electronic medical record, optometric practices and clinics may improve workflow, maximize electronic medical record use, and enhance patient experiences and satisfaction.[1] Despite some attention to the advances relevant to the practice of optometry in the past decade, many optometric educators are still not fully embracing these advances in the informatics field and their growing importance to optometric practice or the delivery of optometric curriculum.[2-4] Optometric education is a relative latecomer to the field of medical informatics.[5] Nevertheless, some optometry schools have increased the use of informatics in their programs, but only in their clinical facilities.[2-6] Although computing skills have increased among optometry students,[2] and prospective students may enter optometry school better prepared to use the technology,[3] there is still a need for improvement in preparing optometry students for the technology challenges they will encounter as future practitioners.[3] After graduation, information technology and computing resources can play a major role in their optometric practice.[4]

Optometric informatics may be defined as the use of electronic communication and information technologies to provide and support a diverse group of activities related to eye health and vision care for the practitioner. This definition of optometric informatics could even be expanded to include the myriad technologies used in educating the optometric physicians of tomorrow. The American Medical Informatics Association (AMIA) defines medical informatics more broadly, "Biomedical and health informatics has to do with all aspects of understanding and promoting the effective organization, analysis, management, and use of information in health care."[7] Optometric informatics covers many activities, including diagnosis, treatment, prevention, patient education, practice management, research, community outreach and even optometric education of future practitioners. If implemented and used optimally, it will change the delivery and efficiency of eye health and vision care curricula and better prepare future optometric physicians. The Association of Schools and Colleges of Optometry (ASCO) formally recognized the importance of informatics to optometric education by supporting formation of the ASCO Optometric Informatics Special Interest Group (SIG) in December of 2000.[8] Now known as the Educational Technology SIG, one of its most important activities has been the development of guidelines (June 2007) for the use of information technology by ASCO's member schools and colleges of optometry.[9] Unfortunately, a review of many of the current programs' curricula finds optimal application of these guidelines lacking.

Jenna Hildebrand et al. (2007) suggest, contrary to popular belief, that optometry students may not be as "computer-savy" as many educators expect them to be.[10] Interviewees, after experiencing their clinical externships, expressed a general interest for more exposure and training in information technology within the optometric curriculum.[10]

In the following section, integration of informatics into an optometry program is discussed, and a framework for the design of an optometric informatics curriculum is presented. The aim is to discuss concepts and topics that would be essential for integration into an optometry program and to present an approach currently being utilized at the Southern College of Optometry (SCO) in Memphis, Tenn.

Objectives

An optometry informatics curriculum should be designed to develop intelligent consumers, managers and researchers of optometric informatics through guided exploration into the components of information systems. The courses should involve the practical application of optometry informatics. Specifically, the courses should address the following:

- Overview of the field of optometric informatics
- The role of optometric informatics in practical applications of information systems in eye health and vision care
- Fundamental concepts of information systems in the optometric setting
- Current trends in health care and telecommunication technology that affect the design and evolution of optometric informatics applications
- The use of optometric informatics in the assessment of a community's eye health and vision care needs.

Upon successful completion of this curriculum, students should be able to:

- Determine the need for optometric informatics applications in practice
- Utilize the role of informatics in optometric care process re-engineering
- Describe the data and information security needs of optometric care processes
- Implement an evaluation framework for optometric informatics applications
- Utilize current technology in the diagnosis, treatment and management of eye health and vision care disorders.

Curriculum Framework

The proposed model curriculum described below is adapted from one currently in use at SCO. For several years now, the administration, faculty and staff have incorporated new approaches to didactic, laboratory and clinical instruction to fully utilize optometric informatics. From technology in the classroom and laboratory to focused instruction in clinical (CLN) courses, every attempt is being made to assist the Millennial learners' acceptance and assimilation of material and technology.

The process of conversion to this new delivery system has been rather smooth yet not without challenges. Faculty members with 15 or more years of experience in academic optometry have had to rethink their delivery methods and find ways of incorporating technology and engaging students for the most effective outcomes. In the clinical setting, attending optometric physicians have been challenged to interact with interns and residents with technology and in ways other than the traditionally accepted Socratic Method of engagement. The students and residents have responded positively to SCO's attempts at making material accessible utilizing technology.

The following sections outline the ideal components of an optometric informatics curriculum.

Definitions/glossary

Students should be introduced to formal definitions of health informatics and optometric informatics. Because of the continuous advancements in telecommunications, application areas for informatics are evolving, and new terms arise. Frequently, one term is used to describe different tasks. It is important for students to be equipped with a definitions list, which should include the items of the "Informatics Guidelines for Schools and Colleges of Optometry" proposed by ASCO[11] and be expanded to incorporate specific terms that are currently used in optometric informatics. In addition, students should be introduced to the wealth of resources related to informatics, such as the major journals of the field, sites of national and international associations and online databases.

Evolution of the field

Interest in optometric informatics seems to have increased in the past few years due to recent advances of telecommunication technology.[12] An introduction to the history and evolution of optometric informatics will help students understand the diffusion and development of this innovation and its growing use in optometric practice.

Technical background

Optometry students are traditionally being introduced to data transfer and communication within other undergraduate or graduate courses related to computer science. However, a brief review of information technologies and protocols that are being utilized for informatics applications is a necessary component of an optometry informatics course. This section is *not* designed to provide expertise in the technical aspects of informatics but rather to familiarize optometry students with the terminology and different types of technologies and networks, their features, limitations and costs. Students' awareness of clinical and practice management technology limitations, including costs, facilitates the understanding of informatics evaluation studies.

Informatics' Impact on Optometry

Cost of care

One of the learning objectives of this section should be to make clear that the measurement of potential cost savings associated with informatics application depends on the interest group (e.g., optometrist, patient, health maintenance organization, society).[13]

Quality of care

Informatics assists in the measurement of the quality of care provided either on a biomedical/bioengineering basis (clinical performance, clinical efficacy, efficiency, safety) or a health services basis (appropriateness of the treatment chosen, policy adapted to improve health status).[14,15]

Access to care

Access to health services reflects the "fit between healthcare resources (including hospitals, clinics, optometry offices) and the healthcare needs of the people they serve."[14] Students should discuss the three primary types of barriers to access[16] in relation to informatics — structural, financial and personal/cultural — and the ways informatics can eliminate those and possibly introduce new ones because of the technology use.

Success and failure factors

Students should study literature that shows the success or failure of informatics interventions and identify common patterns that could be listed as success predictors or lessons learned from past applications.[16,17]

Legal and ethical issues

A series of legal and ethical issues associated with the utilization of informatics should be introduced to students. These issues should include licensure, accreditation, privacy of medical data, malpractice liability and reimbursement to name a few. For example, interstate practice of optometric consultations using optometry informatics or telemedicine raises licensure questions, such as whether optometrists can be practicing telemedicine in a remote state in which they do not have a practicing license. The Health Insurance Portability and Accountability Act of 1996 (HIPAA)[18] and the Family Educational Rights and Privacy Act of 1974 (FERPA)[19] are two examples of federal legislation to protect the personal information of all individuals to whom clinical or academic services are provided. Other federal and state legislation extends similar protection to sensitive information. It also includes protection from the inadvertent destruction or corruption of information due to failures of hardware or software, losses of information due to carelessness, ignorance, accident on the part of authorized users, and those resulting from natural disasters such as fire, flood, earthquake and unexpected surges or loss of electrical power.[11]

Security essentials

It is essential that optometry students understand the importance of information confidentiality, integrity and accessibility. These goals safeguarding patient privacy may be achieved more efficiently through the application of informatics applications in addition to current administrative and physical safeguards.[11] ASCO lists guidelines to follow when adopting clinical systems at schools and colleges of optometry, which include that clinical software should be Health Level 7 compliant, and diagnostic instruments should be DICOM-compliant.[11]

Training tools

Active learning in the classroom is achieved through incorporating interactivity into instruction. Today's students are tapping into numerous technologies to enhance productivity as well as lend real-world relevance to their studies.[20] We must no longer expect teaching methodologies of the past to be sufficient for the Millennial learner. The lecture, structured note service, guest speaker and activities in which students work individually and in groups must utilize new technologies to present time-honored material and provoke ever-increasing levels of critical thinking.[21] Throughout the curriculum the following tools should be used:

1) Literature review. Because of the innovative and recently evolving nature of the field, optometric informatics literature is lacking a great number of quality studies, data collection instruments that have been tested for reliability and validity, and, in some cases, sound statistical methods. It is therefore important to encourage students to be critical of the generalization of methods and results.
2) Practical exposure. On-campus clinical facilities should be equipped with state-of-the-art diagnostic, treatment, patient care and business operations technology. During the first two years of the professional program, site visits to clinical settings where informatics is being practiced can be of benefit to optometry students. During the clinical externship, selection of sites with advanced technology and clinicians versed in informatics applications is desirable. During these experiences, students will have the opportunity to assess healthcare providers' perceptions of and attitudes toward optometry informatics applications and discuss their impact on daily care delivery. Additionally, industry representatives and vendors should be invited to interact and present their products for different application areas throughout the program.
3) Use of educational technology. Tools such as Computer-Assisted Testing System (CATS), CourseWeb, MediaSite, Moodle, Student Response Systems and Tegrity Campus should be implemented throughout the didactic and laboratory course work. The application of informatics in patient care and business operations in the clinical setting is also essential.[22]

Optometric Informatics Experience: Southern College of Optometry

SCO has been working to most effectively model the leading-edge 21st century optometric practice in its clinical facilities while incorporating appropriate standards as outlined in the Educational Technology Guidelines for Schools and Colleges of Optometry.[11] This effort has resulted in the incorporation of various topical and technological inclusions in SCO's curriculum to address the changing needs of today's professional student and to highlight the use of optometric informatics in clinical practice. An emphasis is placed on the aspects of optometric informatics relating to cost of care, quality of care, access to care, use of electronic health records and privacy of personally identifiable health information.

The use of technology to better meet the needs of the Millennial-aged professional student in knowledge acquisition and critical thinking has been implemented throughout the curriculum. Most recently these changes have taken place in the didactic classroom and laboratory as educational technology, and new approaches to the traditional lecture have been applied.[21,23-25] SCO has been involved in optometric informatics through a vision science index-referenced service, Visionet, since 1975. Technology advances have allowed SCO to embrace the concept of library as a "Learning Commons" – a physical and virtual space providing access to information, materials and software to authenticated users regardless of their physical location. Today our students have access to the same resources at home or in the local coffee shop as they do in our library on campus. Additionally, since early in the 21st century, SCO has had faculty actively engaged in the development and utilization of educational software specific to optometric education, from computerized models to assist in understanding ray tracings and physiological optics to simulation of the eye movements of a patient with Brown's Retraction Syndrome.[26,27]

Within the past three years, SCO has added the use of four forms of commercially available educational technology to assist in the delivery of curricular content. These include Moodle, McGraw-Hill's Tegrity Campus, Turning Technologies Turning Point audience response system (ARS) and Tech Smith's Camtasia Studio. Moodle is an open-source, course management system.

Figure 1
Turning Technologies ResponseCard RF

SCO uses this system as a platform for online courses and in "blended learning" courses to augment face-to-face instruction. The software contains activity modules such as forums, databases and "wikis" that provide for the creation of elaborate communities around individual courses. Tegrity Campus is an automated lecture capture system that SCO utilizes in traditional, hybrid and online courses. It records presentations and supplemental course content for reference, review and study by students. This has proven to be especially helpful as students prepare to take national board examinations. The software package also allows personalized learning features for users enabling them to better organize material and even review related topical content in previously taken courses. Use of Turning Point ARS helps faculty better engage students and creates a more active learning environment. This automated student response system is composed of radio-frequency (RF) ResponseCards. It provides an opportunity for student-lecturer interaction in larger classes and accommodates testing. **(Figure 1)** When it is used as a means of formative assessment, immediate feedback is provided to students on their performance as it relates to other members of their class or team-based learning (TBL) group. Student data is captured, graded and prepared for transfer to Moodle or other grading formats. Camtasia Studio is a powerful software format that facilitates the creation of professional-grade videos allowing on-screen activity and interactive elements and transmission capabilities for sharing with anyone, on nearly any device in person or remotely.

Little has been written regarding the Millennial-aged learner in professional healthcare education, especially optometric curriculum, and the SCO faculty is working to adapt the current theories and approaches in pedagogy and use of technology.[20,22,24] This requires a rethinking of delivery methods at all levels of the curriculum and cannot be adequately undertaken without a firm understanding of the role of technology and informatics.

Table 1 represents a curriculum model for optometric informatics instruction. Beginning in the first professional year (PY1) of the program, concepts related to optometric informatics are presented in OPT 219 - Practice of Optometry I. In this course, PY1 students are introduced to the impact of informatics on quality of care, cost of care and the importance of published studies to aid utilization. The first in a two-year sequence of Optometric Theory & Methods courses (OPT 110, 120, 200, 210, 220) introduces the PY1 student to Compulink Electronic Health Records (CEHR). **(Figures 2 and 3)** The CEHR is in use in the clinical facilities of the program, and students begin recording data and manipulating screens in the system two years before using the CEHR to assist optometric physicians in the provision of patient care in The Eye Center (TEC) at SCO or other external clinical facilities.

In the second professional year (PY2), concepts of patient access, inter-pro-

Table 1
A Curricular Model for Optometric Informatics Instruction*

Professional Year	Course Title	Relevant Content	Educational Modality
PY1	*Optometric Theory & Methods I & II*	Application of optometric informatics in clinical setting - skills and techniques for direct patient care	**Traditional lecture, e-capture, e-management & practical laboratory**
	Practice of Optometry I	Introduction to optometric informatics in clinical setting - access, quality of care, cost of care	**Blended learning, e-capture, e-management**
PY1	*Optometric Theory & Methods III , IV & V*	Application of optometric informatics in clinical setting - skills and techniques for direct patient care	**Traditional lecture, e-capture, e-management & practical laboratory**
	Practice of Optometry II	Legal & ethical issues related to informatics, assessing community health needs, HIPAA, DICOM	**Blended Learning, e-capture, e-management**
	Clinical Communication & Patient Care	Application of optometric informatics in clinical setting - skills and techniques for direct patient care	**Blended learning, e-management & practical laboratory**
PY3	*Clinical Internship I, II & III*	Application of technology in patient care, general office operation and patient satisfaction	**Active participation, online resources**
	Practice Management	Design & assessment of optometric informatics for patient flow, patient contact, office efficiencies, patient experience	**Blended learning, e-capture, e-management**
PY4	*Clinical Internship IV*	Application of technology in patient care, general office operation and patient satisfaction	**Active participation, online resources**
	Clinical Externship I	Observation, assessment and critical analysis of optometric informatics in various practice modalities	**Active participation, online educational modules**
	Clinical Externship II	Observation, assessment and critical analysis of optometric informatics in various practice modalities	**Active participation, online educational modules**

***Curriculum based, in part, on that in place at SCO for Academic Year 2012-2013. This model does not include the various basic science and optometric curricular components without a direct tie to the informatics content.**

e-Capture with Tegrity Campus®

e-Management with Moodle®

Online Educational Modules with Camtasia Studio® by Tech Smith® & Moodle®

Figure 2
Compulink Sign-In Tab

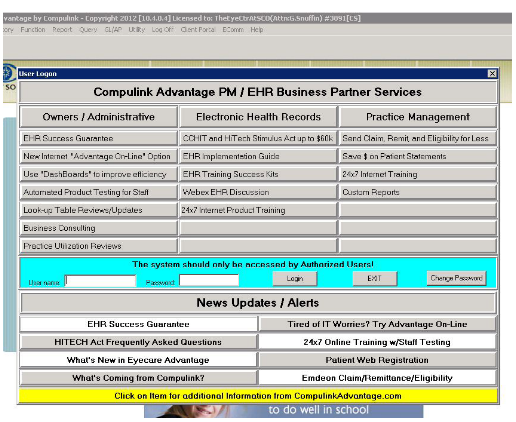
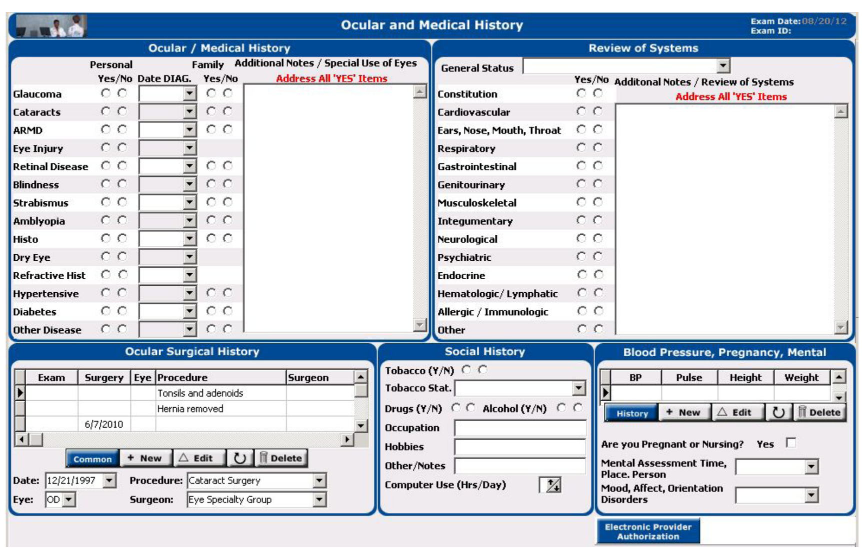


Figure 3
Compulink Electronic Health Record (CEHR) History Tab



fessional relationships and legal and ethical issues associated with informatics use are covered (OPT 219 – Practice of Optometry II). In this course a thorough review of the application of HIPAA is covered. In OPT 216 – Clinical Communication & Patient Care, PY2 students are involved in the practical application of informatics and data manipulation as it relates to community health initiatives and direct patient care. Vital data gathered from the School Screening Program of the Community Vision Health Services of the Clinical Programs at SCO is analyzed by students including various forms of statistical analysis aided by technology.

Third professional year (PY3) interns are introduced to the many uses of informatics in the practice setting in courses entitled Clinical Internship I, II, and III (CLN 306, 316, 326). The students' use of CEHR reaches its most practical application in the clinical setting during PY3. During this first year of the clinical internship, the PY3 student is actively engaged, as a non-physician extender, with optometric physicians (i.e., clinical faculty) providing comprehensive eye health and vision care at TEC. Through secure, encrypted web-based access, interns utilize the CEHR in external clinics as well as the nursing home/assisted living program. Clinical faculty utilize each patient encounter for maximum educational exposure including, but not limited to, enhancing quality of care, increasing efficiency, enhancing patient satisfaction, and practice management utilizing informatics and technology. An emphasis is placed on the methodical development of appropriate critical thinking skills in the clinical setting.[21,29] Informatics is utilized in the clinical facilities at SCO including practice management software (PMS); interfaces with external databases and clearing houses for insurance authorization and electronic claim submission; CEHR; e-prescribing; interface with the Essilor Mr. Blue Fabrication System in the SCO finishing laboratory; and in conjunction with Demand Force, a web-based patient contact software system providing text and e-mail contact for scheduling appointments, appointment reminders and notification of completed optical jobs.

During PY3, the interns are immersed in these practice management and efficiency-enhancing aspects of effective patient care, and utilize the clinical application of basic technology in the contemporary practice of optometry (i.e., diagnosis, treatment and management). Today, it is considered "standard of care" to utilize what even a decade ago might have been considered futuristic technology. Computerized tomography, digitized photography, computer-enhanced and validated perimetry, optic nerve head imaging, electronic transmission of fundus photography, image archival systems and even corneal thickness measurement and analysis is commonplace. All instrumentation in SCO clinical facilities is DICOM (Digital Imaging Communication in Medicine) compliant. This facilitates the development of common formats and protocols for the sharing and output of data from diagnostic equipment. Optometric faculty have naturally incorporated these and many other advanced technologies as they have become accepted and supported by evidence-based studies for their application in patient care.

In the Fourth Professional Year (PY4) of the curriculum, the intern spends one of three trimesters on campus (CLN 400 Series). Two are spent on clinical externship. During their clinical assignments on campus the PY4 interns become fluent in use of the latest in automated technology for subjective refraction. The Marco Total Refraction Systems (TRS) are used in the PY4 Adult Primary Care Services in TEC. These systems incorporate clinical informatics by gathering pretesting data that is automatically entered into the phoroptor and CEHR. Use of this technology enhances efficiency and allows us to model the use of technology in the provision of patient care for the 21st century practice of optometry. While off campus in one of their two clinical externship rotations, interns are engaged and interact with faculty on campus through both required and optional online educational modules. These modules are designed to enhance the clinical externship experience by drawing parallels between the various sites through standardized business

Figure 4
Southern College of Optometry's Advanced Procedures Theater

Figure 5
Digital Observatory at the Southern College of Optometry

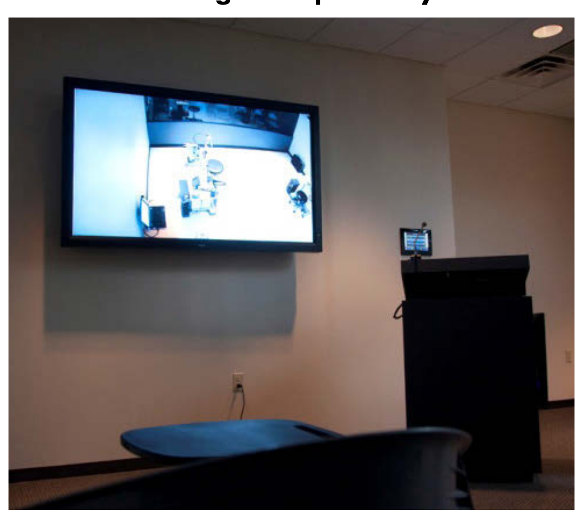
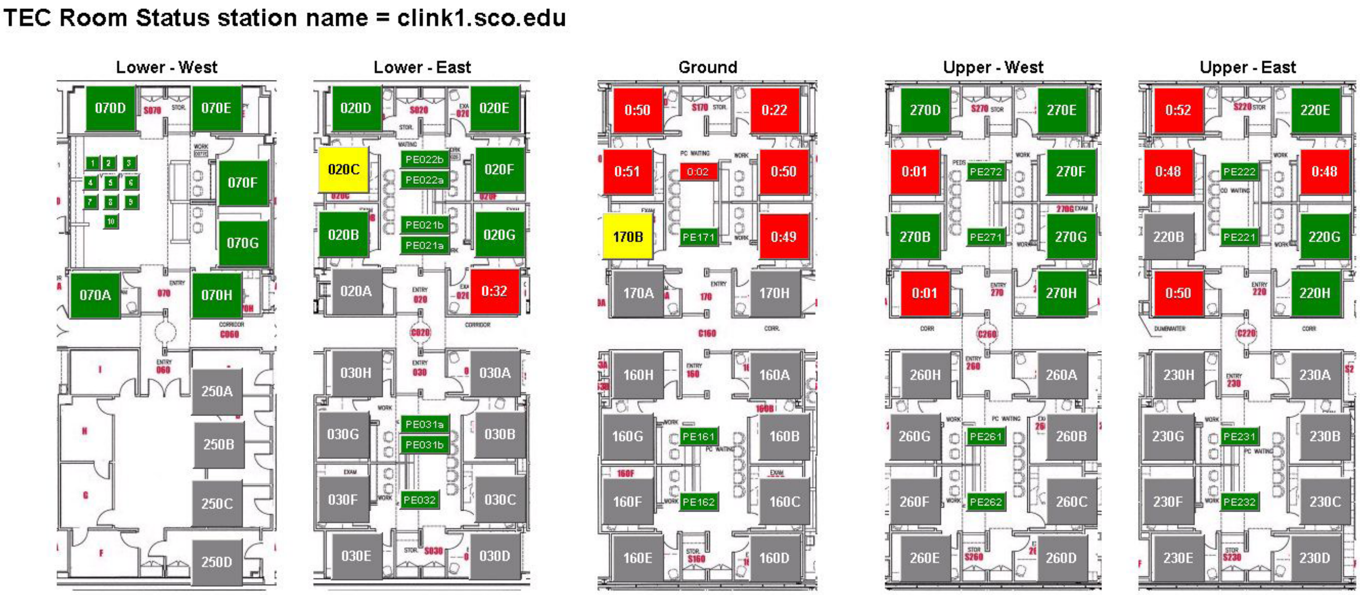


Figure 6
Southern College of Optometry's Patient Flow System
(grey = blocked room, green = room available, yellow = patient in route, red = exam in progress)



practice models. The development of critical evaluation of business practices in various modalities are also fostered through use of this technology.

SCO recently completed construction of a unique Advanced Procedures Theater/Digital Observatory and Digital Examination Rooms located in TEC. **(Figures 4 and 5)** These state-of-the-art teaching facilities use new informatics technology for the clinical instruction of diagnostic and therapeutic procedures including, but not limited to, binocular indirect ophthalmoscopy, biomicroscopy and various ophthalmic laser procedures. Utilizing new video and audio technologies applied to Zeiss ophthalmic equipment, interns are able to observe these procedures being performed in a unique way. Remote observation of the surgeon's field of view, the patient's field of view and generalized video of the procedure environment is transmitted for presentation by clinical faculty in one of two different theater-like settings. The Digital Examination Rooms afford clinical faculty the opportunity to expose greater numbers of students to techniques and interesting clinical findings and SCO interns the opportunity to practice examination techniques in an environment modeled after the National Center of Clinical Testing in Optometry (NCCTO) of the National Board of Examiners in Optometry in Charlotte, NC.

SCO interns also have exposure to proprietary systems designed in-house for the efficient delivery of patient care and clinical instruction. The Information Services Department (ISD) at SCO consists of a half dozen individuals committed to assisting all aspects of the institution in efficient use of technology and informatics. In conjunction with TEC staff members, the ISD developed a one-of-a kind software application, the SCO Patient Flow System. **(Figure 6)** This informatics application monitors examination room status and patient movement throughout the clinic in order to streamline and enhance the patient experience. With 35 optometric physicians, more than 100 interns and 45 staff members providing care to as many as 350 patients each day, TEC could easily become disorganized. The SCO Patient Flow System keeps that from happening. This web-based patient flow system assists in providing care without undue wait times for patients and keeps physicians, interns and staff on schedule. Effective application of informatics is important to patient care but also is essential to 21st century clinical education. SCO clinical Chiefs of Service worked with ISD to develop SCO's e-Clinical Grading System. **(Figures 7 and 8)** This web-based software application tracks each intern's encounters, automatically forwards content to clinical faculty for grading and then sends the results to the intern's internal e-mail immediately upon completion. SCO is currently in the process of evaluating faculty/student reaction to the curriculum.

Conclusion

The use of informatics will be a key element in the future delivery of eye health and vision care for the continued success of optometric practices. It is also essential to include these technologies and practices in the educational curriculum itself. Informatics will not only improve quality of care, patient experiences and business practices but also help to ensure the continued success of the optometric practice in an increasingly discerning and competitive marketplace. The proposed framework in this concept paper constitutes the outline of an optometric informatics curriculum for optometry programs that provides students with an overview of the field and practical ap-

Figure 7
E-Clinical Grading System – Student Tab

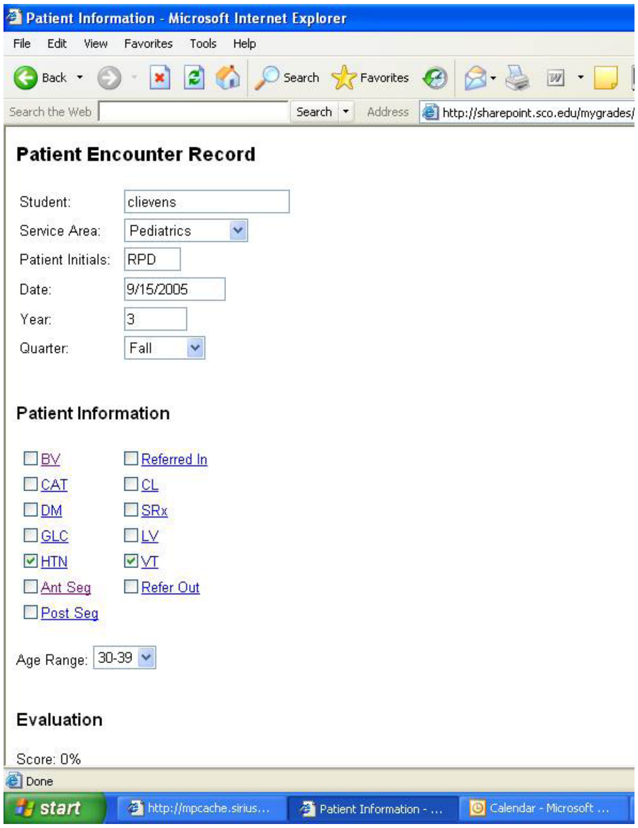
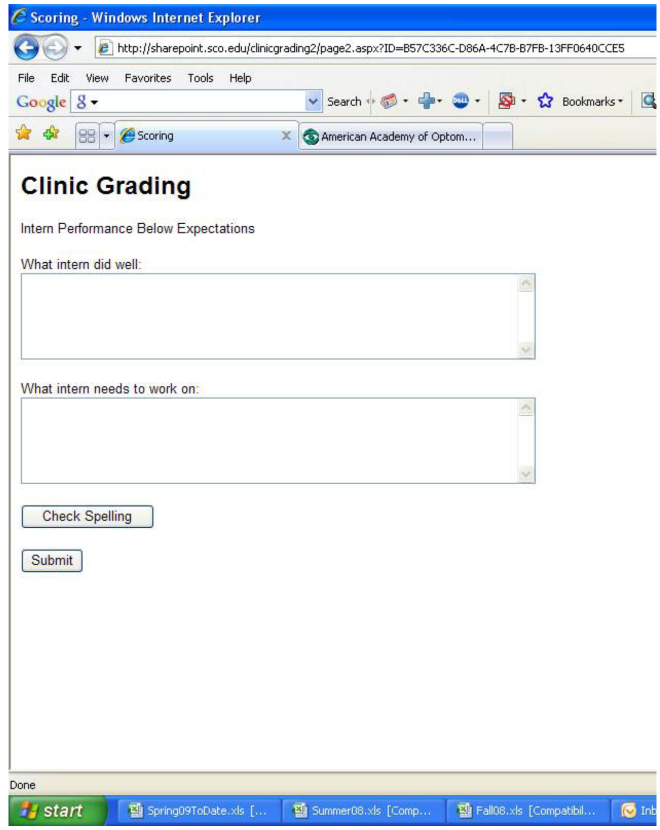


Figure 8
E-Clinical Grading System – Attending Staff Doctor Tab



plication experience and prepares them for their future roles as decision-makers and healthcare practitioners.

Despite these observations, the authors recommend that new studies be conducted to specifically identify learning attributes and outcomes of teaching and utilizing optometric informatics in the widely accepted framework of today's optometric curriculum.

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References

1. Kumar S, Wang EH, Pokabla MJ, Noecker RJ. Teleophthalmology Assessment of Diabetic Retinopathy Fundus Images: Smartphone versus Standard Office Computer Workstation. Telemed J E Health 2012 Mar;18(2):158-62.
2. Rainey B. Optometry Student Computer Skill Trends. Optometric Education 2001;26(4):122-125.
3. Perry CA. Information Literacy in the SUNY Optometric Curriculum. Optometric Education 2001;26(4):105-112.
4. Farra T, Hoppe E, Hutchison L, Scott C. Technology Familiarity and Use among Entering Optometry Students. Optometric Education 2006;31(2):55-58.
5. Fendick M. Informatics in Optometric Education. Optometric Education 2007;33(1):6.
6. DiStefano AF, Dayhaw-Barker P, Oleszewski S, Dell WM. The Pennsylvania College of Optometry transforms its Curriculum for the Preparation of 21st Century Optometrists. Optometric Education 2001;27(1):11-19.
7. American Medical Informatics Association. About informatics [cited 2012 November 27] Available from: http://www.amia.org/informatics/.
8. Association of Schools and Colleges of Optometry. Optometric Informatics SIG [cited 2012 November 27] Available from: http://www.opted.org/pdf/oi.pdf.
9. Association of Schools and Colleges of Optometry. Vision Science Librarians SIG [cited 2012 November 27] Available from: http://www.opted.org/pdf/vsi.pdf.
10. Hildebrand JM, Stolee P, McKillop I, Jones DA, Strong GJ. Senior Optometry Students' Experiences With Information Technology in Optometric Practice. Optometric

Education 2007;33(1):19-24.
11. Informatics Guidelines For Schools And Colleges Of Optometry, ASCO, May 2007.
12. Gerson-Cohen J, Colley A. Telediagnosis. Radiology 1950;55:582-7.
13. Committee on Evaluating Clinical Applications of Telemedicine. Field MJ (ed). Telemedicine: A Guide to Assessing Telecommunications in Health Care. Washington, DC: National Academy Press, 1996.
14. Bashshur R, Sanders J, Shannon G. Telemedicine: Theory and Practice. Springfield, IL: Charles C Thomas, 1997.
15. Fineberg H, Bauman R, Sosman M. Computerized cranial tomography: effect on diagnostic and therapeutic plans. JAMA 1997;238:224-30.
16. Millman M. Institute of Medicine: Committee on Monitoring Access to Personal Health Care Services. Washington, DC: National Academy Press, 1993.
17. Allen A, Perednia D. Telemedicine and the Health Care Executive. Telemed Today 1996;4-23.
18. Lax JR. HIPAA Privacy Rules: What they are and what they mean for optometrists; J of the AOA 2001;72/8;529-540.
19. HL7 website [cited 2012 November 27] Available from: http://www.hl7.org/about/.
20. Project Tomorrow, 2011; The New 3 E's of Education: How Todays Students are Leveraging Emerging Technologies for Learning; Speak Up 2012 national Findings.
21. Beckwith M, Beckwith P. Reflection or Critical Thinking?: a pedagogical revolution in North American health care education; E-Leader, Krakow, 2008.
22. Ironside PM. New Pedagogies for Teaching Thinking: The Lived Experiences of Students and Teachers Enacting Narrative Pedagogy. J of Nursing Education 2003;42/11;509-516.
23. McClatchy; More College Instructors are "Flipping" the way they Teach; Curriculum & Instruction; 2012.
24. Abdelkhalek N, Hussein A, Gibbs T, Hamdy H. Using Team-based Learning to Prepare Medical Students for Future Problem-Based Learning. Med. Teach 2012;32/2:123-9.
25. Beaty S, Kelley K, Metzger A, Bellebaum K, McAuley J. Team-based Learning in Therapeutics Workshop Sessions; Am J Pharm Educ 2009;73/6:100-104.
26. Steinman SB. The Oculomotor Suite: Educational Software for the Interactive Demonstration in the Classroom of Strabismus and Oculomotor Paralyses. J Optometric Educ 2007;33/1:24-26.
27. Steinman SB. Ray Trace: Software for Thin Lens Refraction in the Classroom. J Optometric Educ 2007;33/1:27-29.
28. Candler C. Effective Use of Educational Technology in Medical Education – Colloquium on Educational Technology: Recommendations and Guidelines for Medical Educators. AAMC Institute for Improving Medical Education. 2007; Association of American Medical Colleges.
29. Kaplan B. Evaluating Informatics Application – Clinical Decision Support Systems Literature Review; International Journal of Medical Informatics 2001;64:15-37.

Use of Google as a Tool to Aid Diagnosis by Optometry Students

Frank Eperjesi, BSc, PhD, MBA, FCOptom, Dip Orth, FAAO, SFHEA, PGCertHE

Jon Gibson, MB BS, MD, FRCS(Ed), FRCOphth

Hannah Bartlett, BSc (Hons), PhD, MCOptom, PGCertEd, FAAO

Abstract

Background: *Previous work has shown that medical problems can be diagnosed by practitioners using Google. The aim of this study was to determine whether optometry students would benefit from using Google when diagnosing eye diseases.* ***Methods:*** *Participants were given symptoms and signs and instructed to list three key words and use them to search Aston University e-Library and Google UK.* ***Results:*** *Aston University e-Library only search resulted in correct diagnosis in 16 of 60 simulated cases. Aston e-Library plus Google search resulted in correct diagnosis in 31 of 60 simulated cases.* ***Conclusion:*** *Google is a useful aid to help optometry students improve their success rate when diagnosing eye conditions.*

Key Words: *Aston e-Library, diagnosis, Google, ocular conditions, optometry students*

Dr. Eperjesi is an Associate Professor in Optometry, Head of Department and a Senior Fellow of the Higher Education Academy, UK.

Professor Gibson is an ophthalmologist that splits his time between research, clinic and education.

Dr. Bartlett is a Senior Lecturer in Optometry and an Associate of the Higher Education Academy, UK.

All authors are affiliated with the Ophthalmic Research Group, School of Life and Health Sciences, Aston University, Birmingham, UK.

Introduction

Recent reports in the literature indicate that medical students and young and experienced doctors can be assisted in reaching the correct diagnosis for uncommon medical conditions using the Google search engine.[1-3] Greenwald reported a single case study of correct diagnosis of a condition using Google, while Tang and Ng more methodically showed how two experienced medical doctors diagnosed 58% (15/26) of difficult medical cases correctly using carefully selected search terms and Google Web Search.[2] Similarly, Falagas et al. showed that one trainee medical doctor and two final-year medical students increased their total correct diagnoses by almost 10% when using PubMed or Google.[3] Tang and Ng suggested that doctors, especially those in training, should be proficient in the use of web-based search engines.[2]

Twisselmann, however, reminds us that "Google is not set up as a diagnostic decision support system — although it can be a useful aid to differential diagnosis once a diagnosis has been made" and that "other internet resources exist, for example PubMed and other specialty databases, which might be more specific and useful than Google and of course these sources contain mainly peer-reviewed information."[4] Our experience suggests that optometry students frequently use the internet to search for information to aid their learning. The authors wondered whether Google Web Search (from now on referred to as Google) could help optometry students make a correct diagnosis in eye conditions.

The aim of this study was to determine whether conducting internet searches using Google would aid optometry students in the diagnosis of ocular conditions when compared to the Aston University e-Library. Aston University e-Library is a portal to peer-reviewed academic papers in PubMed, Web of Knowledge and other databases. The authors decided to use Google as it had been used in several previous similar studies,[2,5] because it has been reported that in 2005 Google led more visitors to biomedical journal websites than did other widely used search engines such as Yahoo and PubMed[6,7] and because it is widely available, fast and easy to use.

Methods

Subjects

Twelve final-year optometry students were recruited after a call for participants was sent by e-mail to all 115 students in the third year of our institution's three-year optometry degree program. The University's Ethics Committee approved the study. All subjects signed an informed consent form and all procedures adhered to the tenets of the Declaration of Helsinki.

The second year of the optometry degree program consists of courses in Further Investigative Techniques (contact tonometry and slit lamp biomicroscopy), Contact Lenses (fitting a range of contact lenses and the principles of aftercare), Primary Optometric Examination (subjective refraction techniques and binocular vision evaluation), Ophthalmic Optics (spectacle lens thickness calculations and optics of low vision aids), Vision Science and Research Methods (bottom-up and top-down visual processing and experimental design) and Clinical Practice Development (differential diagnosis and communication skills). Marks are obtained through continuous assessment of practical and clinical skills throughout the academic year and with an end-of-year written exam. The marks of each module are summed and an average year mark is obtained for each student. Each participant's end of second year overall percentage mark was determined from University records, and the overall mean and standard deviation (SD) for our 12 subjects was calculated.

The third (final) year of the optometry program consists of five lecture-based courses, one research course and one clinical course. The latter involves working under supervision in public service general optometry, contact lens, pre-screening, pediatric, binocular vision, low vision and dispensing clinics.

All participants had completed 11/24 weeks of the third-year program. This included 33 hours of lectures on anterior and posterior eye conditions and 80 hours of working under supervision in public service general optometry and contact lens clinics. The remaining 13 weeks of education, including lectures on ocular disease, were delivered following the study.

Procedure

One of the authors (FE) selected a convenient sample of five anterior and five posterior eye conditions from an ophthalmology textbook by Kanski and Menon[8] and extracted key information on symptoms and signs in order to produce 10 simulated cases. See **Figure 1** for examples of extracted signs and symptoms information. See **Table 1** for a list of the conditions used in this study. The authors decided not to use cases from the New England Journal of Medicine (NEJM) as used in other previous studies,[2,5] as many of the NEJM ophthalmology cases involved rare systemic conditions and included information on imaging and medical procedures and would have been too complex for our subjects.

Participants were given paper copies of the symptoms and signs and instructed to independently list three key words in total after having read the symptoms and signs information. **(Figure 1)** The information provided to the participants did not contain any images.

Six students were instructed to use their key words to search Aston University e-Library only for a diagnosis of the first group of five simulated cases (all anterior eye conditions) and then to use their key words to search Aston e-Library and Google UK (www.goggle.co.uk) for a diagnosis of the second group of five simulated cases (all posterior eye conditions).

The other six students were instructed to use their key words to search Aston e-Library only for a diagnosis of the first group of five simulated cases (all posterior eye conditions) and then to use their key words to search Aston e-Library and Google for the second group of five simulated cases (all anterior eye conditions).

The study took place in a computer lab with two of the authors (FE and HB) present throughout. The students did not know the diagnoses in advance and all had the same education. They were allowed to use search terms individually, all three together or any combination of pairs. This was not monitored or recorded. Google does not suggest a diagnosis, so students were asked to select one diagnosis that best fit the case. All participants had received instruction in the use of Aston e-Library from a librarian experienced in using search tools prior to taking part in the study.

Subjects were instructed not to make a diagnosis based solely on the written description of the simulated case but to use one of the study search strategies as per the study protocol. Although they did have some knowledge of eye diseases, having completed two-thirds of an optometry degree program, and had received 33 hours of lectures, it is unlikely that subjects would have had the

Table 1
Anterior and Posterior Eye Conditions Making up the 10 Cases Evaluated by the 12 Participants

Case Number	Anterior Eye Condition
1	Keratoglobus
2	Marginal infiltrates
3	Dendritic ulcer
4	Chalazion
5	Capsular opacification
	Posterior Eye Condition
6	Commotio retinae
7	Lattice degeneration
8	Systemic lupus erythematosus
9	Central retinal vein occlusion
10	Coats' disease

knowledge to make an accurate diagnosis without carrying out an internet search. This is based on our knowledge of the content of the 33 hours of the anterior and posterior courses and our knowledge of the ability of the students who took part. The presence of the two authors in the computer lab would also have encouraged the participants to follow the study protocol.

Key words and diagnoses were recorded by each student on paper and collected at the end of the session. Subjects had their own computer, worked alone contemporaneously and took between two and three hours to complete the task. The time it took to make each diagnosis was not noted. The diagnoses from the participants were then compared with those in the textbook.

In order to determine if academic performance correlated with the students' ability to choose successful key words to help diagnose the conditions, end of second year overall percentage marks were compared with each of the search methods (Aston e-library plus Google and Aston e-library only) using Pearson's correlation.

Results

Twelve final-year optometry students with a mean (±SD) end of second year overall percentage mark of 63.34 (±5.32) and a range of 50.12 to 75.00 participated. An average end of second year mark of 50 is poor, while an average of 75 is excellent. The average end of second year mark for our group (63.34) was similar to the average of whole year group (65.00). Each subject considered all 10 cases.

In total, subjects used Aston e-Library only to consider 60 simulated cases and Aston e-Library plus Google to consider 60 simulated cases. Use of Aston-e-library only resulted in a correct diagnosis in 16 out of 60 simulated cases and use of Aston e-Library plus Google led to correct diagnosis in 31 out of 60 simulated cases. The authors also noticed a difference between anterior and posterior conditions. The Aston e-library group did worse than the Aston e-library plus Google group in determining the correct diagnosis for the anterior segment conditions (4 vs. 15 correct diagnoses respectively) while for the posterior segment conditions they were closer (12 vs. 16 correct diagnoses respectively). See **Table 2** for a breakdown of the results by participant, condition and search type. No correlation was found between mean end of second year percentage mark and correct diagnosis with Aston e-Library only ($r = 0.149$, $p < 0.05$) or Aston e-Library plus Google ($r = 0.446$, $p < 0.05$).

Figure 1
Examples of Extracted Signs and Symptoms Information

Three examples of the symptoms and signs as extracted by FE from Kanski and Menon,[7] instructions provided to each participant, and the key words used by the students. The examples are keratoglobus, marginal infiltrates and central retinal vein occlusion. Each triplet of key words is from one student.

Example 1

Symptoms

Vision is quite poor from induced myopic astigmatism and glare is a significant problem.

Signs

The corneal diameter may be increased and the cornea is thinned throughout. Maximal thinning is usually in the mid-periphery. There may be scattered deep stromal abnormalities but no iron deposition lines present. The anterior chamber is characteristically very deep. Hydrops can occur.

Key words used by students in the order they were written by each student: thinned cornea, deep anterior chamber, poor vision-corneal thinning, mid-periphery, poor vision-astigmatism, hydrops, thinning-myopic astigmatism, glare, anterior chamber-corneal thinning, hydrops, deep anterior chamber-corneal thinning, deep anterior chamber, myopic astigmatism-myopic astigmatism, corneal thinning, glare-myopic astigmatism, stromal abnormalities, hydrops-corneal thinning, hydrops, myopic astigmatism-myopic astigmatism, corneal thinning, hydrops-glare, hydrops, induced myopic astigmatism-myopic astigmatism, hydrops, corneal thinning.

Example 2

Symptoms

Patients complain of photophobia, slight ocular irritation, increased lacrimation, red eye and slight blurring of vision. Recurrences are common. Involvement is usually unilateral.

Signs

The lesion is usually unilateral and typically found in the inferior paralimbal cornea with a 1- to 2-mm clear area of uninvolved cornea between the lesion and the limbus. Lesions may be multiple and grey to white in color. They are typically rounded, approximately 1 mm in diameter and involve the superficial stroma. There is usually a small overlying epithelial defect. The adjacent conjunctiva is usually slightly injected and inflamed. The anterior chamber is usually quiet or with only a trace of cells and flare.

Key words used by students in the order they were written by each student: unilateral vision loss, inferior paralimbal cornea-superficial stroma-unilateral lesion, cornea, photophobia-round, superficial stroma, lesion-lesion, paralimbal cornea, photophobia-photophobia, corneal lesion, red eye-conjunctival injection, stromal lesions, unilateral-red eye, multiple grey lesion, superficial stroma-photophobia, ocular irritation, blurring of vision-photophobia, red eye, rounded lesions-paralimbal cornea, unilateral lesion, photophobia-red eye, multiple grey lesions, photophobia-paralimbal lesion, red eye, inflamed conjunctiva

Example 3

Symptoms

Unilateral sudden painless loss of vision.

Signs

Dilated and tortuous veins, flame, dot-and-blot hemorrhages, retinal edema and cotton wool spots. Later signs may include hard exudates, macular edema and neovascularization.

Key words used by students in the order they were written by each student: unilateral, sudden, painless loss of vision-sudden loss of vision, tortuous retinal veins, dot-and-blot hemorrhages-sudden, painless, loss of vision-hemorrhages, edema, unilateral-unilateral vision loss, tortuous veins, hemorrhages-unilateral, hard exudates, macular edema-sudden loss of vision, cotton wool spots, retinal edema-unilateral, dilated and tortuous veins, hemorrhages-unilateral vision loss, retinal hemorrhages, tortuous veins-cotton wool spots, retinal edema, hard exudates-tortuous veins, dot and blot hemorrhages, hard exudates-dot and blot hemorrhages, hard exudates, painless loss of vision.

Instruction to Participants

Select three key words from the signs and symptoms provided. You can list paired words, e.g., red eye, and use them in your search as if it were one word. Use all your key words (or paired words) together when you search for the diagnosis.

Table 2

Breakdown of Results by Participant, Condition and Search Type
(√ represents a correct diagnosis; X represents an incorrect diagnosis)

Anterior Eye Conditions	Students 1 to 6 used Aston e-library only						Students 7 to 12 used Aston e-library + Google						Aston e-Library only no. of correct diagnoses	Aston e-Library + Google no. of correct diagnoses
	1	2	3	4	5	6	7	8	9	10	11	12		
Keratoglobus	X	√	X	X	X	X	X	X	X	X	X	X	1	0
Marginal infiltrates	X	X	X	X	X	X	X	X	X	X	X	√	0	1
Dendritic ulcer	X	X	X	√	X	X	X	√	√	√	√	√	1	5
Chalazion	X	X	X	X	X	X	√	√	√	√	√	√	0	6
Posterior capsular opacification	X	X	X	√	√	X	X	X	X	√	√	√	2	3
	Total no. correct anterior eye condition diagnoses												4	15
Posterior Eye Conditions	**Students 1 to 6 used Aston e-library + Google**						**Students 7 to 12 used Aston e-library only**							
	1	2	3	4	5	6	7	8	9	10	11	12		
Commotio retinae	X	√	X	X	X	√	X	X	X	X	X	X	0	2
Lattice degeneration	√	√	X	√	√	√	X	X	√	X	√	√	3	5
Systemic lupus erythematous	X	X	X	X	X	X	X	X	X	X	X	X	0	0
Central retinal vein occlusion	X	X	√	√	√	√	√	X	√	√	X	√	4	4
Coat's disease	√	√	√	√	X	√	X	√	√	√	√	√	5	5
	Total no. correct posterior eye condition diagnoses												12	16
	Sum of total no. of correct anterior and posterior condition diagnoses/60												16	31

Discussion

Our aim was to determine if Google could aid optometry students in the diagnosis of eye conditions. The use of Aston e-library plus Google when compared to Aston e-library alone increased the number of correct diagnoses from 16/60 (26.7%) to 31/60 (51.7%). This was independent of previous academic performance. In other words, there was no relationship between academic ability and the ability to make a correct diagnosis using symptoms, signs and either of our search strategies. This is in agreement with other studies where computer skills and choosing appropriate key words were important.[2,3]

All the students who took part in the study were in year 3 of a 3-year BSc Optometry program with a mean (±SD) end of second year overall percentage mark of 63.34 (±5.32) and a range of 50.12 to 75.00. The overall percentage mark refers to their average mark from all their year-2 modules. These modules cover instrumentation, vision science and research methods, primary eye examination, contact lenses, ophthalmic optics and clinical visual biology. The study was conducted in December, half way through the teaching element of year 3. Year-3 modules include anterior and posterior eye disease topics. We do have some students in the total year group (115) who had a high overall year average (75-80%) and others with a low overall year average (45-50%). Our range (50 to 75%) shows that we had a variety of students with a range of academic ability that reflected the spread in the total year group. Furthermore, the end of year average for the whole year group (115 students) was 65%. These figures are similar to those from other optometry year groups at our university and to those at other UK optometry schools and probably reflects a UK marking style which is likely to be different from that in North America. It is our opinion that the students who volunteered to take part in this study were of a wide academic range and that there is unlikely to be inherent bias in the dataset due to the students who participated.

Our correct diagnosis percentages are lower than Tang and Ng's result of 58% correct diagnoses[2] from 26 cases when using Google. This is not surprising since Tang and Ng allowed three to five search terms per case while our subjects were limited to three in order to complete the study within a reasonable time period.[2] Furthermore, in the Tang and

Ng study participants chose the three most likely diagnoses that seemed to fit the symptoms and signs provided for each case and if one of those was correct the search was regarded as successful.[2] Our subjects were limited to making one diagnosis as in our opinion this related better to the real-world clinical setting.

Siempos et al. used the same 26 cases as Tang and Ng and asked four physicians and four non-physicians to select three potential diagnoses for each case.[5] If one of the three diagnoses was correct, the search was regarded as successful. The physicians had a 50.9% (95% CI 37.4-64.5%) success rate, which is broadly similar to that found in the current study. However, as in the Tang and Ng study,[2] differential diagnosis encompassing three possibilities has a many times greater chance of hitting on the right diagnosis than a single attempt.

Our subjects worked on 10 simulated cases while those in the Tang and Ng and Siempos et al. studies[2,5] worked on 26 actual cases. It is not clear how the success rate of our participants would have been affected by a greater number of cases and whether the fact that our cases were simulated made any difference to our findings.

A difference in diagnosis success rate between anterior and posterior conditions was noted. The Aston e-library group did worse than the Aston e-library plus Google group for the anterior segment conditions (4 vs. 15 correct diagnoses respectively) while for the posterior segment conditions they were closer (12 vs. 16 correct diagnoses respectively). The cause of this is not clear to us. Students had approximately the same exposure during their education (year 1, year 2 and 11/24 weeks in year 3) to the anterior and posterior conditions that were used in the study. This difference in success rate between anterior and posterior conditions could relate to a difference in the teaching skills or styles of the faculty who lectured on anterior and posterior segment conditions or it may simply have occurred by chance.

Google will be useful in developing countries where internet access is likely to be easier and cheaper than purchasing an up-to-date medical textbook. Google is free and without registration although some of the sites found by Google may require subscription. A person who is not affiliated to a large medical center or university will benefit from the availability of, and quick access to, research material from a knowledge base that is increasing. With the advent of smartphones and tablet devices, a convenient computer is not required to access Google, just internet connectivity. In a recent comparative study of the usability in obtaining medical and health information of four popular internet search engines, Google had the best search validity in terms of whether a website could be opened.[9]

The number of people with internet access is increasing and thus patients and not only physicians may have access to medical information. Giustini asked: "Is an observer who can accurately select the findings to be entered in a Google search all we need for a diagnosis to appear?"[6] Our response to this question is no. The efficiency of the search is determined by the choice of key words and this will depend on the experience of the practitioner. Our third-year optometry students had a basic level of experience. An experienced practitioner more efficient at selecting key words and at identifying key documents from the Google search is likely to have a better diagnosis rate.

An outcome that emerged from this study is the need to be able to identify key words that will aid in web-based diagnosis. Training in this area has been incorporated into our optometry program and computer software that allows second-year students to practice investigating and managing virtual patients using standard computer systems has been developed. Part of the investigation aspect involves choosing key words from signs and symptoms generated by the software for each virtual patient. Evaluation of this software is being undertaken and will be published as part of a PhD thesis in 2015.

Falagas et al. noted that internet sources are more useful in uncommon cases than for ordinary diagnostic problems where a good medical background is likely to be sufficient.[3] The authors agree with Giustini, who advocated the use of a Google search tool (Google Scholar) in addition to PubMed, Web of Knowledge and/or Cochrane in searches for clinical trials and systematic reviews and Google alone where quick diagnosis is required.[5]

In terms of future work, it would be interesting to repeat the study using experienced qualified practitioners and also to determine the patient's perception of a clinician's ability if Google is used in front of them and to evaluate this in an educational and practice setting. Furthermore, as the determination of key words is critical in the success of Google as a diagnostic tool, the authors plan additional studies to examine the analysis of key words in relationship to success of diagnosis or the clinical reasoning used by students to determine key words.

Finally, it is our opinion that while it is reasonable for modern eyecare practitioners to be familiar with internet resources, make proper use of them, and to be as up-to-date as possible, clinical experience cannot be substituted but only complemented by the internet.

Conclusion

Google is a useful aid in helping optometry students improve success rate when diagnosing eye conditions. This is independent of previous academic performance. Skill in choosing key words from clinical cases is important when using internet search engines to aid clinical diagnosis. Training in selecting key words should be part of the optometry degree curriculum. Further research using a similar protocol with experienced eyecare practitioners and another study investigating the patient's perception of the use of Google as a diagnostic aid is planned.

References

1. Greenwald R. … And a diagnostic test was performed. N Engl J Med 2005;353(19):2089-90.
2. Tang H, Ng JHK. Googling for a diagnosis-use of Google as a diagnostic aid: internet based study BMJ 2006;333(7579):1143-1145.
3. Falagas ME, et al. Do PubMed and Google searches help medical students and young doctors reach the correct diagnosis? A pilot study. Eur J Intern Med 2009;20(8):788-90.

4. Twisselmann B. Use of Google as a diagnostic aid: summary of other responses. BMJ 2006;333(7581):1270-1.
5. Siempos II, et al. Non-physicians may reach correct diagnoses by using Google: a pilot study. Swiss Med Wkly 2008;138(49-50):741-5.
6. Giustini D. How Google is changing medicine. BMJ 2005;331(7531):1487-8.
7. Steinbrook R. Searching for the right search-reaching the medical literature. N Engl J Med 2006;354(1):4-7.
8. Kanski JJ, Menon J. 2003. Clinical Ophthalmology. 5th ed. London: Butterworth Heinemann.
9. Wang L, et al. Using internet search engines to obtain medical information: A comparative study. J Med Internet Res 2012;14(3):e74.