WHAT IS TELEMEDICINE AND HOW IS IT RELEVANT TO NEURO-OPHTHALMOLOGY?

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LEARNING OBJECTIVES
1. Describe the spectrum of telemedicine interactions
2. Understand the basic questions that must be addressed to develop a useful telemedicine system
3. Identify challenges to implementing telemedicine systems for neuro-ophthalmology

CME QUESTIONS
1. True/False: Telemedicine is possible only with the use of high-speed electronic connections allowing real-time interactions.
2. True/False: Patients do not like telemedicine because it detracts from the face-to-face doctor-patient relationship.
3. True/False: Data security requires active identification of potential problems and frequent adaptation to new threats.

KEYWORDS
1. Telemedicine
2. Asynchronous
3. Store-And-Forward
4. Teleconsultation
5. Data Security

INTRODUCTION
Telemedicine is not a separate discipline but rather a description of techniques and processes used to facilitate communication amongst healthcare professionals as well as between a remote provider and a patient. While the majority of current telemedicine efforts are very image-dependent, much wider deployment of teleconsultation may be accomplished either in real time or by store-and-forward technologies. The impending shortage of neuro-ophthalmologists may be addressed in part by making better use of telemedicine to expand the reach of our specialty and allow more effective triage of referred patients, increasing the yield of “positive” cases that present in person for evaluation.

The concept of telemedicine was popularized in the 1950s with the advent of widespread broadcast television in the developed world. Through the 1960s to the mid 1980s, a number of efforts to develop telemedicine systems were funded by national governments, in hopes of providing access to care in remote and underserved areas. Unfortunately, most of these early efforts failed to establish durable systems beyond the initial periods; cost, technological challenges, and resistance to change all contributed to the lack of long-term success. The main exception was teleradiology, in part because Medicare payment for this consultation service was authorized despite the lack of a face-to-face encounter [1]. Interest in telemedicine has burgeoned in the past 20 years with availability of high-speed photographic and video capabilities, and it is the visually-oriented specialties that have both expended the most effort and shown the greatest promise and results to date in using telemedicine not only to improve access but also to enhance quality of care beyond what can be delivered using the traditional medical system.

As defined by the American Telemedicine Association,

Telemedicine is the use of medical information exchanged from one site to another via electronic communications to improve patients’ health status. Closely associated with telemedicine is the term “telehealth,” which is often used to encompass a broader definition of remote healthcare that does not always involve clinical services. Videoconferencing, transmission of still images, e-health including patient portals, remote monitoring of vital signs, continuing medical education and nursing call centers are all considered part of telemedicine and telehealth.”

http://www.americanantelemed.org/i4a/pages/index.cfm?pageID=3333

This very broad definition captures several of the important considerations in approaching telemedicine. Patient care and clinical interactions via telemedicine raise the most complex issues of privacy, accuracy, compliance, and reimbursement. Nonetheless, rapid expansion of telemedicine systems into technology-driven specialties such as cardiology and intensive care has occurred with some success. Ophthalmology and other “visually oriented” specialties have been at the forefront of telemedicine efforts given our dependence on images for diagnosis. Telemedicine for education offers a tremendously powerful means of distributing medical care.
knowledge to large numbers of professionals who would be otherwise unable to access the information. Substitution of telemedicine conferences has even been proposed as a way of conserving resources and combating possible global climate change[2], although the overall effect of a wholesale change in how we conduct medical education is significantly more complex, as the authors acknowledge. Restrictions on pharmaceutical representative visits to physicians’ offices have led, in part, to increased use of “e-detailing” and third-party survey methods for dissemination of new drug and device information. With the wide array of methods included under the umbrella of telemedicine, it is important to recognize characteristics of the various techniques that will affect the immediacy, thoroughness, and long-term effects of their results. Several questions should be answered before starting any telemedicine effort that involves clinical care (these issues are less critical or relevant for education alone):

- What is the purpose of the interaction (screening, diagnosis, monitoring)?
- Who will collect the data (patient alone, paraprofessional, physician)?
- Will the telemedicine interaction occur in realtime? If not, what is the expected window for receiving a response?
- How is the remote opinion or interpretation communicated to the patient? Who is responsible for implementing any changes based on the opinion?
- How will security and privacy of the data be maintained?
- Will the data be stored for future patient care use (i.e. monitor disease progression or resolution) and future consultation as well?

WHY USE TELEMEDICINE?
It may not be obvious why a telemedicine system should be used for a particular purpose, since the equipment and techniques lend themselves to a variety of use. Screening and diagnosis have been the two main areas of use relevant to ophthalmology and neurology; ongoing monitoring of chronic disease states as well as inpatient monitoring are used much less frequently by neuro-ophthalmologists. In fact, most neuro-ophthalmologists will find telemedicine useful primarily for diagnosis of disease in a patient located in an area that lacks direct neuro-ophthalmic care. Logistics are somewhat easier in this case, as it is the patient’s physician or other health care professional who determines when the patient needs a teleconsultation, unlike like screening programs where patients need to be recruited and drawn into the system for evaluation.

DATA COLLECTION
Costs and reimbursement are covered in a separate syllabus section, but the cost for acquiring and maintaining ophthalmology telemedicine equipment can be substantial if sophisticated imaging devices are to be used. Creating a system that is designed to capture only the essential data may be preferable from a cost perspective, and to minimize complexity. Images and other data may be acquired by a non-ophthalmologist or neurologist, and having very specific protocols for image and other data acquisition will improve quality and reproducibility. Coordination between the referring physician and an ophthalmologist may be needed because of imaging requirements.

TIMING OF ANALYSIS (REALTIME VS. STORE-AND-FORWARD)
Evaluation of patient data may occur with real-time interaction (synchronous) or with review in a more consultative fashion (asynchronous)[3]. In early telemedicine projects, synchronous data review was limited by both the cost of data transmission and the low resolution and fidelity of the data exchanged. Because many efforts were specifically targeted at remote image interpretation, the quality of the image was more important than immediacy, and thus asynchrony was usually accepted to allow for more accurate and detailed image transmission and review. Cost and bandwidth limitations can still impact modern projects, as data transmission from remote locations may happen across robust, but low throughput, cellular systems or even satellite telephone. Reliability for synchronous systems must be extremely high, and dedicated, hard-wired network systems are recommended for clinical care purposes. A key example is the teleintensive care model listed below; while one could envision a physician monitoring ICU data from any location including a home office, almost all systems in place require the physician to be present physically in a facility that is set up specifically for the ICU monitoring and to use only the devices provided there. Data security is also preserved in this way.

Asynchronous data interpretation permits a much broader range of devices and data transmission systems to be used. At one end of the spectrum, email with or without attached ancillary data can be the equivalent of a “curbside” consultation. This concept has been tested by a number of organizations, in particular the US military, as a means of improving clinical care and reducing costs through triage of non-urgent cases. In both ophthalmology[4] and neurology[5], accuracy of diagnosis has been improved by the use of teleconsultation, and unnecessary evacuation of non-urgent casualties from remote foreign facilities to a major medical facility in Germany or the United States has been avoided. Mobile devices are very well suited for asynchronous telemedicine because network connectivity cannot always be assured, but when data can be received and transmitted, high quality imaging can be displayed, and a timely response by the consultant may be provided by telephone, email, or designated web form completion. Since many mobile devices use wireless networks that are either unsecured or have weak encryption, data security is a concern and must be addressed systemically.

COMMUNICATION BETWEEN PROFESSIONALS AND THE PATIENT
Since most teleconsultations and other telemedicine procedures do not occur in realtime, a process must be in place to ensure that the consultant’s opinions are relayed
to the referring provider and that timely implementation of the recommendations occurs. Alerts to the consulting professional by email or text message, creation of a daily or weekly conference to review the results (perhaps by live interaction without the patient present), or other systems are needed. Similarly, patient notification of the results and need for changes to the diagnostic or therapeutic plan, especially if they involve transporting the patient to the consultant’s location for testing and/or procedures, should be done as quickly as possible once the results of the consultation are known. Limited air or land evacuation facilities may be available, and consolidation of cases is ideal.

DATA SECURITY AND PRIVACY
Even before passage of the Health Insurance Portability and Accountability Act (HIPAA) in the United States, telemedicine researchers and practitioners were forced to consider ways to protect patient information from improper disclosure and/or use. Early data transmission systems lacked encryption, and patient anonymity or privacy was maintained by stripping identifying information from the dataset. For clinical care, strong data encryption both on the transmitting and receiving devices as well as in transmission is required, and penalties for improper disclosure remain high in the US. Password protection of devices and systems may not be adequate because of the possibility for data to become misdirected or willfully intercepted en route. Most medical imaging systems do not incorporate encryption and are typically not password protected at the device level, and medical device data standards have understandably been developed with compatibility and simplicity rather than security in mind. Using strong encryption also may not be possible when conducting some international or multinational projects because of export restrictions on data encryption technology.

DATA STORAGE
With increased adoption of electronic medical records, it will be important to integrate telemedical consultation results as well as the imaging and other data into the patient’s overall health record. To date, most telemedicine systems have been self-contained for research purposes or existed within an email or similar framework, leaving it up to the consulting professional to determine which portions of the data are transferred into the “regular” clinical record. If the volume of such consultations is to increase and gain wider acceptance, then a more structured approach to handling the information needs to be developed to avoid data loss and needless repetition of studies.

TELEMEDICINE OUTSIDE OF OPHTHALMOLOGY
Teleradiology has established itself as a standard subcategory of radiology service. Initially promoted by the military, it has gained popularity because it allows for round-the-clock review of imaging studies with costs distributed among a number of institutions subscribing to the service. It provides a means of taking an asynchronous service and making it nearly synchronous; most services include telephone or immediate email or chat communications between the onsite professional and the remote radiologist[6]. Remote image interpretation has met with resistance in some academic institutions (including ours), especially from surgeons, because some clinicians feel uncomfortable making care decisions based on reports from radiologists they do not know personally. Local credentialing of the remote physicians and re-review of the images by hospital staff radiologists may seem intellectually unnecessary or redundant but provide reassurance for patients and staff alike.

Remote intensive care unit monitoring allows one physician to provide oversight at a number of facilities and to relay real-time (synchronous) interpretations to onsite personnel. Outcomes research indicates that remote monitoring may improve adherence to best practice guidelines and reduce the risk of adverse events such as ventilator-associated pneumonia and central line-associated bloodstream infections[7]. Thus, although a primary goal of televitalsist coverage has been to improve care at small community hospitals that cannot afford a full-time physician, a beneficial effect may be seen regardless of the site chosen. Telecardiology benefits from similar monitoring and analytic technologies, with the goal of early identification of myocardial infarctions and life-threatening arrhythmias before (at home) or during hospital transport via ambulance[8].

Home monitoring techniques with data transmission to either primary care or specialty professionals have been proposed for management of common chronic diseases including hypertension and diabetes. Widespread adoption of these methods has not yet occurred, although some longstanding programs in specific communities have provided measurable benefits for objective outcomes such as HgbA1C[9] and systolic blood pressure[10].

TELE NEURO-OPHTHALMOLOGY
The potential application of telemedicine in neuro-ophthalmology was suggested more than 10 years ago[11], and while ophthalmology has embraced telemedicine and been at the forefront of technological development, telenurology has been slower to take hold[12]. The scarcity of neuro-ophthalmologists outside of major cities and academic medical centers makes telemedicine an especially attractive means of providing consultation services. As discussed in the section on reimbursement, the potential for clinical payment to the consultant does exist when synchronous interaction with the patient via videoconferencing occurs. In addition, such services will generate in-person consultations and diagnostic services that cannot be provided by telemedicine (i.e. specialized neuroimaging or ophthalmic imaging, detailed neurological examinations, electrophysiological tests, and others) and referrals to specialists in related disciplines (neurosurgery, otolaryngology, rehabilitation). The principles of telemedicine stated above are also applicable here, in particular the prevention of needless travel for specialty care that could be provided locally with appropriate guidance from the subspecialist. As neuro-ophthalmologists often are
able to use their experience to interpret imaging and laboratory studies in the context of the patient’s disease, they can provide these services remotely and asynchronously. Many academic medical centers have established “second opinion” mechanisms that serve as teleconsultation systems through which referring physicians can advocate for their patients.

The future of neuro-ophthalmology consultation could include innovative telemedicine techniques, such as remote monitoring of chronic disease such as pseudotumor cerebri via home-based collection of weight information, visual fields, and fundus imaging (see other talks for technology developments that may allow such images to be acquired), similar assessment of multiple sclerosis patients by evaluating realtime or stored eye movement recordings, and determination of ocular perfusion pressures in the fellow eye of patients with NAION. While none of these techniques will be available in the near future, technology is being created that makes them highly likely to be feasible within the next decade. As an example, in 2003, transmission of video information at speeds beyond 384 Kbits/sec was extremely costly and considered prohibitive; even homes now routinely access information at speeds beyond 25 Mbits/sec (nearly 100 fold faster).

EDUCATIONAL TELEMEDICINE
Not surprisingly, this technique enjoys widespread popularity and acceptance because fewer reimbursement/payment issues and no patient care issues are involved. In ophthalmology and neurology, the major clinical research journals and/or their affiliated “throwaway” publications have online quizzes or cases that can be answered in a competitive forum or for CME credit. The American Academy of Ophthalmology has established the O.N.E. (Ophthalmic News and Education) Network that contains peer-reviewed educational videos and courses and also permits discussion amongst members within topical forums. NANOS maintains NANOSNET, an email-based discussion group for any interested neuro-ophthalmologists and related professionals, and the NOVEL (Neuro-Ophthalmology Virtual Education Library) hosted by the University of Utah contains a wealth of video and pictorial resources on a variety of topics. The American Academy of Neurology offers a searchable digital library of images and instructional materials. All of these services are popular because they are either given at no cost or as a member benefit. Webinars with or without speaker interaction have attracted smaller audiences, in part because they do not provide the flexibility of large online collections. An exception in ophthalmology (and other surgical specialties) is live surgery sessions, where the audience can interact with the surgeon while he/she is operating, although this practice has met with some controversy given the potential that the surgeon could be distracted from the procedure and even end up not putting the patient’s needs first in a teaching arena. A number of independent entities have also launched online ophthalmology or neurology educational services, mainly as a means of review for board examinations. Reflecting concerns about the Internet as a whole, the quality and accuracy of the information provided may be difficult to determine.

CME ANSWERS
1. False
2. False
3. True

REFERENCES
INTERACTIVE CASE:
SCREENING FOR DISEASE BASED ON PRESENTING SYMPTOMS

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LEARNING OBJECTIVES

1. The attendee will be able to describe situations in which telemedical screening for ophthalmic disease would improve the medical management of patients

2. The attendee will be able to list advantages of the use of non-mydriatic fundus photography via telemedicine within neuro-ophthalmology

3. The attendee will be able to list barriers to the use of non-mydriatic fundus photography via telemedicine in the emergency department and other non-ophthalmic settings

INTRODUCTION

Telemedicine in ophthalmology was initially directed at improved screening for sight-threatening disease in at risk populations, e.g., retinopathy of prematurity and diabetic retinopathy. More recently, fundus photography has been applied to patients with general medical complaints, such as headache and hypertension, to evaluate for findings indicative of more severe, and in some cases life-threatening, illness. A case is presented to illustrate the tele-medical use of fundus photography in the evaluation a headache patient presenting to the emergency department (ED).

CASE

A 28-year-old known migraineur presents to the ED complaining of a severe, throbbing headache for two days. Further questions reveal that this headache is “different” than usual, but certainly not the worst headache she has ever had. The emergency physician attempts direct ophthalmoscopy, but he is unable to perform it. However, non-mydriatic fundus photographs were taken at triage by a nurse and are available for review on the electronic medical record (EMR). The remainder of her examination, including a complete screening neurological examination, is normal. Non-contrast computed tomography of the head is read as normal. The emergency physician reviews the fundus photographs and notes what he suspects is mild optic disc edema, but is unsure. An ophthalmology consult is called, but the consultant is at another ED evaluating an open globe trauma and unable to immediately see this patient in person. The ophthalmologist remotely logs into to the EMR and reviews the photographs, confirming that the patient indeed has mild optic disc edema, and makes additional recommendations for testing, including for the patient to have an in-person examination and formal visual field testing in her office the following day. An MRI and MRV of the head with and without contrast are obtained and show a cerebral transverse sinus thrombosis without infarction. Opening pressure on lumbar puncture is 36 cm of CSF and the contents are otherwise normal. Neurology admission is arranged.

DISCUSSION

In this case, a severe underlying diagnosis would have likely been missed without the availability of non-mydriatic photography as an alternative to direct ophthalmoscopy.

CME QUESTIONS

1. True/False: Telemedical availability of non-mydriatic fundus photographs taken in the emergency department can assist with the evaluation of patients with certain symptoms.

2. True/False: Tele-ophthalmology can replace in-person consultation in many cases.

3. True/False: It would likely to be a relatively simple process to create a workflow within a local emergency department to screen appropriate patients with non-mydriatic fundus photography and to provide the photographs for remote review.

KEYWORDS

1. Telemedicine
2. Headache
3. Non-Mydriatic Fundus Photography
4. Screening
5. Emergency Department
Telemedicine allowed the ED physician to receive confirmation regarding his suspicion of optic disc edema, provided confidence to the emergency physician and patient regarding the additional evaluations performed, and comforted the consultant that unnecessary testing was not being recommended in the face of inadequate information. While non-mydriatic ocular fundus photography combined with telemedicine cannot replace in-person ophthalmologic consultation, it is an excellent adjunct to ophthalmologic consultation in settings such as the ED. It can be particularly helpful in rural areas and large urban areas where ophthalmologists frequently cover multiple hospitals, allowing for more effective triage of patients as in our case.

The Fundus Photography vs. Ophthalmoscopy Trial Outcomes in the Emergency Department (FOTO-ED) study has demonstrated that ED physicians performed direct ophthalmoscopy on only 14% of patients who presented to the Emory University ED with complaints and conditions warranting ocular fundus examination (headache, acute focal neurologic deficits, visual changes, and severely elevated blood pressure) [1, 2]. Among the 350 patients enrolled during the first phase, 13% had a finding with relevance to their ED management and disposition, such as papilledema or grade III/IV hypertensive retinopathy. In addition, more than 60% of these funduscopic findings were identified solely by non-mydriatic ocular fundus photography obtained by nurse practitioners and reviewed by neuro-ophthalmologists [1, 2]. The FOTO-ED study also found that fundus photography could be integrated into the ED workflow and is well liked by patients and the ED staff.[2]

Most recently, the FOTO-ED study has found that ED physicians without any additional training are substantially better at finding abnormalities using non-mydriatic ocular fundus photographs than with direct ophthalmoscopy (correctly identifying 46% of the abnormalities with photographs vs. 0% with direct ophthalmoscopy [3]). While one can only expect that further training will improve ED physician’s ability to using ocular fundus photographs, it is also likely that telemedicine will be a critical supplement to the use of these photographs by non-ophthalmic physicians.

However, there remain several practical issues that must be studied further before the more widespread deployment of these methodologies. For example, how are these system deployed within the workflow of various ED and hospital structures? How are the technical issues resolved so that photographs can be entered into the EMR or another secure system in the face of numerous incompatible software packages currently in use? Finally, how are billing and medico-legal concerns worked out?

CME ANSWERS
1. True
2. False
3. False

REFERENCES
INTERACTIVE CASE:
ACUTE STROKE REAL-TIME TELE-CONSULTATION

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LEARNING OBJECTIVES

1. The attendee will be able to list advantages and disadvantages of real-time telemedicine compared to store-and-forward methods.
2. The attendee will be able to list some common structures for telemedicine networks.
3. The attendee will be able to describe emerging technologies that can assist with neuro-ophthalmic telemedicine.

CME QUESTIONS

1. True/False: Dedicated teleconsultation software must be used to perform real-time telemedicine.
2. True/False: Over 90% of telestroke programs are built on a “spoke & hub” model.
3. True/False: The top barriers to telestroke network development given by current providers were regulatory and financial.

KEYWORDS

1. Telemedicine
2. Dizziness
3. Stroke
4. Real-Time
5. Video Oculography

INTRODUCTION

Real-time telemedicine, which allows the patient and clinician the opportunity to interact face-to-face, is perhaps best developed in the area of acute stroke consultation. However, the organizational, technical, educational, financial, and regulatory barriers seen in other areas of telemedicine remain limitations in the further expansion of telestroke. Developing technologies, such as portable, quantitative video-oculography may improve bedside examination of the ocular motor system, improving the sensitivity for certain types of infarctions, particularly of the posterior fossa. The current state of acute stroke telemedicine and future possibilities are discussed.

CASE

A 34-year-old man is brought by EMS to a rural emergency department 20 minutes after the acute onset of dizziness and difficulty walking. The hospital to which the patient presents does not have either acute stroke services or rapid access to neurology consultation. However, the hospital is part of a stroke telemedicine network which provides 24-hour on-call consultation with a stroke neurologist at the nearest university hospital via real-time video teleconferencing and teleradiology. The network is activated, and the patient receives a non-contrast computed tomography (CT) of the head, while the consult is arranged. The patient is evaluated by the stroke specialist over video teleconference assisted by local staff. The examination is notable for lack of skew, nystagmus (not direction changing), and a broad-based gait. The National Institutes of Health Stroke Scale (NIHSS) is zero. The CT scan is reviewed by the stroke specialist through a teleradiology system. Because the stroke specialist is still concerned about a posterior fossa infarction, the stroke specialist asks the staff to place a portable video-oculography device on the patient to quantitatively measure the horizontal head impulse test (h-HIT) [1]. Reviewing the results the stroke specialist finds that the h-HIT is normal and is now extremely concerned about the possibility of a cerebellar stroke [2]. The patient is immediately transferred to the university hospital for close observation and for further diagnostic studies and treatment.

DISCUSSION

In this case, real-time teleconsultation was performed using a combination of standard teleconferencing equipment and a teleradiology system between a small rural “spoke”
hospital’s emergency department and a stroke specialist at a large university “hub” hospital. This model is commonly used to evaluate acute strokes for the potential administration of tissue plasminogen activator (tPA) in regions where there is limited access to specialty care [3, 4].

In our scenario, a newly-developed video-oculography device was also used to qualitatively test the h-HIT. The device described in our case was recently used in an early, proof-of-concept study [1] that examined eleven patients with acute vestibular syndrome and definitive neuroimaging. The patients were able to tolerate the test well and reported good comfort. Performance of the HINTS (head impulse, nystagmus, test of skew) [2] battery using the video-oculography device arrived at the correct diagnosis (stroke vs. peripheral vestibular) in all patients.

There is substantial evidence regarding the benefit of real-time video-telestroke programs in improving the outcomes of patients compared to the administration of tPA by local physicians with limited stroke expertise or by the use of telephone consultation only [4]. A recent survey of telestroke programs in the U.S. identified 97 potential programs across 43 states with 56 of these 97 programs reporting that they were active [3]. Thirty-eight programs participated in the survey. Almost all (95%) of the programs were organized as distant spokes around a regional hub hospital providing the teleconsultation and the average number of spokes were 7.8 in 2009. However, other models existed such as remote hospitals that had the ability to transfer patients to hub hospitals for critical care but contracted with for-profit telemedical companies for consultations. Of note, only 44% of the programs used dedicated teleconsultation software. The top 3 clinical needs met by the telestroke programs were emergency department consultation (100%), patient triage (83.8%), and inpatient teleconsultation (46.0%), while the top 3 barriers they listed were inability to obtain physician licensure (27.77%), lack of program funds (27.77%), and lack of reimbursement (19.44%). So, while telestroke is widespread and quite well developed in the U.S., similar organizational, technical, educational, financial, and regulatory burdens faced in other arenas of telemedicine also hamper the advancement of telestroke programs.

In the future, robots[5] may be used to act as the hands of the examining neurologist providing direct tactile feedback so that he or she can check reflexes and feel the motor power in a patient’s limb. It may also be possible to automatically analyze the results of the h-HIT and other aspects of the oculomotor examination without interpretation by an expert. So, perhaps surprisingly, there are aspects of our care that may transition through a period of telemedicine before transitioning back to in-person evaluations because of even more advanced technologies. How could real-time teleconsultation transform neuro-ophthalmology?

CME ANSWERS
1. False
2. True
3. True

REFERENCES
INTRODUCTION
Telemedicine is an emerging technology in which health care providers deliver remote care to patients using telecommunications. This has potential to improve accessibility, quality, and cost of ophthalmic care. This talk will review key types of telemedicine, along with potential benefits and challenges of implementation. We will discuss characteristics of diseases that are amenable to telemedicine diagnosis, and will summarize evaluation data on applications of telemedicine in an example disease: retinopathy of prematurity (ROP). This will include discussion of the diagnostic accuracy and reliability of remote image interpretation by experts, the cost-effectiveness of telemedicine, and potential barriers to implementation. General principles will be drawn from these specific examples.

RETINOPATHY OF PREMATURITY: BACKGROUND
Retinopathy of prematurity (ROP) is an ophthalmic disease in which telemedicine has been studied extensively. In this talk, ROP will be used to provide examples of general principles regarding telemedicine implementation and evaluation. ROP is a vasoproliferative retinal disorder affecting low birth weight infants. Treatment criteria for severe disease, using laser photocoagulation and cryotherapy, have been established through the Cryotherapy for Retinopathy of Prematurity (CRYO-ROP) and Early Treatment for Retinopathy of Prematurity (ETROP) trials.1,2 ROP diagnosis has been supported by an international disease classification system.3 Nevertheless, ROP continues to be a leading cause of treatable childhood blindness in the United States and throughout the world. There are many logistical challenges to providing optimal ROP care: (1) Examinations require specialized training and are typically performed by retinal specialists or pediatric ophthalmologists, who may not be readily available in rural and other areas. (2) Infants typically receive multiple examinations at regular intervals, requiring coordination of care between ophthalmologists and neonatal intensive care unit (NICU) staff. (3) The precise documentation of examination findings, which traditionally relies on hand-drawn pictures with annotation of zone, stage, extent, and presence of plus disease, is somewhat subjective and may be a source of medico-legal liability. (4) There is a growing shortage of physicians who manage ROP. A 2006 American Academy of Ophthalmology survey found that only 54% of retinal specialists and pediatric ophthalmologists are willing...
to manage ROP, and that over 20% plan to stop because of concerns such as poor reimbursement, logistical difficulty, and medico-legal liability.

Telemedicine has the potential to address some of these challenges associated with current ROP management and quality of care. In store-and-forward telemedicine programs for ROP, wide-angle retinal images would likely be captured by trained neonatal personnel using commercially-available cameras (RetCam; Clarity Medical Systems, Pleasanton, CA) for subsequent grading by a remote ophthalmologist. This could improve travel time for ophthalmologists, logistical coordination with neonatal staff, and accessibility to expert care for patients. Serial retinal imaging may offer a more objective method for documentation of disease findings and progression. In addition, widespread retinal imaging for ROP would provide opportunities to create digital libraries for educational and research purposes. This could potentially improve the uniformity of ROP diagnosis. Retinal photography might also cause less physiologic stress to infants than ophthalmoscopy with scleral depression. Of note, digital retinal imaging has been successfully utilized in other pediatric retinal conditions such as retinoblastoma and shaken baby syndrome.

CASE A
A 1 month-old premature infant in the neonatal intensive care unit (NICU) requires examination for retinopathy of prematurity. The NICU is 15 minutes away, and the examining ophthalmologist considers performing the examination using telehealth screening. What validation is required to establish that the diagnosis can be made accurately?

DISCUSSION OF CASE A: BARRIERS TO IMPLEMENTATION OF TELEMEDICINE SYSTEMS
Although there are important potential benefits of telemedicine, there are key barriers that must be addressed before these systems can be implemented successfully. Appropriate diseases and telemedicine strategies must be identified. The accuracy and reliability of remote diagnosis must be established through clinical studies. Telemedicine systems must be shown to be acceptable by patients and clinicians. Logistical problems regarding convenience, scheduling, workflow, medico-legal liability, technology, privacy, and security must be solved. Finally, the cost-effectiveness of telemedicine systems must be established. Overall, evaluation studies must be designed and conducted to address these questions.

DISCUSSION OF CASE A: SUMMARY OF EVALUATION STUDIES IN ROP
A recent American Academy of Ophthalmology (AAO) technology assessment reviewed the published literature involving evaluation studies of remote diagnosis in which review of wide-angle retinal images was compared to a gold standard of indirect ophthalmoscopy by experts. There were 18 published studies from 2000-2010, involving 10 independent patient cohorts. Seven of these studies (including 458 infants total) were rated Level I evidence: sensitivity was 76-100% for remote diagnosis of type 2 (moderate) or worse ROP, and 87-100% for remote diagnosis of type 1 (severe) or worse ROP. Specificity for remote diagnosis of type 2 and type 1 or worse ROP was 37-98% among those Level I-rated studies. Three of those studies (including 1462 infants total) were rated Level III evidence: sensitivity was 100% for remote diagnosis of type 1 (severe) or worse ROP, and specificity was 99-100% for remote diagnosis of type 1 or worse ROP.

DISCUSSION OF CASE A: WHAT IS THE GOLD STANDARD FOR TELEMEDICINE DIAGNOSIS?
In most evaluation studies within ophthalmology and other fields, the accuracy of telediagnosis is compared to a reference standard of clinical examination by an expert physician. However, it is not clear that this represents a true gold standard. This section will illustrate these points using representative studies involving retinopathy of prematurity (ROP).

The gold standard for ROP examination is considered dilated indirect ophthalmoscopy by an expert. In principle, these clinical examinations should be rigorously standardized because of the international classification system developed by expert consensus during the 1980s that defined clinical parameters such as zone, stage, and plus disease. Based on multi-center NIH-sponsored clinical trials, presence of plus disease (arterial tortuosity and venous dilation greater than or equal to that of a standard published photograph) and zone I disease (peripheral ROP located within a circle with diameter equal to twice the disc-to-macula distance) are the most critical clinical features which define severe treatment-requiring disease. However, ophthalmoscopy is technically challenging because of infant movements and limited examinations from labile infants. Paper-based documentation of retinal findings from indirect ophthalmoscopy may also be less objective and subject to observer variation. An epidemiological study in Australia and New Zealand suggested that the varying rates of ROP incidence across geographical regions may result from observer bias. A clinical study to directly examine the accuracy of serial
DISCUSSION OF CASE B: EVALUATION STUDIES

- **Acceptability by parents:** One published study described a questionnaire that was developed from existing psychometric instruments for telemedicine evaluation, and validated by internal consistency and by using factor analysis to identify sub-domains representing different underlying concepts. Fifteen questions were developed, each scored on a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree). This was administered to 42 parents of infants who received ophthalmoscopic exams and imaging for an ROP telemedicine study. Five questions were related to imaging: the highest-rated was “digital pictures of my child’s retinopathy should be included in the permanent medical record” (4.4/5.0), and the lowest-rated was “digital cameras and computers are reliable” (3.8/5.0). Ten questions were related to telemedicine: the highest-rated were “overall, technology will improve the quality of medical care for my child” (4.3/5.0) and “it is essential to meet face-to-face with my child’s doctor” (4.3/5.0), and the lowest-rated was “I am worried sending these pictures electronically will create risks for the privacy of my child’s medical information” (2.6/5.0).

- **Cost-effectiveness:** One published study developed a cost-utility model involving decision analysis methods, evidence-based outcomes, Medicare reimbursements, present value modeling, and sensitivity analysis. This showed that telemedicine is more cost-effective than standard ophthalmoscopy for ROP management ($3193/QALY vs. $5617/QALY).

- **Speed of examination:** One published study described a time-motion analysis in which the time required to perform ROP diagnosis by three ophthalmologists was compared using ophthalmoscopy vs. telemedicine. This showed that telemedicine was significantly faster than standard ophthalmoscopy for ROP diagnosis (1-2 minutes/exam vs. 4-6 minutes/exam).

CME ANSWERS

1. False
2. True
3. d

REFERENCES


indirect ophthalmoscopy by multiple examiners on the same infants has never been conducted, and might be impractical because of concerns about infant safety.12

Scott et al. performed a study that controlled for interphysician variability by examining ophthalmoscopic and telemedical examinations of 67 infants by the same graders. There was substantial to near-perfect agreement in these diagnostic modalities, with absolute agreement of 86% (178/206 eyes) and kappa of 0.66-0.85 between ophthalmoscopy and telemedicine.13 Among the 14% (28/206 eyes) discrepancies in this study, some cases provided photographic documentation suggesting that ophthalmoscopic examination may have missed signs of mild ROP. In addition, there were several discrepancies between presence of zone I ROP and presence of plus disease, in which telemedicine may have provided the theoretical advantages of allowing examiners to review their diagnoses, make more exact measurements of anatomical landmarks defining zone I of the retina, and directly compare images to the standard photographic definitions of disease.13

Furthermore, research has suggested that there may be significant variability in ROP diagnosis, even among experts.14-15 During ophthalmoscopic examinations in the multi-center CRYO-ROP trial, 12% of eyes diagnosed with treatment-requiring “threshold disease” by one study-certified expert were diagnosed with less-than-threshold disease by a second certified expert who was asked to perform a confirmatory examination.16 The second examiner was unmasked to the fact that the first examiner had diagnosed threshold ROP, and this level of disagreement may have been even higher in the setting of a fully masked study design. A study of image-based plus disease detection found that 22 experts agreed on the same diagnosis (plus vs. not plus) in only 21% (7/34) of images, and that the mean kappa for each expert compared to all others was 0.19-0.66.14 Compared to a reference standard defined as the diagnosis selected by a majority of experts, the sensitivity of those 22 experts for plus disease diagnosis ranged from 0.31-1.00 and the specificity ranged from 0.57-1.00.14 Widespread retinal imaging, with subsequent development of image libraries and computer-based tools for diagnosis of plus disease based on quantitative vessel properties, might result in improved consistency.

CASE B

A 1 month-old premature infant in the neonatal intensive care unit (NICU) requires examination for retinopathy of prematurity. The NICU is in a rural area, approximately 4 hours from the nearest medical center. There is no qualified ophthalmologist locally who is willing to perform ROP screening examinations. Telehealth may be the best option for performing these examinations. What are other issues required for telehealth implementation? In particular, will parents be willing to see a virtual ophthalmologist? Will the speed and workflow be adequate for ophthalmologists? Will this system be cost-effective?


DOLLARS AND SENSE: BILLING, CODING AND REGULATIONS

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LEARNING OBJECTIVES
1. To understand the qualified services, practitioners, and sites for telemedicine as defined by The Centers for Medicare and Medicaid Services (CMS)
2. To recognize the regulatory issues of licensure, credentialing and privileging, and risk management that are specific to telemedicine in the United States
3. To know the general reimbursement structure for telemedicine via Medicare

CME QUESTIONS
1. True/False: Under Medicare, even if an originating site is located within a Metropolitan Statistical Area, as long as it is a rural site, it is considered an eligible location for Telemedicine services and Medicare reimbursement.
2. True/False: The correct billing procedure modifier for real-time/interactive telemedicine services is GT.
3. Which of the following statements is TRUE:
   a. Congressional passage of the Balanced Budget Act of 1997 was progressive legislation in allowing for store-and-forward methods of telemedicine, utilization of non-physicians (e.g. registered nurses) as presenting providers to the consultant, and equal reimbursement to both referring and consulting providers.
   b. Congressional passage of the Medicare, Medicaid, and SCHIP Benefits Improvement and Protection Act of 2000 was highly restrictive and limited in scope and led to the contraction of telemedicine services in the United States.
   c. The Center for Medicare and Medicaid Services (CMS) adopted as its final ruling in 2011a progressive and forward measure in providing the ability for originating sites to credential and privilege providers at distant sites via “privileging via proxy” methods.
   d. Each of the 50 states in the U.S. can provide limited telemedicine licensure for out-of-state physicians.

KEYWORDS
1. Telemedicine
2. Regulatory Issues
3. Reimbursement
4. Billing

INTRODUCTION
Telemedicine as defined by the Institute of Medicine of the National Academy of Sciences is the use of electronic information and communication technologies to provide and support health care when distance separates its participants. This can include live, interactive video conferencing between patient and provider or through asynchronous means such as store-and-forward methods where a provider at the patient site can capture diagnostic information to be retrieved and interpreted by a remote site clinician at a different time. In the United States, while various forms of communication have been utilized over the last forty years for providing health care at a distance, it has largely been within the last fifteen years when passage of key federal legislation has led to the expansion, utilization and reimbursement of telemedicine. In many instances, telemedicine services are covered benefits, billable by governmental programs and private payers. Topics to be covered here include the regulatory and reimbursement issues surrounding telemedicine services in the United States as defined by the Centers for Medicare and Medicaid Services (CMS).

MEDICARE: ELIGIBLE LOCATIONS, SERVICES, AND PROVIDERS
The Centers for Medicare and Medicaid Services (CMS) administers Medicare programs in the United States and is the national health insurance program for people age 65 or older, individuals with disabilities, or people with end-stage renal disease. Under Medicare, telemedicine coverage can include remote patient face-to-face services seen via live video conferencing, non face-to-face services that can be conducted either through video clips or store-and-forward telecommunication services, or home health care services under specific regulations. Medicare defines the originating site is the location of the patient at the time the medical service is provided via a telecommunication system. The distant site is where provider of the medical service is located at the time of the telemedicine service. For reader reference, a glossary of telemedicine terms as it relates to...
regulatory issues is available at the end and those terms are bolded throughout the text. Medicare covered telemedicine services with the CPT codes are listed in Table 1.

For remote patient face-to-face interactive services, the service must be provided to an eligible Medicare beneficiary in an eligible facility (see below) located outside of a metropolitan area. There is no restriction on the location of the health professional delivering the medical service at the distant site, but the patient must be located either in a rural Health Professional Shortage Area (HPSA), a rural county which is a county that is not a Metropolitan Statistical Area (MSA), or an entity that participates in a Federal Telemedicine demonstration project. If the county is considered rural (non-MSA), any location in the county is considered to be a reimbursable patient site. If the county is considered urban (MSA), patient sites in that county are ineligible for telemedicine reimbursement, no matter how remote an individual area within that county may be, unless the remote site is located in a HPSA. An eligible facility for an originating site authorized by law include offices of physicians or practitioners, hospitals, Critical Access Hospitals (CAH), Rural Health Clinics (RHC), Federally Qualified Health Centers (FQHC), Hospital-based or CAH-based Renal Dialysis Centers and its satellites, skilled nursing facilities (SNF), and community mental health centers (CMHC). Qualified practitioners who may furnish and receive payment for covered telemedicine services include physicians, nurse practitioners, physician assistants, nurse midwives, clinical nurse specialists, clinical psychologists, and clinical social workers.

**REGULATORY ISSUES**

**LICENSURE**

For physicians providing telemedicine in the same state where they hold a license, regulations for practicing telemedicine would be the same as the delivery of routine face-to-face medical care. However, with telemedicine and the delivery of medical services across state lines, this issue becomes more complex and is determined by each individual state. Currently, 10 states (Alabama, Louisiana, Minnesota, Nevada, New Mexico, Montana, Ohio, Oregon, Tennessee, Texas) provide either a special purpose license, certificate, or process for physicians practicing telemedicine from out-of-state locations. The remaining states require a physician to obtain a medical license in the state they wish to practice telemedicine. Federally-employed physicians (i.e. in Veterans Administration facilities) or active-duty military physicians are exempt from these licensure restrictions based on longstanding regulations allowing them to practice in Federal facilities in any state as long as they hold an unrestricted license in one jurisdiction.

**CREDENTIALING AND PRIVILEGING**

There have been significant regulatory changes in recent years regarding the credentialing and privileging of telemedicine providers. In July 2011, CMS issued their final rule permitting hospitals to credential and grant clinical privileges to a telemedicine provider based upon the credentialing and privileging decisions of another entity who provides the telemedicine services as long as the distant site telemedicine entity’s credentialing and privileging process meets or exceeds CMS standards. Thus, if it so chooses, the hospital where the patient is located is no longer required by CMS to independently credential and privilege each telemedicine provider who treat its patients.

The origin of this credentialing and privileging process dates back to 2004, when the Joint Commission revised its 2001 standards to allow telemedicine practitioners to be credentialed and privileged by proxy. For many small, rural hospitals, “privileging by proxy” has been the only way they can provide telemedicine services as they often lacked the resources and clinical expertise to credential all the specialty telemedicine providers. This allowed the originating site hospital to rely on the credentialing and privileging decisions of the distant site hospital, with the only requirement that the distant-site was accredited by the Joint Commission. Under these former standards, the originating–site hospital was not even required to grant clinical privileges to each individual, such that the provider could be permitted to practice based on a contract between the originating and distant site hospital.

CMS disagreed with the Joint Commission’s approach and felt it was in direct conflict with the Medicare Conditions of Participation (CoPs). CMS felt that telemedicine practitioners were providing a “medical level of care” and thus must be individually credentialed and privileged by each originating site hospital. CMS was concerned that nothing bound the telemedicine provider to comply with Medicare’s CoPs for hospitals. In 2008, via Congress’ passage of the Medicare Improvements for Patients and Providers Act (MIPPA), hospitals accredited by the Joint Commission were no longer “automatically deemed” as meeting the Medicare CoPs and “privileging by proxy” was no longer permitted. While the Joint Commission revised its telemedicine standards to be compliant with CMS requirements, it continued to lobby for “privileging by proxy.” In 2010, CMS published proposed telemedicine credentialing regulations such that the originating site hospital was allowed to rely on information only from a Medicare-participating distant site hospital. This restrictive proposal would not allow information provided by entities other than Medicare-participating hospitals.

However, in response to comments received by the restrictive proposed ruling, CMS’ final decision in 2011 essentially adopted the Joint Commission’s method of “privileging by proxy,” with the change that the telemedicine providers be bound by Medicare’s CoPs. While each hospital may continue to fully credential and privilege telemedicine providers through their own protocol, they now have the option of the more streamlined process via proxy. In addition, CMS took an additional step in their final ruling, recognizing that non-Medicare entities provide critical contributions to the delivery of telemedicine services, including teleradiology,
teleICU, and teleneurology, such that CMS now allows these entities to be included in the optional streamlined credentialing process with the originating site hospitals.5

RISK MANAGEMENT CONSIDERATIONS
The main guiding principle of telemedicine and risk management is to utilize the same standard of care that one would apply if the patient were in one’s office or facility. Sources that may help define standard of care include professional associations (AMA, AAO and AAN), licensing boards and peer reviewed studies. While some state licensing boards do not mention telemedicine specific requirements, others have established comprehensive standards for practicing telemedicine. Physicians practicing telemedicine should know what is expected by all relevant medical and state licensing boards where they provide care.

In addition, one needs to ensure that the technology available is sufficient for the medical evaluation. Various professional organizations publish standards for technologies. The American Academy of Child and Adolescent Psychiatry (AACAP) published their parameters for telepsychiatry, which includes a thorough discussion of the process of establishing a telemedicine practice.6 The American Telemedicine Association (ATA) has published general practice guidelines with technology standards as well as specialty-based guidelines for dermatology, ophthalmology, mental health, and pathology.7

As part of meeting the standard of care in any telemedicine encounter, the distant site provider must be able to confirm that the person requesting treatment is in fact the patient and have a plan in place to verify the location of the patient. This may be accomplished by simply asking the patient at the outset of the session to verify their identity and location. Alternatively, if one needs to independently verify the source and location of the originating site, some technologies may allow for geolocation of the patient via global position systems. Also, the treating distant site provider will need to obtain the patients’ informed consent for treatment via telemedicine including a discussion of the limitation of telemedicine. It is advisable for telemedicine providers to familiarize themselves with the emergency resources available at the patient’s location, understand how to activate them and the general response times for such services. Other important questions to address regarding the role of the distant site provider include: “Who will be prescribing medications?” “Who will be providing follow-up care?” and “How will laboratory tests be obtained and interpreted?”

Having an actively collaborating local physician available at the patient’s originating site is the best approach to satisfying clinical and legal concerns. Not only can this provider verify the patient’s identity and location, but also they can provide same-day prescriptions, follow-up care, immediate intervention in urgent situations, and restore lost abilities (smell, touch) during the clinical exam. Lastly, providers should have a contingency plan in place in the event of a technological failures.8

PRIVACY AND SECURITY
The Health Insurance Portability and Accountability Act of 1996 (HIPAA) required the U.S. Department of Health and Human Services (HHS) to develop regulations protecting the privacy and security of certain health information.9 HHS fulfilled this requirement through publishing what are commonly referred to as the HIPAA Privacy Rule and the HIPAA Security Rule.10 The Privacy Rule (or Standards for Privacy of Individually Identifiable Health Information) established national standard for the protection of health information. The Privacy Rule applies to protected health information (PHI) which can be information in any medium, related to the individual’s health, treatment or payment that identifies the individual in any way. The Security Rule establishes national standards specifically for the security of electronic health care information. The Security Rule specifies a series of administrative, technical and physical security procedures for covered entities to use to assure the confidentiality of electronic health information and only applies to electronic protected health information.11

In regards to telemedicine, the HIPAA Privacy Rule would be applied similar to how it is utilized by covered entities (health care provider, health plan or clearinghouse) and business associates (person or entity who on the behalf of the covered entity performs a function involving the use or disclosure of individually identifiable health information including claims processing, billing, utilization review and practice management) with routine face-to-face encounters with patients in the protection of their identifiable protected health information.

There are, however, some unique aspects of telemedicine and the HIPAA Security Rule worth highlighting. With the Security Rule, the safeguards with electronic PHI include authentication, access controls, audit controls, integrity controls, work station security, transmission security, and breach notification. Many vendors and manufacturers may market their technology and products with the term “HIPAA compliant” and that can be misleading. A distinction needs to be made regarding HIPAA compliance versus HIPAA compatible. HIPAA applies only to covered entities and business associates, so non-covered entities such as technology vendors and manufacturers do not have any liability under HIPAA. Practitioners and providers needs to be HIPAA-compliant. Covered entities need to ensure that the technologies utilized are compatible with HIPAA standards and should never rely on the claims of HIPAA compliance by third parties.12

Another important consideration with the HIPAA Security Rule is the use of web-based platforms (i.e. Skype) in providing telemedical services. Many of these platforms are proprietary and thus, covered entities do not have access “behind the wall” to reliably develop and verify an audit trail, obtain notification when a breach of information has occurred, verify transmission security and ensure integrity controls. There are also concerns how information is stored on these free web-based platforms. While the federal government has no official position on the use of these platforms, telemedicine legal experts feel they do not meet HIPAA security regulations and do not recommend using them.13
REIMBURSEMENT
Until the last decade, public and private payers did not have specific policies regarding payment for telemedicine services. As a result, reimbursement has been limited and haphazard with private and public payers reluctant to reimburse for telemedicine services on par with face-to-face services.\(^1\)

Historically, Medicare has paid for telemedicine services that did not require face-to-face interaction with the patient, including teleradiology and telepathology. However, consultations and office visits required being face-to-face with the patient in order to be eligible for reimbursement. The passage of the Balanced Budget Act (BBA) of 1997, however, led to significant changes in Medicare payment policies for telemedicine reimbursement, requiring implementation of these telemedicine provisions by January 1, 1999.\(^1\) While the BBA provided an excellent forward step in telemedicine services and reimbursement, in practice there were many restrictions that limited telemedicine utilization and expansion. For instance, under the BBA, only services to patients in federal-designated HPSAs were considered eligible for reimbursement. This overlooked patients with access to primary care providers, but not to specialists. In addition, BBA covered “interactive consults” via a limited set of CPT codes. Consultations could be for new or established patients in outpatient clinic settings and limited reimbursement only to encounters where the patient was present. Hence, “store and forward” consults with asynchronous transmission of medical information to be reviewed at a later time by a physician at a distant site did not fall under an “interactive consultation.” Also, under the BBA, eligible practitioners included the referring practitioner or the consulting practitioner. In order to be paid, the referring practitioner was generally required to be present during the consultation. These restrictions did not reflect the reality and practice of telemedicine in rural areas, where often the referring practitioner was unavailable, leaving only “ineligible” providers such as registered nurses or licensed practical nurses to be present. This rendered the consult ineligible for payment. Another challenge under the BBA was that the referring and consulting practitioners were required to fee share for the teleconsult: 25 percent to the referring provider, 75 percent to the consulting provider. Split fees were problematic on multiple fronts, including accounting and fee tracking difficulties to the IRS and consultants refusing to accept 75 percent of their normal fee for a consult.\(^1\) By September 2000, nearly 22 months into the program, Medicare had only reimbursed $20,000 for 301 telemedicine claims.\(^1\)

At the end of 2000, Congress passed the Medicare, Medicaid, and SCHIP Benefits Improvement and Protection Act (BIPA) which eliminated the fee sharing and telепresenter requirements, allowed originating sites to be paid a facility cost fee, expanded telemedicine services to include direct patient care, physician consultations and office psychiatry services, permitted “store- and-forward” use for Hawaii and Alaska, included payment for the distant site provider at a rate generally provided for such a service, and expanded the types of eligible presenters, CPT codes and geographic area limits eligible for reimbursement.\(^1\)

These changes via BIPA, in large part, reflect Medicare’s current reimbursement for telemedicine services and are explained in greater detail below.

ORIGINATING SITE REIMBURSEMENT
Currently, the originating site receives a flat reimbursable rate, outside of any other reimbursement arrangement such as inpatient diagnosis-related group (DRG) or RHC per-visit payments. The billing code for the originating site facility fee is HCPCS code Q3014, “telehealth originating site facility fee.” The provider or office that serves as the originating site bills the Medicare Carrier or A/B Medicare Administrative Contractor (MAC) for the facility fee.\(^1\) The payment amount is updated on a calendar year basis as part of Medicare’s Physician Fee Schedule annual update. For calendar year 2012, the facility fee payment amount is 80% of the lesser of the actual charge amount or $24.24.\(^2\)

DISTANT SITE REIMBURSEMENT
Medicare reimbursement for the distant site provider is the regular Medicare reimbursement amount for the service. The distant site provider submits the claim for telemedicine services using the appropriate CPT or HCPCS code for the professional services along with the telehealth modifier “GT,” for live interactive telemedicine. By coding and billing the GT modifier with the covered telehealth procedure code, the consultant is certifying that the beneficiary was present at an eligible originating site when the telehealth service was provided. In the situation of a Federal telemedicine demonstration program conducted in Alaska or Hawaii, the claim would be submitted using the appropriate CPT or HCPCS code for the professional service along with the telehealth modified “GQ,” for store-and-forward applications.\(^2\)

Distant site practitioners bill the Medicare Carrier or A/B MAC for the covered telemedicine service. The provider is paid the appropriate amount under the Medicare Physician Fee Schedule (PFS) for the telemedicine service.

STORE-AND-FORWARD
Store and forward telemedicine services are only permitted in federal demonstration programs currently conducted in Alaska and Hawaii.\(^2\)

MEDICAID
In contrast to Medicare, Medicaid leaves it to the states to decide if telemedicine services are eligible for reimbursement. The Center for Telehealth and e-Health Law (CTeL) completed a 50 state survey, reviewing each state’s telehealth reimbursement policies and found that 39 states have some type of reimbursement for telehealth services.\(^2\)

PRIVATE PAYERS
There are a growing number of states enacting telehealth parity statutes, requiring health insurers to pay for services provided via telehealth in the same way they would for services provided in-person. Currently, there are 15 states that
have signed legislation requiring health insurance providers to recognize claims for health services delivered by telemedicine. The following states with telehealth reimbursement legislation include: California, Colorado, Georgia, Hawaii, Kentucky, Louisiana, Maine, Maryland, Michigan, New Hampshire, Oklahoma, Oregon, Texas, Vermont, and Virginia. With the increasing number of state legislatures passing telehealth parity statutes, the expectation in the decade ahead is that utilization of telemedicine will continue to grow with the greater availability of telemedicine reimbursement.

TELEMEDICINE BEYOND THE UNITED STATES

CANADA

Given Canada’s large, vast territory, the government has recognized the importance of developing telemedicine in order to reach all citizens. In 2003, the First Ministers’ Accord on Health Care Renewal outlined the development of telemedicine as a priority, especially for care in the rural and remote regions. Currently, the federal government has invested $108 million in the Canada Health Infoway for telehealth projects, and nearly all jurisdictions have taken advantage of this funding. The Health Council of Canada released in June 2012, its “Progress Report 2012: Health care renewal in Canada,” which describes in detail the latest telemedicine outreach projects throughout the country. The use of telemedicine has grown by 35% annually over the past five years and is projected for further growth. In 2010 alone, there were nearly 260,000 telemedicine events held, including approximately 94,000 in rural or remote regions. There were approximately 80 different types of telemedicine clinical services provided across Canada, with mental health services accounting for more than half of the consultations, followed by internal medicine and oncology. The Progress Report notes that the next step involves transforming these many successful pilot telemedicine projects into sustained initiatives. In addition, most of the emphasis has been on parity between jurisdictions, not necessarily improvements in healthcare delivery. Other considerations for the future include moving Canadian telemedicine beyond primary care and further improve access to specialists. The 2012 Progress Report can be accessed at (http://healthcouncilcanada.ca/tree/ProgressReport2012_FINAL_EN.pdf) and an appendix to the report detailing each province/jurisdiction’s telemedicine initiatives can be accessed at (http://healthcouncilcanada.ca/tree/ProgressReport2012_Profiles_FINAL_EN.pdf).

MEXICO

In recent years, the Mexican Ministry of Health created the National Center for Health Technology Excellence for the purpose of developing a framework to implement a national public policy related to e-health and telehealth. An update from 2011 indicates that they are currently working on developing best practice guidelines and standards, creating a legal and bioethical framework for telemedicine practice, and coordinating with other institutions regarding regulatory issues of telehealth. Goals mentioned include providing telehealth services in all thirty-two states, developing teleradiology, and providing tertiary medical care to Mexicans in rural regions. More information in Spanish can be accessed through the National Center for Health Technology website (http://www.cenetec.salud.gob.mx/).

GLOSSARY

Benefits Improvement and Protection Act (BIPA): federal act of 2000 that significantly altered Telemedicine services as covered by Medicare

Business Associate: (as defined by HIPAA) a person or entity that performs certain functions or activities that involve the use or disclosure of protected health information on behalf of a covered entity


Distant Site: site where physician or provider of the professional service is located at the time the service is provided via Telemedicine

Federally Qualified Health Center (FQHC): federal designation for a facility providing primary care and other services to underserved population. (http://www.census.gov/population/metro/data/maps.html) To locate a FQHC (http://findahealthcenter.hrsa.gov/Search_HCC.aspx)

GT: Real-time/interactive Telemedicine billing procedure modifier

GQ: Store and forward Telemedicine billing procedure modifier

Health Professional Shortage Area (HPSA): as designated by the federal Health Resources and Services Administration (http://hpsafind.hrsa.gov/)
HIPAA (Health Insurance Portability and Accountability Act of 1996): Title II of HIPAA the portion pertinent to the establishment of national standards for electronic health care transactions as well as provisions for the security and privacy of health data. The Privacy Rule regulates the use and disclosure of protected health information by covered entities. The Security Rule was issued in 2003 and complements the Privacy Rule by dealing specifically with security safeguards for the use of electronic protected health information.

Medicaid: U.S. health program for certain people and families with low incomes or with people with certain disabilities that is jointly funded by the state and federal governments, but managed by the states.

Medicare: Federal program that guarantees access to health insurance for Americans ages 65 and older, younger people with disabilities and individuals with end-stage renal disease. Part A coverage includes inpatient care in hospitals, nursing homes, skilled nursing facilities and critical access hospitals. Part B coverage includes medically necessary doctor’s services, outpatient care and other services (physical, occupational therapy and some home health services). Part C (Medicare Advantage Plan), combines Part A and Part B through private insurance companies approved by Medicare to provide this coverage. Part D is the prescription drug coverage insurance provided by private companies approved by Medicare.

Metropolitan Statistical Area (MSA): a term used to Medicare to identify an urban county. All counties not designated MSA are considered rural. Medicare only covers telemedicine services for non-MSA areas. (http://www.census.gov/population/metro/data/maps.html)

Originating Site: location of an eligible beneficiary at the time that the Telemedicine service occurs

Originating Site Facility Fee: payment amount for eligible originating site which presents the patient


Store-and-Forward: Telemedicine encounter or consult that utilizes asynchronous transfer of still digital images of patient or clinical data (e.g. EKG or blood glucose levels), from one site to another for the purpose of rendering a medical opinion or diagnosis. Common use of store-and-forward services include radiology, pathology, dermatology, ophthalmology and wound care.

CME ANSWERS

1. False
2. True
3. c

REFERENCES


Service | Healthcare Common Procedure Coding System (HCPCS)/CPT Code
---|---
Telehealth consultations, emergency department or initial inpatient | HCPCS codes G0425-G0427
Follow-up inpatient telehealth consultations furnished to beneficiaries in hospitals or SNFs | HCPCS codes G0406-G0408
Office or other outpatient visits | CPT codes 99201–99215
Subsequent hospital care services, with the limitation of 1 telehealth visit every 3 days | CPT codes 99231–99233
Subsequent nursing facility care services, with the limitation of 1 telehealth visit every 30 days | CPT codes 99307–99310
Individual and group kidney disease education services | HCPCS codes G0420-G0421
Individual and group diabetes self-management training services, with a minimum of 1 hour of in-person instruction to be furnished in the initial year training period to ensure effective injection training | HCPCS codes G0108-G0109
Individual and group health and behaviour assessment and intervention | CPT codes 96150–96154
Individual psychotherapy | CPT codes 90804–90809
Pharmacologic management | CPT code 90862
Psychiatric diagnostic interview examination | CPT code 90801
End-Stage Renal Disease (ESRD)-related services included in the monthly capitation payment | CPT codes 90951, 90952, 90954, 90955, 90957, 90958, 90960, and 90961
Individual and group medical nutrition therapy | HCPCS codes G0270 and CPT codes 97802–97804
Neurobehavioral status examination | CPT code 96116
Smoking cessation services | HCPCS codes G0436 and G0437 and CPT codes 99406 and 99407

For ESRD-related services, at least one “hands on” visit (not telehealth) must be furnished each month to examine the vascular access site by a physician, NP, PA, or CNS.


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TELEMEDICINE: BEYOND REMOTE DIAGNOSIS

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LEARNING OBJECTIVES
1. Describe emerging technologies for remote patient care, including patient monitoring, home telecare, and telepresence
2. Present examples of computer-based decision support from image analysis as potential added value from clinical telemedicine systems
3. Present examples by which telemedicine can be used for testing and remote education of non-experts

CME QUESTIONS
1. True/False: Remote monitoring devices are typically used for home-based diagnosis of new disease via telemedicine.
2. True/False: Telesurgery systems have allowed surgeons to successfully perform procedures remotely.
3. True/False: Computer-based image analysis has potential to improve the accuracy and reproducibility of ophthalmic diagnosis.

KEYWORDS
1. Telemedicine
2. Biomedical Informatics
3. Clinical Research
4. Retinopathy of Prematurity

INTRODUCTION
Telemedicine refers to the use of information technologies to support health care between participants who are separated from each other.1 It has potential to improve the accessibility, quality, and cost of healthcare, and may also contribute to medical education and research. Beyond applications for direct clinical diagnosis, telemedicine principles may be applied for remote management. In addition, these systems may provide infrastructure to add value to standard clinical ophthalmic diagnosis through mechanisms such as computer-based decision support from automated image analysis. We will discuss examples from one disease (retinopathy of prematurity [ROP]) that may be generalized broadly.

REMOTE MONITORING AND HOME TELEHEALTH
Remote monitoring is a type of telemedicine that involves data capture in the patients’ homes or other areas outside clinical provider offices, with subsequent transmission for review by an expert. This strategy is based on the underlying assumptions that clinically significant changes occur between regularly scheduled patient visits, that these changes can be detected by home monitoring, and that patient care will improve if these changes can be addressed through remote management.

Unlike traditional “telemedicine,” remote monitoring strategies typically involve patients who are already known to have specific diseases. Traditionally, the most common parameters measured for these applications have included blood glucose for diabetic monitoring, spirometry for asthmatics, blood pressure for hypertensives, remote monitoring of pacemaker function, and home coagulation monitoring for patients on anticoagulation treatment. Within recent years, a variety of monitoring devices have been developed to interface with mobile devices, which subsequently transmit the data to a provider for review (“mobile health, mHealth”). Several factors limit the widespread use of remote monitoring: (1) unclear large-scale demonstrations of efficacy, (2) unclear standard for who will review the remotely-transferred data, and (3) unclear reimbursement for these services.2

Home telehealth is a related form of remote management. This may be divided into two major categories: (1) Telehome care, in which real-time video visits are conducted between providers (e.g. nurses) and patients in the home. Growth of this strategy has been spurred by incentives to reduce costs because of prospective payment for home nursing care.
These interactions are similar to visiting nurse services, in that they are often time-limited services that are intended to emphasize recovery following hospital discharge or other discrete clinical events. (2) Chronic disease management, in which real-time video conferences typically emphasize patient education for chronic diseases.²

Within ophthalmology, a pilot study involving home monitoring for early choroidal neovascularization in age-related macular degeneration has been performed at Tel Aviv Medical Center in Israel. The basis for this study is that preferential hyperacuity perimetry is a technology that has been shown to have high sensitivity and specificity for detecting early CNV during diagnostic and treatment stages. Regular use alerts retina specialists and patients of detected changes and allows patients to come in for visits when CNV begins or recurs. To maximize the benefit of recent breakthroughs in CNV treatment, patients should be better monitored with the ForeseeHome to detect new CNV while their vision is still good, and to promptly manage recurrence after treatment.³

TELEPRESENCE

Telepresence systems go beyond diagnosis, in that they permit clinicians to act remotely. For example, surgical telepresence systems allow remote surgeons to conduct two-way audio-video communications and thereby observe, teach, and collaborate with local surgeons while they operate on patients.² Other surgical telepresence systems allow surgery to be performed remotely through operation of robotic surgical instruments, along with utilization of tactile feedback systems. For example, a trans-Atlantic endoscopic cholecystectomy was successfully performed in 2001.⁴

More generally, robotic surgery systems, which are generally controlled remotely by surgeons while viewing a three-dimensional image of anatomic structures, have been commercially available since the early 2000s. It is estimated that several hundred surgical robotic systems are currently being used for routine care throughout the world. Within the United States, these systems are most often used by surgeons seated adjacent to their patients, rather than remotely. Surgeons control these robotic instruments while viewing a magnified 3-dimensional camera image of the patient’s anatomical structure – analogous to laparoscopic surgery.

The underlying motivation for promoting adoption of robotic surgery for minimally-invasive surgery is that fine-tissue manipulation (e.g. dissection and suturing) is more difficult than in traditional open surgery because of technical limitations created by rigid, hand-operated instruments passed through small incisions and viewed on video monitors. In principle, robotic surgery could provide greater surgical precision, increased range of motion, improved dexterity, enhanced visualization and improved access (http://www.intuitivesurgical.com). Potential advantages of remote robotically-assisted surgery may include smaller incisions, improved anatomic visualization, and finer control of surgical instrumentation.² Studies comparing robotically-assisted surgery with traditional surgery have suggested that outcomes are comparable, although published evidence has been limited.⁵,⁶

A critical issue for robotic surgery is haptic feedback, which relays force feedback sensations from the operative field back to the surgeon. This simulates tactile sensation, and augments the visual information displayed for surgeons by cameras. Accurate real-time force feedback requires millisecond latency. It is for this reason that remote telesurgery has been historically limited to distances under 100 miles (e.g. the endoscopic trans-Atlantic gall bladder surgery described above was likely feasible because that procedure relied almost exclusively on visual feedback to the remote surgeon, and was performed using a dedicated and custom-configured 10Mb/s fiberoptic network with a 155 millisecond latency).⁴ Providing tactile feedback over large distances actually requires providing the surgeon with simulated feedback while awaiting transmission of the actual feedback data. Such simulation requires massive computing power and is an area of active research. Finally, telesurgery of course requires extremely high-reliability connections.

One commercially-available device is the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA). This device has primarily been FDA-cleared for a range of procedures within urology, gynecology, cardiac surgery, and general surgery, and has been studied experimentally for ophthalmic surgery. It has been used for small-incision laparoscopic surgery as well as traditional open surgery.
Within ophthalmology, the da Vinci Surgical System has been used successfully in a pilot study at the UCLA Jules Stein Eye Institute for suture repair of corneal lacerations. A follow-up study involving intraocular robotic surgery using this device found that control of the robotic instruments allowed for full range of movement during 25-gauge pars plana vitrectomy. It was felt by the authors that the system provided adequate dexterity for intraocular surgery, but the kinematics of the robotic arms were insufficient for intraocular surgery. In addition, the system endoscope did not yield the same detail as an ophthalmic microscope.

Overall, the increasing availability and use of these robotic surgery systems creates possibilities for an increasing number of telesurgery applications, including within ophthalmology.

**COMPUTER-BASED IMAGE ANALYSIS: POTENTIAL ADDED VALUE TO TELEMEDICINE SYSTEMS**

Because of the potentially subjective and qualitative nature of ophthalmic diagnosis, one area of possible added value from image-based telemedicine systems in ophthalmology is development of computer-based image analysis systems as a clinical diagnostic aid. By quantifying various parameters of retinal vessels, these image analysis systems may improve the objectivity and reproducibility of diagnosis. For example, individual measurement techniques devised by Parr and Spears were used to quantify arteriolar narrowing secondary to hypertension. Hubbard developed formulas to analyze venular changes and to calculate an arteriole-to-venule ratio (AVR). Larger arteriolar and venular diameters have been associated with progression of diabetic retinopathy and hypertension, and coronary heart disease in women has been associated with a lower AVR. In ROP, several computer-based image analysis systems have been developed, particularly for detection of plus disease. These systems have been used to quantify retinal vascular parameters such as arterial tortuosity and venous dilation, and pilot studies have demonstrated that they have potential to identify plus disease with comparable or better accuracy than experts.
REMOTE EDUCATION: POTENTIAL ADDED VALUE TO TELEMEDICINE SYSTEMS

Work in ROP has demonstrated additional potential added value for telemedicine systems with regard to education and training. In particular:

• Retina fellows and pediatric ophthalmology fellows have been shown to have significantly lower diagnostic accuracy than experienced examiners, particularly for identifying clinically-significant levels of ROP.\(^\text{19,20}\) This is important because fellows often examine infants independently at academic training centers despite lack of experience, and because half of American ROP examining ophthalmologists are known to be general ophthalmologists with even less formal training in ROP.\(^\text{21,22}\)

• Areas with limited access to ROP ophthalmic care resources, even those in developing countries, often still have a strong Internet infrastructure.

• Proof of concept studies have been carried out in Mexico and Armenia (e.g. T. Lee, R.V.P. Chan, AEC) to show that in-country education, followed by regular mentored ophthalmic exams using remote image interpretation, lead to apparent improvements in diagnostic skills.

SUMMARY

Ideal diseases for telemedicine management in ophthalmology will address gaps in delivery or quality of care, will involve clinical data that is straightforward to obtain and transmit (e.g. image-based data), will be based on clinical management strategies with well-defined diagnostic standards and outcome parameters, and will be supported by thorough evaluation studies. Within the broader medical community, telemedicine strategies have been extended beyond diagnosis to involve remote disease management, home monitoring, surgical procedures, computer-based decision support using quantitative image analysis, and tele-education. There may be areas in which these methods can be applied to improve the delivery and accessibility of neuro-ophthalmology care.

CME ANSWERS

1. False
2. True
3. True

REFERENCES

LEARNING OBJECTIVES

1. The attendee will be able to list major functional areas where mobile devices can be used in neuro-ophthalmology.
2. The attendee will be able to discuss how to choose an appropriate mobile device for use in a neuro-ophthalmology practice.
3. The attendee will be able to describe types of software available and their potential application to neuro-ophthalmology practice.

CME QUESTIONS

1. True/False: Modern tablet computers are distinguished from former tablets because they generally run special mobile operating systems.
2. True/False: The marketshare of a given device plays an important role in the potential functionality of a smartphone.
3. True/False: Only anecdotal evidence is available regarding the role of smartphones in tele-neurology and tele-ophthalmology.

KEYWORDS

1. Telemedicine
2. Smartphone
3. Tablet
4. Operating System
5. Application

INTRODUCTION

When I was in medical school in 2002, I recall one of my attending physicians describing how the cellular telephone had revolutionized his on-call experience. Instead of taking his two golden retrievers on an aborted stroll because the pager rang out among the chirping birds, he could now answer the page while standing in the middle of the Chattahoochee River as his dogs played in the water. There is no doubt that this was revolutionary, and amazingly one which has come to be taken for granted, perhaps because it has become to be a burden of its own. Why? Probably because it seems that in the blink of an eye (even though it has been a decade) we not only have a phone, but an amazingly powerful computer, in our pocket. Indeed, a computer that is more powerful in many ways than the monster that occupied our offices. While nearly omnipresent connectivity to our work, friends, and family is one of the most powerful features of these devices, they can now be used increasingly to improve our work as physicians (Lord 2010) as will be discussed below.

THE DEVICES

SMARTPHONES

According to Merriam-Webster a smartphone is a cell phone that includes additional software functions such as e-mail or an Internet browser. These devices generally run special operating systems (an operating system is the software that runs the rest of your computer, e.g., Windows, MacOS X, or Linux on your desktop) that are designed for the mobile environment. Currently, the largest variety of devices are running the Android operating system that was developed by Google. However, iOS phones from Apple have a similar marketshare despite the more limited number of devices available (i.e., the iPhone) (Blodget 2012). Blackberry and Microsoft (Windows Mobile) also have their own proprietary mobile operating systems. The core functionality of the operating system may be less important than having widespread adoption of the devices you choose, as popularity drives the development of “apps,” short for applications, which are analogous to the programs that you use on your computer such as Photoshop, Word, Excel, etc. The variety of apps available for a given device tends to make it more or less useful for medical and business applications, as the operating system itself usually contains only a limited number...
of productivity apps, usually a phone, e-mail, calendar, to-do, and notes functionality. Your choice of devices also tends to be limited by what smartphones were built to be compatible with the network of a given cellular provider. For example, if you have T-Mobile, you can only use an iPhone 4 with their network in a limited fashion and with some do-it-yourself know-how combined with some basic technological expertise.

TABLETS
Tablet computers, or simply tablets, are mobile computers integrated into flat touch screens, which are larger than mobile phones, and which are interacted with primarily though a touch screen interface rather than a physical keyboard and mouse (“Tablet Computer,” 2012). Several devices that fit this definition have existed before the advent of smartphones, but they usually carried the label personal digital assistant, PDA, or palmtop computer; or they were based upon a modified desktop operating system. Instead, these newer tablet computers run a special mobile operating system, like smartphones, instead of an only slightly modified version of a desktop operating system. Tablets which run these mobile operating systems are often referred to as post-PC (i.e., post-personal computer) tablets (“Tablet Computer,” 2012). The current archetype of a post-PC tablet computer is Apple’s iPad, which runs the same operating system as the iPhone (iOS). Overall, there is the same variety of operating systems for tablets as there are for smartphones: Android, Windows Phone, and BlackBerry.

In the two years since the iPad’s release, 31% of US Internet users now own a tablet computer (Moscaritolo 2012). There are numerous other devices in this category, for example, Samsung’s Galaxy Note 10.1, Google Nexus 7, and Toshiba Excite.

Most of these devices do not have built in phone capabilities. However, if you use VoIP (voice over IP) services such as Skype these applications can be used when you are within a WiFi connection or if you have a cellular data plan for your tablet.

BLURRING THE LINE
New devices that blur the line between tablets and phones have been introduced (generally with screens in the 5–7 inch range). These devices are too large to generally carry as a phone, but are smaller and easier to hold one-handed than tablets. Categories include the mini tablet with screens generally about 6–7 inch diagonal, such as the Google Nexus 7, Samsung Galaxy Tab 7-inch, Amazon Kindle Fire, and Barnes and Noble Nook). So far, Apple does not have a device in this category although one is rumored to be planned for release in late 2012 (Paul 2012). An even smaller category that some have called phablets, typically with 5–6” diagonal screens include the Galaxy Note (and yes that is different than the Note 10.1), LG Optimus Vu, and Dell Streak.

ADD-ONS
In addition to the devices themselves, there are attachments which can be added on to these devices to assist with examination. For example, iExaminer ($179) from Intuitive Medical Technologies allows you to attach a Welch Allyn Panoptic ophthalmoscope to an iPhone 4 in order to take photographs of the posterior pole. There are similar attachments (e.g., the Keeler Portable Slit Lamp’s iPhone attachment, $195) to allow smartphones to be attached to the slitlamp although some with a steady hand are able to do it without such attachments or with homemade versions (for tips see Smart Phoneography on eyewiki.aao.org). MobiSante has an (non-ocular) ultrasound attachment for the iPhone that is FDA cleared.

THE PROS AND THE CONS
Significant advantages of mobile devices are their ultra-portability, nearly ubiquitous connectivity to other people and to information, and integration of multiple devices (e.g., phone, computer functions, camera, voice recorder, audio player) into a single device. However, that connectivity can be a double edged sword and always being “on” can facilitate an unhealthy life-work balance and burnout. The small size and relatively high value of the devices makes them prone to loss and theft and like other computers they can be prone to malware and viruses. This creates substantial security concerns regarding personal and patient data.

CHOOSING THE BEST DEVICE FOR YOU
Most people tend to carry a single device for work and for personal use. While this is convenient there may be advantages to having two separate devices if you are one who prefers to keep these two aspects of your life as separate as possible or if work provides a device for you.

DESIGN
The size and weight should be considered. How will you carry the device? In your pocket, on your belt, in a bag? How presbyopic are you? All of these factors make a difference in the ideal device for you.

CAMERA
Do you intend to take photographs at work or at play with the device? You will definitely want a camera with at least 5 megapixels, autofocus, and zoom. A good camera is a great way to make a quick note of something if you do not plan to edit it later.

CONNECTIVITY
Do you plan to use the device as a phone? Most have speakerphone, three-way conferencing, call waiting, and voice dialing, but you probably want to make sure. Will you only use the device in environments where you have WiFi connectivity or do you need to have a cellular data plan to use the device in a wider variety of settings? The latter is a particularly relevant question for tablets where one needs to purchase a tablet capable of connecting
to the cellular networks up front, and also expect the additional monthly service fees above and beyond their normal smartphone use.

**BATTERY LIFE**

Rarely is battery life an issue these days, but ensure that the device has a life that can make it through your work day, if not your entire waking day, with typical use without needing a recharge.

**ADDITIONAL FEATURES**

Additional features such as an audio player, GPS, and the availability of applications to help you do your job are each factors to consider. The more niche the operating system the fewer apps that will available for that operating system specific to the tasks we have talked about above. As of December 2011, Apple and Android had hundreds of thousands of apps available with Apple having about twice that of Android. Blackberry and Windows Mobile apps numbered in the tens of thousands. Sheer number is however not necessarily an indicator of quality.

**A HYPOTHETICAL DAY IN THE LIFE OF A 21ST CENTURY NEURO-OPHTHALMOLOGIST**

(This example will focus on free applications for the iPhone & iPad for illustrative purposes, but similar functionality is generally available for Android. Note that not all apps can be used without additional equipment/infrastructure.) Apps used are in bold.

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:45 am</td>
<td>Awake to the sound from the iPhone’s <strong>Clock</strong> alarm (by the way it makes a very reliable travel clock too!)</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Clock Alarm" /></td>
</tr>
<tr>
<td>6:46 am</td>
<td>Unplug the phone from the charger</td>
</tr>
<tr>
<td>6:47 am</td>
<td>Review e-<strong>Mail</strong> from overnight. Note that the neurology service has requested a bedside inpatient consult for a patient with subarachnoid hemorrhage. Quickly respond that you will see the patient before clinic gets started today</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Email" /></td>
</tr>
</tbody>
</table>

2013 Annual Meeting Syllabus | 413
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>7:00 am</td>
<td>Call the office using <strong>Phone</strong> and leave a message for your secretary letting them know that you will be slightly late for the first patients scheduled.</td>
</tr>
<tr>
<td>7:20 am</td>
<td>After parking, take your iPad out and start-up <strong>Citrix Receiver</strong> which allows you to connect to your hospital’s electronic medical record and begin to review the consult’s data.</td>
</tr>
<tr>
<td>7:25 am</td>
<td>Hmmm . . . what’s this Neupro the patient is taking? <strong>Epocrates</strong> tells you that it is transdermal rotigotine for restless legs.</td>
</tr>
</tbody>
</table>
7:30 am  Forgot to bring the transilluminator for the pupil check... never fear... **Flash-light** is very bright.

7:32 am  Actually, I left everything but the Panoptic back at the office. **EyeHandbook** has the testing tools.

7:50 am  A Tersons syndrome. Let’s snap a photo on our phone with our **iExaminer** application and its associated attachment to our Panoptic ophthalmoscope.
9:45 am  
“Yeah, doc, I’m on this round, red pill for my blood pressure; you know the one, right?” No, but Epocrates’ Pill ID does.

12:30 pm  
Is there time for lunch? Let’s check the Calendar.

1:05 pm  
Heading back from lunch no reason to wait to get to my desk to send off a quick e-mail use Dragon Dictation to dictate it as you walk back.

Hi Dave, I was wondering if we could meet on Tuesday, August 31 at 3 PM for a meeting regarding the research project in the emergency department. Let me know if that will work for you. Talk to you soon.
1:30 pm Patient cancelled . . . how about I pick up some CME (Medscape) and see what's new in medicine today (NEJM).

2:14 pm What's the right E&M coding level for this patient (Code My Note Basic)?

3:46 pm What's the ICD-9 code for Alzheimer’s disease (Google via Safari)? Use EyeHandbook for ophthalmic ICD-9 and CPT codes.
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td>4:38 pm</td>
<td>Review a fundus photograph from sent from the emergency department (Lamirel 2012)</td>
</tr>
<tr>
<td>6:40 pm</td>
<td>Page received. Call back and then make myself a <strong>Reminder</strong> to follow-up in the AM.</td>
</tr>
<tr>
<td>11:30 pm</td>
<td>Plug phone back in to charge still with more than 20% battery life.</td>
</tr>
</tbody>
</table>
THE EVIDENCE FOR SMARTPHONES IN NEURO-OPHTHALMOLOGY

While many of the practical benefits of improved communication and productivity are obvious, what evidence do we have that these devices can allow us to provide adequate if not better telemedical care in the neuro-ophthalmology arena? To my knowledge, only two studies have thus far assessed the capability of smartphones vs. standard desktop computers for the telemedicine in ophthalmology. The first (Kumar 2012) found that the ophthalmologists who reviewed images of patients for the telemedical diagnosis of diabetic retinopathy had very high agreement (kappa 0.9) and gave high scores to the image quality on the iPhone. Likewise, our group (Lamirel 2012) compared a five-point overall quality rating assigned by two reviewers to 100 photographs on a desktop computer and the iPhone 3G. We found very high intra- and interrater agreement on the iPhone (kappa 0.96) and high agreement between the same reviewer between the two devices (0.82–0.91). However, both reviewers on average rated the same image as higher quality on the iPhone compared to the desktop computer (chi square >36, p<0.001). On the neurology side, an agreement study of a bedside reviewers National Institutes of Health Stroke Scale (NIHSS) vs. that of a reviewer remotely directing and observing the examination with an iPhone 4 (Anderson 2011) demonstrated excellent agreement for 10 items (level of consciousness, month and age, visual fields, right motor arm, left motor arm, right motor leg, left motor leg, sensation, language, and neglect), moderate agreement for 3 items (gaze, facial palsy, and dysarthria), and poor agreement for 1 item (ataxia). The overall NIHSS scores obtained at bedside and remotely showed excellent agreement (intraclass correlation coefficient, 0.98).

THE FUTURE

The future of smartphones in neuro-ophthalmology is unclear. One can even argue that it is unclear that we will still be using smartphone 10–15 years from now. Instead, such devices may be replaced with wearable computers, such as the proposed “Google Glasses” (Google’s Project Glass, google.com/+projectglass). Even if smartphones are usurped by another revolutionary technology, there is little doubt that miniaturization and mobility will continue to drive technology. Will we have handheld non-mydriatic fundus cameras with built-in optical coherence tomography capability? Only time will tell.

It is also worth noting that mobile devices will continue to play an increasing role in our patients’ lives likely offering new avenues for patient-physician collaboration, disease monitoring and treatment, and in-home consultation.

CME ANSWERS

1. True
2. True
3. False

REFERENCES