

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.

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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.>



Figure 1 After logging on to <http://www.cybersight.org> and selecting "E-Consultation", the unique user name and password are entered.


Doctor		Location									
Category	Oculoplastics	Date									
Patient Name		Age / Gender	3year oldFemale								
Vision	OD: 20 / 60 OS: 20 / 30	Refraction	<table border="1"> <tr> <td>OD</td> <td>sph: +0,75</td> <td>cyl: +1,5</td> <td>axis: 90</td> </tr> <tr> <td>OS</td> <td>sph: +0,75</td> <td>cyl: +0,5</td> <td>axis: 100</td> </tr> </table>	OD	sph: +0,75	cyl: +1,5	axis: 90	OS	sph: +0,75	cyl: +0,5	axis: 100
OD	sph: +0,75	cyl: +1,5	axis: 90								
OS	sph: +0,75	cyl: +0,5	axis: 100								
Patient History	<p>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.</p>										
Pictures											
											

Figure 2 After logging in the partner chooses the sub-specialty, describes the case along with pictures and or images.

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

Partner Diagnosis	
Current Diagnosis	OD Congenital ptosis.
Tentative Plan	The pictures are at different ages. I would try a levator aponeurosis resection.
Special Questions or Comments	the parents want an aesthetical improvement.

Figure 3 The partner gives a diagnosis and treatment plan.

pictures. Each picture is approximately 4×2.5 cm in the montage but these can be enlarged individually to 12.5×9.5 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

Mentor Diagnosis	
Mentor Diagnosis	congenital ptosis
Mentor Response - Monday, June 05, 2006	
Mentor Response	Based on the history of difficult to manage amblyopia, I would recommend surgery. Nothing wrong with a berke type levator resection. However, the reported low levator function and photos that show poor levator function suggest that a sling may be necessary. While ptosis repair will help with esthetics, I would encourage you to discuss with them that the poor levator mechanics prevents getting a surgical result where the affected eyelid and the non-affected eyelid look identical. No matter how good of levator or sling surgery you perform, that eyelid will never look exactly like the normal eyelid. Despite that limitation, she looks like a good candidate for surgery. Good luck,

Figure 4 Mentor response.

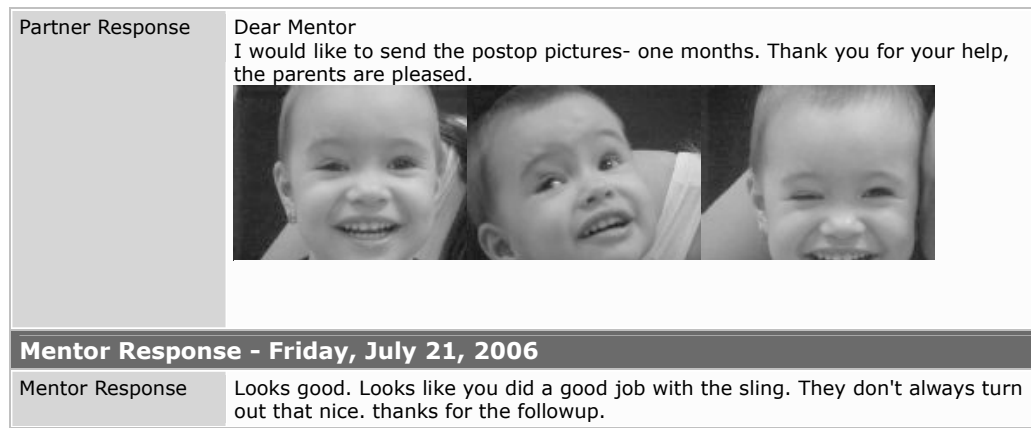


Figure 5 Post operative results and comments.

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

Table 1 Oculoplastics data; 42 cases

Age (mean) years	19.7 (0.1–68)				
Laterality	18/42 (42%) RT	15/42 (36%) LT	9/42 (22%) BE		
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	Ptosis 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.

Table 2 Pediatric Cataract data; 7 cases

Age (mean) years	5.14 (0.2–13)		
Laterality	Left 14.3%	Right 28.6%	BE 57.1%
Correct partner diagnosis	6/7	86%	
Correct partner plan	5/7	71%	
Mentor add on	7/7	100%	
Sex	86% males	14% females	

a brief intense time teaching and providing service and then leaves with all good intentions to stay connected but in effect with all meaningful contact lost. This Cyber-Sight program aims to deal with this deficiency by creating what is called “extended presence”. This is made possible by information technology in the form of ORBIS Telemedicine, Cyber-Sight. In the future, controlled studies will be required to show that this type of intervention actually improves patient care and enhances the professional skill of the partners. For now the successes recorded are more anecdotal, but supported indirectly by the fact that partners find enough value in the system to stay with the program and continue to use it once they have started, and in addition provide satisfactory post treatment results in many cases.

The present study utilized four of the categories of ophthalmic disease that can be selected for consultation by partner ophthalmologists. This telemedicine consultation in the four categories studied produced similar results to those found in a larger study of patients with strabismus, a condition that seems to us to be well suited to management with telemedicine. To date the areas of ophthalmology most often managed by telemedicine has been screening for diabetic retinopathy. Other areas of activity, but with much less volume, are screening for ROP, management of strabismus, ocular trauma, cataract and refractive surgery, retinal vascular disorders, low vision, and a wide array of ocular health conditions in hard to reach places including prisons, rural area, and even space (Yogesana et al 2006).

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 3 External disease data; 70 cases

Age (mean) years	26 (0.5–75)			
Laterality	RT 33% (23/70)	LT 33%(23/70)	BE 34% (24/70)	
Correct partner diagnosis	53/70	76%		
Correct partner plan	49/70	70%		
Mentor add on	66/70	94%		
Sex	Males 66% (46/70)	Females 34% (24/70)		
By etiology				
	Trauma 13%	Tumor 16%	PUK16%	Others 55%
Correct diagnosis	100% (9/9)	91% (10/11)	63% (7/11)	69% (27/39)
Correct plan	78% (7/9)	73% (8/11)	63% (7/11)	69% (27/39)

Abbreviation: PUK, peripheral ulcerative keratitis.

Table 4 Glaucoma data; 16 cases

Age (mean) years	37 (2–85)			
Laterality	Left 1/16	Right 5/16	Both 10/16	
Correct partner diagnosis	13/16	81%		
Correct partner plan	9/16	56%		
Mentor add on	12/16	75%		
Sex	75% males	25% females		
By etiology				
	Congenital 31%	ACG 25%	OAG 31%	MISC 13%
Correct diagnosis	3/5	4/4	5/5	1/2
plan	2/5	2/4	4/5	1/2

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 studies 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.

References

- Cavallerano AA, Cavallerano JD, Katalinic P, et al. 2005. A telemedicine program for diabetic retinopathy in a Veterans Affairs Medical Center – the Joslin Vision Network Eye Health Care Model. *Am J Ophthalmology*, 139:597–604.

- Cavallerano AA, Cavallerano JD, Katalinic P, et al. 2003. Use of Joslin Vision Network digital-video nonmydriatic retinal imaging to assess diabetic retinopathy in a clinical program. *Retina*, 23:215–23.
- Chiang MF, Starren J, Du YE, et al. 2006. Remote image based retinopathy of prematurity diagnosis: a receiver operating characteristic analysis of accuracy. *British Journal of Ophthalmology*, 90:1292–6.
- Chiang MF, Keenan JD, Starren J, et al. 2006. Accuracy and reliability of remote retinopathy of prematurity diagnosis. *Archives of Ophthalmology*, 124:322–7.
- Helveston EM. 2005. Surgical management of strabismus. Belgium: Way-enborgh Publishing, p 285–358.
- Helveston EM, Kopecky G, Smallwood LM. 2004. Cyber-Sight ORBIS Telemedicine. *Insight*, 29(3):15–18.
- Helveston EM, Neely DE, Cherwek H, et al. 2006. Diagnosis and management of strabismus using telemedicine. Presented at the annual meeting of the American Academy of Ophthalmology, Las Vegas.
- Helveston EM, Orge FH, Naranjo R, et al. 2001. Telemedicine: strabismus E-consultation. *Journal of AAPOS*, 5:291–6.
- Helveston EM, Thazhathu MJ, Smallwood LM. 2006. ORBIS telemedicine: cyber-sight. In: Kanagasingam Y, Kumar S, Goldschmidt L, et al eds. *Tele-ophthalmology*. Berlin: Springer, p 187–93.
- Kawasaki S, Ito S, Satoh S, et al. 2003. Use of telemedicine in periodic screening of diabetic retinopathy. *Telemed JE Health*, 9(3):23.
- Kennedy C, Bowman R, Fariza N, et al. 2006. Audit of web-based telemedicine. *Journal of Telemedicine and Telecare*, 12:88–91.
- Mehyar MY, Nawaiseh I, Qaddoumi I, et al. 2006. ORBIS in ocular oncology: cost-effectiveness, efficacy, and practicality profile – the King Hussein Cancer Center experience. Poster, American Academy of Ophthalmology, Las Vegas.
- Patton N, Aslam TM, MacGillivray T, et al. 2006. Retinal image analysis: concepts, applications and potential. *Prog Retin Eye Res*, 25:99–127.
- Yogesnan K, Kumar S, Goldschmidt L, et al (eds). 2006. *Tele-ophthalmology*. Berlin: Springer.

