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UTMB Hospitals and Clinics

Department of Ophthalmology
and Visual Sciences

October 31, 2000

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Magalie Roman Salas
Secretary, F.C.C.
455 12th Street, S.W.
Washington, D.C. 20554

RE: Ultra-Wide Band (ET Docket 98-153)

Dear Ms. Salas:

I'm writing on behalf of the American Telemedicine Association, where I am a Board Member, and my own personal interest in Telemedicine as the Director of Tele-Ophthalmology at the University of Texas Medical Branch in Galveston, Texas, in response to the FCC Notice of Proposed Rulemaking on ultra-wide band (UWB) radio. We would like to encourage the FCC to move forward with supporting this proceeding to make faster affordable UWB wireless networking technologies available as soon as possible. The State of Texas is 80% rural and I can foresee the tremendous potential this modality will bring to advance telehealth applications so that all Texans can have access to medical care and education. This currently is quite difficult due to the prohibitive cost of laying cable and building a network.

As a physician and a sub-specialist I can see the need for access to telemedicine specialists like me for patients who do not have access to large Medical Centers. This technology will help tremendously in this area.

For all the above reasons, I strongly urge the commission to move forward to approve the ultra-wide band products.

Sincerely,

Rosa A. Tang, M.D, MPH
Medical Director, UTMB
Director of Tele-Ophthalmology Project, UTMB
President, ICOT
Member of the Board, American Telemedicine Association

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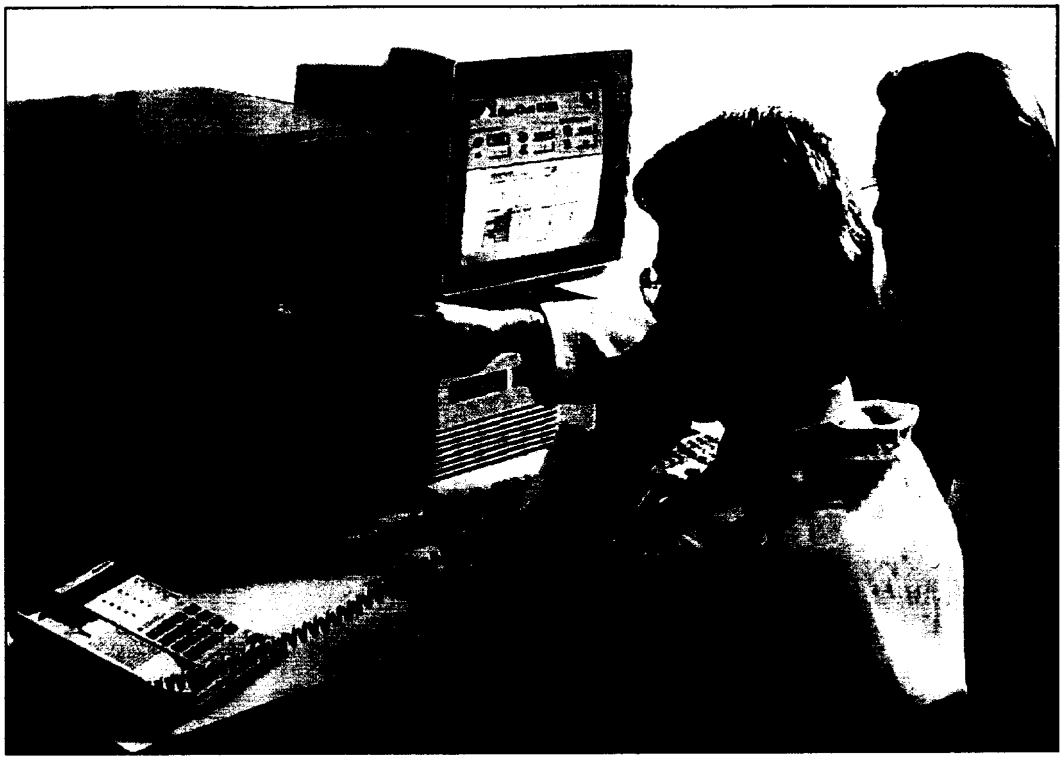

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Telemedicine Enters Eye Care: Practical Experience

Jade S. Schiffman, MD
Helen K. Li, MD
Rosa A. Tang, MD, MPH

Telemedicine as a vehicle for the delivery of eye care services is relatively new, but is well suited for certain eye care applications. In this article, we discuss our practical experience with tele–eye care prototypes in different clinical settings and emphasize ways that this health care delivery option can help to improve access to eye care for patients living in underserved areas. For eye care technical personnel, a role as either remote presenters to ophthalmic consultants or trainers of non-ophthalmic health care professionals is envisioned in this new form of health care delivery.

Eye care has an obvious, yet greatly underutilized telemedicine application. This may be because the stakes for misdiagnosing visual problems are so high and because eye care is such a specialized discipline, requiring high-resolution images.[1]

A combination of store-and-forward technology and videoconferencing technology can be used in eye care and other medical specialties.

Store-and-forward/videoconferencing technology

In eye care, *store-and-forward* capabilities for capturing still images are essential for several reasons:

- Higher resolution can be captured with still images than with video images.
- These high-resolution still images can therefore monitor various diseases (e.g., diabetic retinopathy, cytomegalovirus retinitis, or glaucoma) serially for advancement or regression.
- Images obtained by this technique do not require on-line evaluation by a consultant. They can be captured and stored at the remote site and sent either immediately or at a later time to be reviewed by a specialist at his or her convenience, thereby eliminating the logistic problems of scheduling for real-time examinations.
- Simple electronic files can be kept for tele-education.

Generally, in eye care, a *real-time system* (videoconferencing) has not been a major focus due to the importance of the resolution of still images. Tele–eye care would be limited to those subspecialties where the image alone may be the entire essence of the evaluation, rather than to subspecialties such as neuro-ophthalmology where the history and a dynamic examination are essential for diagnosis.

Because we recognize the importance of both store-and-forward technologies and videoconferencing technologies, we use a "hybrid" system (Aethra Inc., Miami, FL) that combines the two. This hybrid system uses videoconferencing hardware and software running on a Pentium personal computer with an image-capture board, and uses integrated services digital networks (ISDN) lines as the type of telecommunication line. Therefore, there can be some interaction while the high-resolution images are downloaded for review

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either during the patient's visit (e.g., the consultant may be online with the patient for the videoconferencing part of the encounter while waiting for the images to be transmitted) or before or after the videoconferencing encounter.

The store-and-forward system integrated with a videoconferencing system that we currently use (Fig. 1) allows whiteboarding and audio conversation. A window, which can be increased or decreased in size, runs on the monitor, allowing the specialist to observe and potentially direct the remote examination grossly. During a live, interactive session, the bandwidth used determines the resolution of the information presented by the remote site presenter. The consultant can also help direct the examination if necessary while online (e.g., grossly directing the angle of the slit lamp). As previously reported,[2] the videoconferencing technology can be used to "plug into" the same camera that will take the still images. This allows the consultant to see the details of what the remote site examiner is viewing (e.g., on the slit lamp). As a result, the consultant gets a more panoramic view as opposed to just a one-section slice, allowing him or her to have a better grasp of the condition. Additionally, the consultant can contribute to the decision as to what view should be captured. This image can be sent to the consultant immediately (e.g., whiteboarding). This technique provides improved resolution by capturing the image with the store-and-forward technology, thereby overcoming the degradation of the same images when low bandwidths are used. Whereas one ISDN line may be inadequate for assessing the subtleties of the pupillary examination and eye movements, full or fractional T1 speeds (e.g., 384 kilobytes per second [kbps] or 3 ISDN lines) may allow satisfactory resolution. Another solution considered for overcoming the problem of high-resolution video images is to capture full-motion clips for subsequent downloading that is independent of bandwidth availability.[3]

Figure 1. Example of a hybrid system, allowing a live interaction online (left) and a transmission of a store-and-forward electronic medical record, a still picture, a video or audio clip, and video–audio clips (right).

Some of the most vexing problems have been in adapting standard eye examination equipment for digital video and still-image capture. Any deficits in standard equipment are accentuated when that equipment is adapted to digital imaging. Because slit lamps that can integrate with this technology begin at approximately $3,800, selecting the correct equipment is extremely important.[4]

There has been difficulty in converting to the monocular (two-dimensional) digital view from the binocular (three-dimensional) standard view, with the potentially important loss of perspective and dimensionality. Another important problem with digital conversion systems that evaluate the fundus has been uncertainty about color verisimilitude. For example, at times, an optic nerve might appear on the specialist's monitor to be white (signaling optic atrophy), when, in fact, this may simply be an artifact or a misrepresentation of the true color. This problem needs to be recognized in order to be fixed by a standard technique. Additionally, a 3-CCD camera could solve problems with resolution, but it is expensive (approximately $6,000 to $10,000) compared with a 1-CCD camera (less than $1,000). Digital cameras are currently being evaluated, although they are expensive.

Evaluation of the technology with regard to eye care applications started at the Texas Department of Criminal Justice, University of Texas Medical Branch in Galveston in 1995. Li et al.[5] studied the capabilities of telemedicine for diagnosing cytomegalovirus retinitis. Thirty patients from the HIV Retina

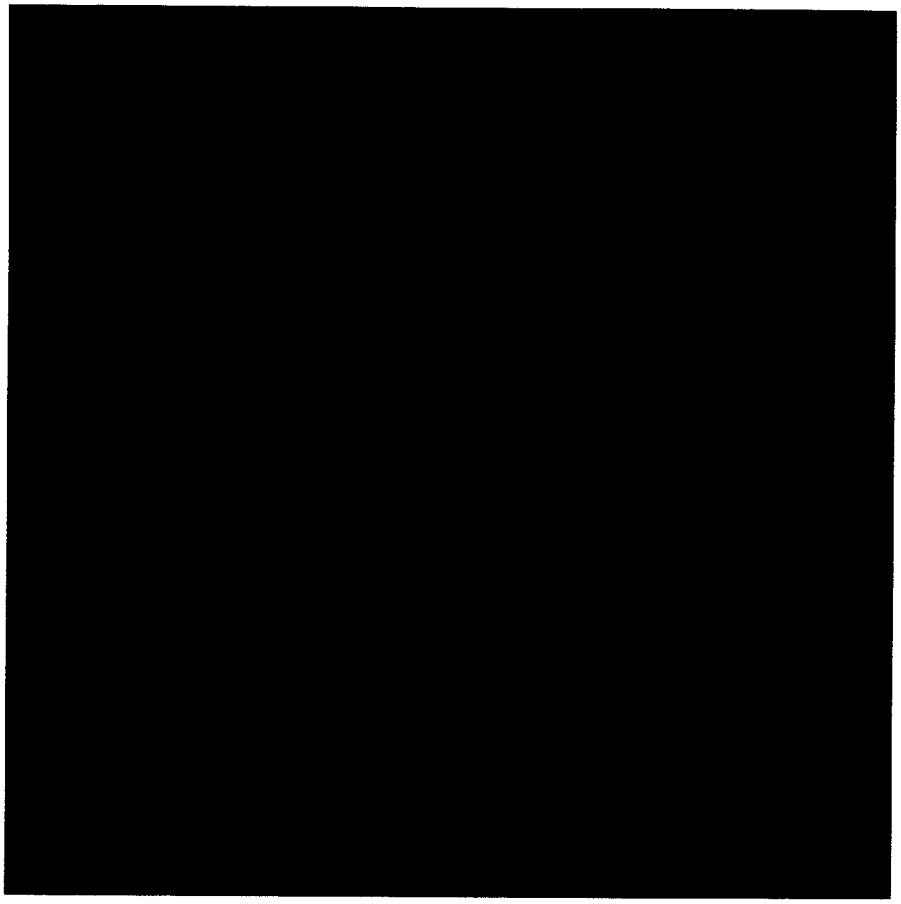

Figure 2. Digital image of a patient with diabetic retinopathy, which can be sent online by store-and-forward technology to another site.

Clinic with cytomegalovirus retinitis were examined. The retinal conditions shown on digital images were compared with those determined after actual examinations. Different modes of acquiring digital images were compared, including those through the slit lamp, the binocular indirect ophthalmoscope, and the fundus camera.

Regarding image acquisition, Li et al.[5] found the following:

1. Indirect ophthalmoscopy proved to be difficult technically.
2. A slit lamp required less operator skill than an indirect ophthalmoscope, but still took great time and effort.
3. The fundus camera was the easiest method technically.
4. Patients tolerated digital fundus photography better than they did an image acquired with a slit lamp or an indirect ophthalmoscope.
5. The quality of digital images improved as the operator's experience increased.

Regarding image resolution, Li et al. found that all three methods displayed adequate images of active retinitis and pigmented and normal retina. The slit-lamp and the fundus cameras provided better resolution and allowed more magnification options. The fundus camera had the least artifacts. Digital fundus photographs were easier to review than slit-lamp or indirect ophthalmoscope images.

Li et al.[5] concluded that digital imagery for tele–eye care is a viable diagnostic option for cytomegalovirus retinitis. The digital fundus camera has the greatest potential for diagnosis of this condition, including the detection of progression of the lesions.

A subsequent tele–eye care application included a pilot study comparing digital imagery with 35-mm photography of the posterior pole retina of diabetic patients at an off-site University of Texas Medical Branch family practice clinic.[6] In this study, 30 diabetic patients had digital and 35-mm fundus images taken of one eye. The quality of digital imagery for screening diabetic retinopathy was compared with traditional 35-mm photography.

Digital images were obtained with a Sony 3-chip CCD video system and Ophthalmic Imaging Systems' (Sacramento, CA) proprietary software. This company integrated their software with a Canon CR5-45NM nonmydriatic fundus camera. Conventional stereo 35-mm color slides were taken with a film back attached to the same fundus camera. The right eyes of the patients were photographed with both technologies.

We found the Canon CR5-45NM nonmydriatic fundus camera to be remarkably easy to use. It required little training or expertise. The camera uses several guides that ensure excellent alignment and focus. The Ophthalmic Imaging Systems' software was very user-friendly. Stored digital images can be enlarged for detailed viewing of a single photograph, or can be displayed in well-organized layouts of multiple views. Flash photography using the Sony video camera was much easier on patients than was the 35-mm film camera. Patients consistently reported that digital images were much more tolerable, although neither method was considered to be unbearable.

At this point we cannot conclude that digital imagery is equivalent to conventional 35-mm film photography for the screening or grading of diabetic retinopathy (Fig. 2), but we feel that this technology is promising and will be extremely useful if guidelines and standards are created and followed.[3,6] A similar study was done to use this technology for screening for glaucoma. We found that this technology was able to do effective screening.

The previous studies were performed using only store-and-forward systems. An additional pilot study using real-time and stored images for tele–eye care consultations was performed at the University of Houston, College of Optometry. During this study, the University of Houston transmitted live and stored digital images of eye examinations to the ophthalmology department at the University of Texas Medical Branch. The experience of consultation with real-time versus store-and-forward techniques was studied. Patients with neuro-ophthalmology problems at the University of Houston, College of Optometry, were examined online by a neuro-ophthalmologist at the University of Texas Medical Branch. The history was the major advantage to the on-line session. Store-and-forward images could be sent while the patient was at the University of Houston. The result of this experience guided our development of clinical protocols needed for efficient and quality care via telemedicine.

Currently, a model for glaucoma consultation from optometry to ophthalmologists is under way using the Telemedicine Aethra hybrid system and ISDN lines. A medically underserved inner-city multidisciplinary primary care clinic serving low-income patients is being linked to ophthalmology consultants to verify that patients can receive needed consults without leaving the examination chair. This will provide a solution to the problems of geography and time.

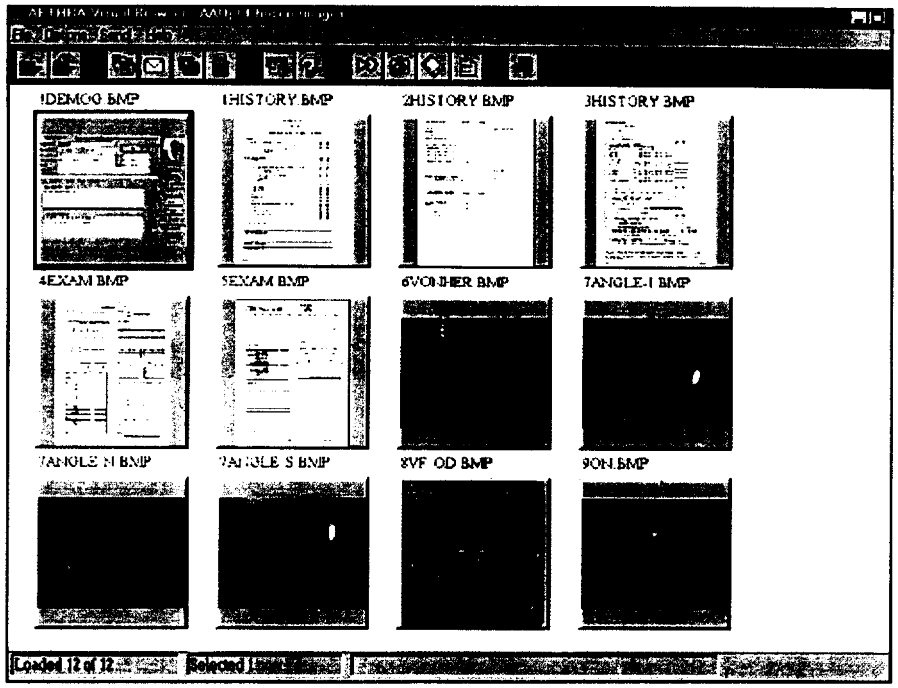

Figure 3. Example of an electronic patient folder composed of history and physical examination protocols, as well as pictures (which may be both still and dynamic).

Consultation through live videoconferencing can be time consuming for both the consultant and the consultee. Clinical protocols are needed to streamline the process (Fig. 3). Tele-education can be more effectively achieved using a shared whiteboard (Fig. 4). Fast transmission rates are critical for effective real-time evaluations, especially in assessing eye movement and pupillary functions, unless video clips are used. We are using this technology for tele-education. Currently, two weekly clinics are ongoing for retinal disorders and disorders related to diplopia. This technology allows interactive, two-way education.

Another important issue in a telemedicine consult is the training and knowledge of the presenter. Eye care technical personnel can have an important role in this emerging health care delivery modality as both the remote presenters to ophthalmic consultants and the trainers of non-ophthalmic health care professionals to be presenters.

Conclusion

Currently, validation of the technology and creation of guidelines for real-time and store-and-forward tele–eye care[7] are under way in our institutions, and are moving from a pilot stage to full-blown regularly scheduled clinics. On the technical end, much "beta" validation continues in collaboration with several vendors, including using systems that send images over standard phone lines and improved image-management software. Technology is changing rapidly while implementation continues; therefore, parallel valida-

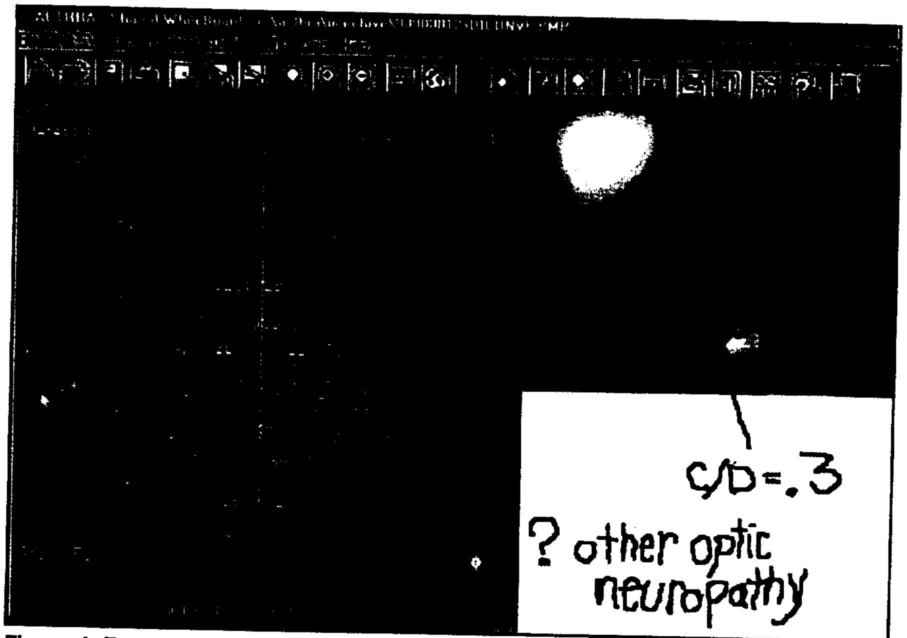

Figure 4. Example of whiteboarding technology allowing both sites to simultaneously discuss and point to areas of concern or education.

Telemedicine
KEYPOINTS

Schiffman JS, Li HK, Tang RA. **Telemedicine Enters Eye Care: Practical Experience.** *Journal of Ophthalmic Nursing & Technology.* 1998;17(3):102–106.

1. A combination of store-and-forward technology and videoconferencing technology can be used in eye care and other medical specialties.

2. Bandwidth is a rate-limiting factor for obtaining a high-resolution, real-time image.

3. Protocols, clinical and technical, must be used to implement telemedicine in an efficient and high-quality manner.

tion studies to test these new devices are ongoing. One of us (Dr. Schiffman) is also involved in integrating electronic medical records and protocols with the real-time and store-and-forward technologies for enhancement of care in telemedicine-related encounters and for training allied health care professionals to fulfill the role of telemedicine presenters.

The International Consortium for Ocular Telehealth has recently been developed. For more information about it as well as teletraining in eye care information, visit the web site of Drs. Schiffman and Tang at <www.neuroeye.com/>. We envision that there will be a great opportunity for trained ophthalmic nurses and technical personnel in the era of telemedicine.

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