Use of telemedicine to assist ophthalmologists in developing countries for the diagnosis and management of four categories of ophthalmic pathology

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Introduction: The diagnosis and treatment plans proposed by ORBIS Telemedicine partners, all of whom were ophthalmologists, via Cyber-Sight, in four ophthalmic sub-specialty categories were compared to those suggested by expert mentors.

Methods: Records of referrals of patients via Cyber-Sight to mentors with a diagnosis of: glaucoma, pediatric cataract, external disease, and disorders related to the ocular adnexa requiring oculo-plastic treatment were reviewed. Records recalled from the Cyber-Sight electronic archives included: medical history, images of clinical findings, partner diagnosis, partner treatment plan, mentor diagnosis, and mentor treatment plan. Partners’ diagnosis and treatment plans were compared to those of the mentors. Based on results of prior studies, mentor opinions were those considered valid (Helveston et al 2001).

Results: A total of 135 cases were reviewed: 70 external disease, 42 oculo-plastics, 16 glaucoma, and 7 pediatric cataract. The partner’s diagnosis agreed with that of the mentor in: glaucoma 81%, pediatric cataract 86%, external disease 76%, and oculo-plastics 86%. Partners were considered to have suggested the correct treatment plan in: glaucoma 56%, pediatric cataract 71%, external disease 70%, and oculo-plastics 60%. Mentors provided additional comments and suggestions for further study in more than three-quarters of the cases.

Discussion: If one considers that the mentors are correct in each case, they offered a different diagnosis in 18% of cases. For treatment, mentors offered an alternate plan in more than a quarter of cases. The basis for considering the mentors being more accurate in diagnosis and treatment planning after viewing pictures and reading history than the partners who actually saw and examined the patients is based on personal experience of the authors. This includes a study done by one of them (EMH) demonstrating that experts when asked to view cases presented via telemedicine agreed nearly 100% on diagnosis and by a like amount on the method of treatment. In addition to this, results of this present study are similar to those for strabismus; a condition that was studied earlier (Helveston et al 2001). Still to be determined is whether this type of consultation changes outcome of treatment.

Introduction
Telemedicine has been shown to be useful for screening, diagnosis, and management in cases of strabismus (Helveston et al 2001, 2004; Helveston 2005; Helveston et al 2006; Kennedy et al 2006) and retina (Cavallerano et al 2003, 2005; Kawasaki et al 2003; Patton et al 2006). In the case of strabismus, suitable clinical images can be obtained using a relatively low cost digital camera producing small pixel size pictures (640 × 480) that are readily transmitted via the internet. Assessing images obtained and placed in the format provided approximates the actual clinical setting. For retinal images, a fundus camera with digital image capture is required.
However even with retina, the picture size for transmission on the internet and viewing on a computer screen can be small (640 × 480) and retain sufficient detail to support a proper diagnosis. The retina image viewed on the computer screen can be seen in more detail with higher image resolution and has also been used extensively in screening for diabetic retinopathy and recently for retinopathy of prematurity (Chiang, Keenan et al 2006; Chiang, Starren et al 2006).

Other conditions involving the anterior segment of the eye can be imaged by close up photography or with the use of a biomicroscope equipped with a digital camera. The purpose of this paper is to describe our experience with telemedicine diagnosis and treatment planning in support of ophthalmologists in developing countries. These are eye health care providers who have no or at best limited access to expert opinion. ORBIS Telemedicine, Cyber-Sight through E (electronic) consultation is an extension of the ORBIS flying eye hospital and hospital (land) based programs (Figure 1, 2). The four eye pathology conditions studied were: glaucoma, pediatric cataract, oculo-plastics, and anterior segment disease.

Materials and methods
Patient records for this study were collected from the case files of ORBIS Telemedicine, Cyber-Sight and were submitted between May 2003 and December 2006. Cyber-Sight partners from the following countries contributed cases: India, Vietnam, Cuba, Romania, Bulgaria, Guatemala, Ecuador, China, Dominican Republic, and Albania. Each partner was trained in the use of the Cyber-Sight method of sending cases for consultation and each was provided with a digital camera, Nikon 2200 (or equivalent), for obtaining external pictures. Fundus pictures were obtained with the partners’ own equipment and included but were limited to images of the optic nerve that were viewed monocularly without enhancement. Retina consultations did not include cases of retinoblastoma.

Using a unique user name and password, each partner is able to access on the world wide web at http://www.
Cybersight.org a formatted page for the uploading of information about the patient including digital images. An example of an oculo-plastics case process is shown (Figure 3). At the time of enrollment into the Cyber-Sight program partners were assigned to a mentor team made up of ten to thirteen expert consultants, all ORBIS volunteer faculty (VF), and representing the full range of sub-specialties in ophthalmology. At the time of case submission partners use a “drop down box” to select the appropriate sub-specialty which in turn ensures that the case will be sent to the appropriate mentor. Before any case is submitted, the patient is asked to read and sign a document informing them that their case will be reviewed by an expert and asking them to grant ORBIS the right to use the patient’s likeness without identification by name for educational and research purposes. This consent form also explicitly states that the partner doctor, the person actually seeing the patient, is responsible for the care of the patient. The mentor assumes no liability and the advice given is followed or not, completely at the discretion of the partner. Institutional review was not obtained because this study was done under the auspices of ORBIS International and not at an academic institution.

Upon receiving a consultation notification by E-mail the mentor opens a password-protected file on the computer, reviews the history and clinical findings, and studies the

| Patient Name | Age / Gender | Vision | OD: 20 / 60 | OS: 20 / 30 | Refraction |
|--------------|--------------|--------|-------------|-------------|------------|
| Patient History | 3 year old | Female |            |            |            |
| Dear Mentor, |            |        |            |            |            |
| This little girl has a congenital ptosis with amblyopia. She refuses the patching now but I follow her from almost two years and she was patched more or less in this period. |            |        |            |            |            |
| The levator function is poor, less than 4 mm and MRD1=+1; MRD2=4 mm. She has also some exophoria with normal versions. Difficult to exam. I understand which are the limits of my evaluation but I would like to improve her situation. |            |        |            |            |            |

Figure 2 After logging in the partner chooses the sub-specialty, describes the case along with pictures and or images.
pictures. Each picture is approximately $4 \times 2.5$ cm in the montage but these can be enlarged individually to $12.5 \times 9.5$ for viewing individually. There was no standardized method for reviewing the material. Each mentor used his/her own method to arrive at a diagnosis and treatment plan. Images were evaluated “as is” and no enhancement other than enlargement was carried out. If the submitted image was unclear, not submitted in the proper format, or otherwise unsatisfactory the partner was asked to re-submit. Only those cases deemed sufficient for study are accepted by the mentors.

The mentor after completing study of the case then responded to the partner as follows:

1. Agrees with the diagnosis and treatment plan and congratulates the partner. In this case the mentor would usually ask to see the results of any treatment undertaken.

2. Agrees with the diagnosis, but disagrees with the treatment plan. In this case the mentor will offer an alternative treatment plan, usually suggesting further evaluation of the patient, and providing additional information about the diagnosis and treatment of a case as in the one shown in Figure 4.

3. The mentor disagrees with the diagnosis and the treatment plan and offers alternatives for both. In this case the mentor provides additional information about the type of case presented, and asks the partner to respond. After the partner reviews the mentor’s comments he/she can ask additional questions and/or provide additional information about the case (Figure 5).

With any of the scenarios above, when the partner is satisfied those questions have been satisfactorily answered; the case is closed by the partner. If additional questions arise or if the partner wishes to present post treatment results, the case can be re-opened at any time.

Cases were collected from Cyber-Sight files that are archived on-line and password protected. All cases in the chosen categories were selected if the files were complete. In each case the following patient information was retrieved: age, gender, laterality, partner diagnosis, mentor diagnosis, partner treatment plan, mentor treatment plan, and mentor comments.

### Results

A total of 135 completed/closed cases were seen in consultation in the four categories between 2003 and 2006. There were 70...
external disease, 42 oculo-plastic, 16 glaucoma, and 7 pediatric cataract consultations. Males were referred overall in 73% of cases. The mean age of patients was: 37 years for glaucoma (this includes 4 congenital cases), 26 years for external disease, 20 years for oculo-plastics, and 7 years for pediatric cataract.

Partners had the correct diagnosis in more than 80% of cases with very little difference between the different diagnostic categories. For treatment plans, partners were considered to have the correct plan in 64% of cases. Partners were most likely to be correct in external diseases, 70%, and least likely in glaucoma, 56%. Mentors provided what they considered the correct diagnosis and treatment plan in all cases that required this, and provided additional information in 70% of glaucoma cases, 94% of external disease cases and in all cases in the categories of oculo-plastics and pediatric cataract. A full compilation of data is found in Tables 1–4.

Discussion
Telemedicine has been used effectively in ophthalmology for a wide variety of circumstances and conditions as reported by Yogesan et al. (2006) in a book dealing exclusively with tele-ophthalmology. However, to our knowledge, none of these studies has shown or even attempted to show that telemedicine diagnosis is superior to and/or provides a more effective treatment plan than does “in person” examination. Likewise it is not our intention to claim this here. Instead, telemedicine has been advocated for situations where the treating doctor has little or no access to expert help. This means that telemedicine should be better than nothing; that is, it should both benefit the patient while not introducing new complications. This study simply records our experience in dealing with ophthalmologists who were originally helped by ORBIS volunteer faculty (VF) “in person” and are now communicating by means of telemedicine, assisting in the management of difficult cases with these mentors and other ORBIS VF who makeup the sub-specialty team made available to each partner. This program was initiated as a response to the frustration arising, and in some cases the criticism resulting from, what has been termed by some “hit and run” assistance. This is when the volunteer doctor spends

| Partner Response | Dear Mentor
|------------------|--------------------------------------------------|
|                  | I would like to send the postop pictures- one months. Thank you for your help, the parents are pleased. |

*Mentor Response - Friday, July 21, 2006*

| Mentor Response | Looks good. Looks like you did a good job with the sling. They don’t always turn out that nice. thanks for the followup. |

Table 1 Oculoplastics data; 42 cases

| Age (mean) years | 19.7 (0.1–68) |
|------------------|---------------|
| Laterality       |               |
| Correct partner diagnosis | 36/42 (86%) |
| Correct partner plan | 25/42 (60%) |
| Mentor add on | 42/42 (100%) |
| Sex | 64% Males 36% Females |
| By etiology | Pтosis 26% Tumors 24% Lid abnormality 29% Dacryocystitis 7% Others 14% |
| Correct diagnosis | 100% (11/11) 70% (7/10) 83% (10/12) 100% (3/3) 83% (5/6) |
| Correct plan | 63% (6/11) 60% (6/10) 42% (5/12) 100% (3/3) 67% (4/6) |

*RT, right; LT, left; BE, both eyes.*
Not included in this report, but an important part of the Cyber-Sight telemedicine program is the retinoblastoma initiative connecting ophthalmologists and pediatric oncologists in Guatemala and Jordan with ophthalmologists at Hamilton Eye Institute and pediatric oncologists at St. Jude Hospital, both institutions located in Memphis, Tennessee, USA. This retinoblastoma diagnosis and treatment program has handled more than 330 requests for consultation dealing with more than 65 patients. The value of the program was demonstrated by those partners in Jordan who were unsure of the appropriate staging and proper treatment needed and therefore required help in 46% of the retinoblastoma cases they encountered when they first started working with St. Jude Hospital and Hamilton Eye Institute. After working with these mentors for two years the accuracy rate in diagnosis and plan of treatment improved to the point that they needed help in only 14% of cases (Mehyar et al 2006).

Of the 2966 consultations seen via Cyber-Sight since 2003, 1,886 have dealt with strabismus and 564 have involved retina, including retinoblastoma. An earlier study, done by one of us (EMH), demonstrated that experts received sufficient information about strabismus patients from telemedicine to arrive at a diagnosis and make a decision about a treatment plan by showing that a panel of experts working independently were in near perfect agreement on diagnosis and agreed in principal on treatment.

In a study reported at the annual meeting of the American Academy of Ophthalmology, October 2006, dealing with Brown and Duane syndromes and superior oblique palsy, partners was considered correct in their diagnosis 77% of the time and were considered correct by the mentor in treatment plan only 48%, numbers similar to the present study. The assumption in both instances was that the mentor diagnosis and treatment plan was more likely correct than the partner.
Table 4 Glaucoma data; 16 cases

| Age (mean) years | 37 (2–85) |
|-----------------|-----------|
| Laterality      | Left 1/16  |
| Correct partner diagnosis | 13/16    |
| Correct partner plan     | 9/16      |
| Mentor add on       | 12/16     |
| Sex              | 75% males  |
| By etiology       |           |
| Congenital        | 31%       |
| ACG              | 25%       |
| OAG              | 31%       |
| MISC             | 13%       |
| Correct diagnosis | 3/5       |
| plan             | 2/5       |
| Right 5/16       |           |
| Both 10/16       |           |

Abbreviations: OAG, open angle glaucoma; ACG, angle closure glaucoma; MISC, miscellaneous.

Based on the results of the data collected here (Tables 1–4), it appears that the results for the four categories of patients studied here, glaucoma, oculo-plastic, external disease, and pediatric cataract are similar to those found for strabismus; that is, partners have a correct diagnosis in about 4 of 5 cases and an appropriate treatment plan in between half and three quarters of the cases.

Conclusion

Telemedicine consultation was provided to ophthalmologists in developing countries most of whom had received short periods of teaching and service support on one or more occasions by ORBIS volunteer faculty. This telemedicine consultation in the form of “extended presence” was described dealing with cases of: external disease, glaucoma, pediatric cataract, and adnexal disease requiring oculo-plastics care. Consultation provided by ORBIS volunteer faculty suggested a different diagnosis from that made by partners in 18% of cases and a change in treatment plan in 36% of cases. Mentors offered additional comments and advice in nearly every case. These statistics are similar to earlier studies dealing with the strabismus entities of superior oblique palsy, Brown syndrome, and Duane syndrome (Helveston et al 2006). This report does not compare the results of “in person” examination with telemedicine consultation. It does make the assumption based on a prior study that the mentor diagnosis and treatment plan is correct for the patient presented via telemedicine (Helveston et al 2001). Still to be determined is whether this type of consultation changes the patient outcome.

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