Telemedicine–Applications in Tele-Ophthalmology

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Introduction

In the recent years there has been an exponential growth in Information technology and its impact on the outlook of our professional lives. The internet has revolutionized the speed of access to information with touch of a button. This revolution has lead to the positive impact in all areas including the medical field where accessibility is a major problem. For instance in India, of the 12,000 (approx.) trained ophthalmologists, very few doctors are trained in sub-speciality services, which is further aggravated by the uneven distribution of specialists skewed towards few urban areas catering to just 10-15% of population requiring such services. Thus the rural population constituting the majority of our population has very little/no access to tertiary eye care. In order to make eye care services accessible to every one, the concept called 'TELEOPHTHALMOLOGY" has come into existence. Tele-ophthalmology is a techno savvy method by which medical facility is taken to rural or remote areas by using computers, video conferencing and internet. Tele ophthalmology enables a doctor from one end to interact with the patients sitting at a remote end in a faraway place through video conferencing, share data through computers and diagnose the patient with the help of local doctor who uses ophthalmic diagnostic equipments to transfer the images. Also ophthalmology is one field of medicine where imaging plays a major role and many a diagnosis can be made by viewing the images. So it becomes apt to use IT in ophthalmology for reducing the urban - rural divide.

Objectives of Tele-Ophthalmology

- To make eye care service accessible and affordable by reducing travel cost and time for the patients.
- To enable people at remote areas have access to specialised eyecare facility
- To act as an interface between doctors to share their experiences.

Modes of Tele-Ophthalmology

Tele ophthalmology can be done over 2 modes.

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Real Time mode: In real time consultation, two or more distant sites may be connected via video conferencing equipments and people at different sites may see and speak with each other.

Store and Forward mode: In this mode audio, static and video images can be captured along with patients clinical data and then forwarded to a specialist who is at a different site. The specialist will diagnose and advise treatment with in stipulated time. This is suitable only for non-emergency cases.

Applications
Patient Consultations

Tele-ophthalmology provides solution to all types of eye diseases. Right from the refractive error to the specialty eye diseases like Glaucoma, Corneal problems and Diabetic Retinopathy, all the sorts of eye problems could be treated by deploying Teleophthalmology complementing the *regular service delivery.*

### Refractive error problem and simple diagnosis

In primary care, Teleophthalmology can be used for general screening, diagnosing common problems such as cataract and refractive errors. This would need a regular Internet connectivity, where patient can interact with the doctor through a web camera or web based health care services such as that offered by TCS

(webhealthcentre.com). Aravind Eye Hospital provides such services through vision centres, an approach taking eye care to the doorsteps of rural people. This centre offers primary eye care services with the help of trained ophthalmic technician at an affordable cost. The centre is connected with the base hospital through internet services to enable direct patient consultation and interaction with the ophthalmologist at the base hospital. This reduces unnecessary visits to base hospital. Another example of this is the mobile screening by a bus with satellite connection used by Shankar Nethralaya in Chennai. This vehicle with an optometrist provides primary eye care to the rural areas and any specialized case comes a connection with the base hospital is established for opinion from the ophthalmologist.

(Please see the Annexure 1 for more clarification)

Diabetic Retinopathy and other specialty eye diseases

Teleophthalmology enables secondary care and tertiary care by screening for specialty eye diseases like diabetic retinopathy, Glaucoma and corneal ulcer. This is more applicable when a general ophthalmologist in a smaller practice seeks opinion of a specialist for a complicated condition. The specialist can guide the primary ophthalmologist in further management of the particular case. This also becomes a
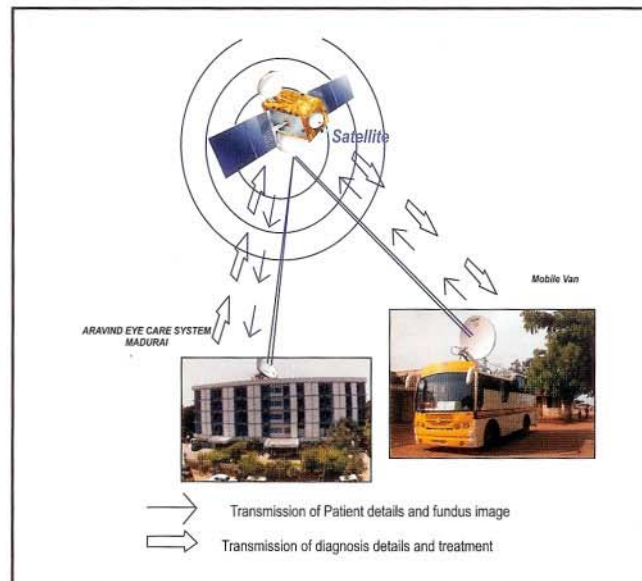
Annexure 1: Image explaining the functionality of Mobile unit

learning tool for the general ophthalmologist to handle similar cases in futures.

The mobile screening unit of Aravind Eye Hospital is an example for secondary care service. It is used in the Diabetic Retinopathy screening to provide Retinal services to the rural patients. Mobile van is equipped with Fundus camera; video slit lamp and VSAT connection (**Provided by Indian Space Research Organisation**). With the help of VSAT connection, ophthalmic paramedic at mobile van can communicate to the specialist sitting in the base hospital. He takes the fundus images of diabetic patients using specialized software and sends it to a Reading and Grading center located in the base hospital. Here the images are viewed by trained (Certified) graders and a report with advice is generated and sent back to the mobile van. Through this patient need not travel and can have screening done at his local place. By this more people are screened as these people are normally reluctant to travel to speciality hospitals. All the screening will be done in the mobile van itself and patient will be asked to come to base hospital only for further treatment.

(Please see the Annexure 2 for more clarification)

Another example is EyeRIS- a diabetic retinal screening service developed by EyeTel imaging and Wilmer Eye Institute .This service is provided with the help of a retinal imaging system called DigiScope. The DigiScope is a digital camera capable of acquiring stereoscopic Fundus images using a gray scale in a composite mosaic. The Digiscope located in a general physcian's
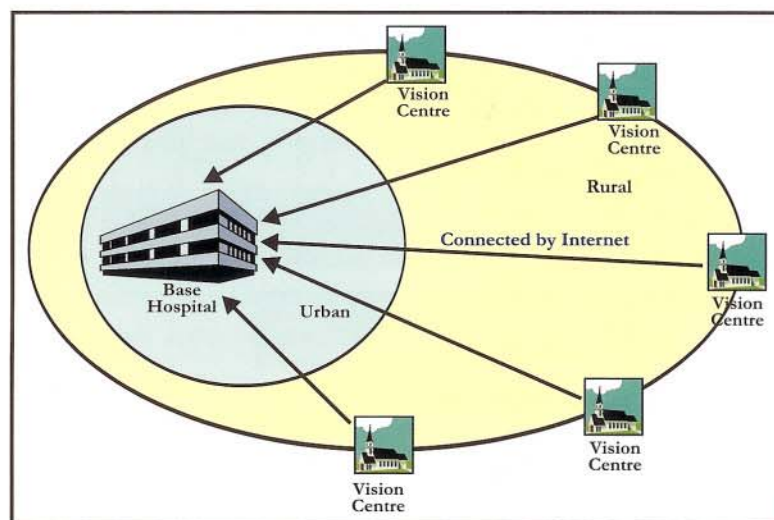
Annexure 2: Concept of Vision centre

office is manned by a technician. The acquired images are sent to expert through internet connection. After receiving the images the expert will grade it and send back the report to the physician. This avoids a trip to ophthalmologist's clinic for the patient and there is a lot of direct and indirect cost savings.

Education and Training

Teleophthalmology is not only useful for patient consultation but also useful for education and training where the doctors from different places can share their experiences with each other. Through video conferencing system each institutes can share their experiences with others. It helps to upgrade their knowledge and provides more insight in their field.
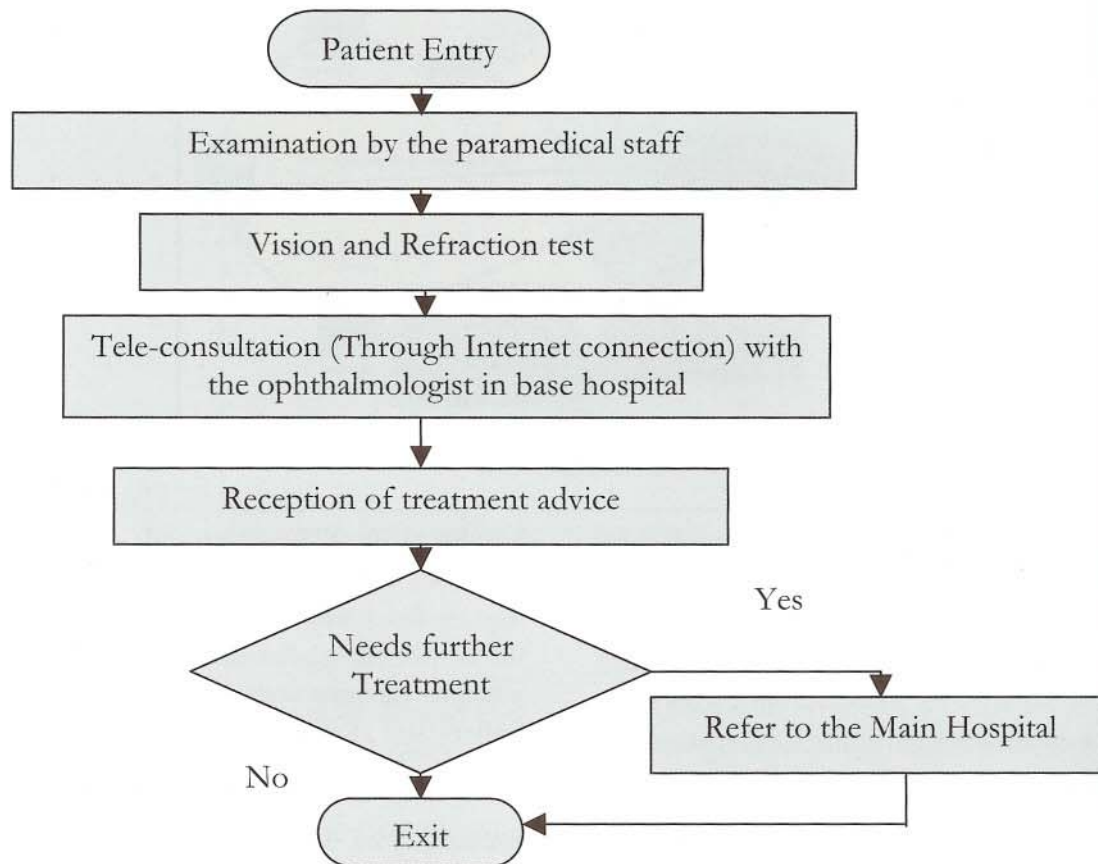
Aravind uses video conferencing system to collaborate with various leading eye institutes like Wilmer eye institute of John's Hopkins University, Cornell University and Columbia University around the world for education, training and research on routine basis. Also the hospital having five centers in different locations conducts online classes for all its centers and also plans to open a virtual university where any center can participate.

Suitability of Tele-Ophthalmology

Teleophthalmology is very much suitable for treating the specialty diseases like Glaucoma, Diabetic Retinopathy and Corneal ulcer. Since all these diseases can be diagnosed by seeing the Fundus image, a digital fundus camera attached to a computer and supporting software alone is required in treating these diseases. More over though these diseases are chronic, they are not emergency cases. So it can be treated through store forward mode of consultancy. In case of Cataract, Teleophthalmology is not used extensively. Though cataract can be

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Flow chart explaining the functionality of Vision Centre

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                    ( Patient Entry )
                           │
                           ▼
        ┌──────────────────────────────────────────┐
        │  Examination by the paramedical staff     │
        └──────────────────────────────────────────┘
                           │
                           ▼
            ┌──────────────────────────────┐
            │   Vision and Refraction test  │
            └──────────────────────────────┘
                           │
                           ▼
        ┌──────────────────────────────────────────┐
        │ Tele-consultation (Through Internet        │
        │ connection) with the ophthalmologist       │
        │ in base hospital                           │
        └──────────────────────────────────────────┘
                           │
                           ▼
            ┌──────────────────────────────┐
            │  Reception of treatment advice │
            └──────────────────────────────┘
                           │
                           ▼
                    ◇ Needs further ◇        Yes
                    ◇  Treatment   ◇ ───────────────┐
                           │                         ▼
                          No            ┌─────────────────────────┐
                           │            │ Refer to the Main Hospital│
                           ▼            └─────────────────────────┘
                      ( Exit ) ◄────────────────────┘
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diagnosed from the simple slit lamp images, the treatment is well known to all ophthalmologists. So people are not using it much extensively for cataract. Through this Teleophthalmology an ophthalmologist can suggest only the treatment adive and it is not developed to the extent of providing treatment by sitting in other end. All these may reduce only the travel time and cost to the patient that is incurred for the initial and follow up visits.

Information Technology & Tele-Ophthalmology

The revolution in the field of Information Technology has made Teleophthalmology a real possibility. Today there is a visible penetration of computers and internet in rural areas, thanks to the organisations like n-Logue, ITC's IT initiatives that is revolutionizing lives of rural masses. The increased access to computers and internet in the rural areas has led to establishing

Kiosks that is also encouraging entrepreneurship, thus enabling every person avail various services including health care which would have been not possible otherwise. This IT revolution is also changing the mindset of people to seek medical services on their own thus helping them to overcome barriers like fear, lack of transportation facilities, local beliefs etc. Aligning with the mission of providing better quality of life to civilians by deploying its applications, today Indian Space Research Organisation (ISRO) is playing a vital role in expanding the reach and access by setting up VSAT connectivity in the remote regions like Andaman & Nicobar Islands, Jammu & Kashmir, Ladakh North-Eastern States, tribal regions in various States etc. where other modes of connectivity is not feasible at all. These places are now linked with tertiary care institutions like SRMC, Chennai, Naryarana Hrudalaya, Bangalore thus enabling access to better care to the local population. Apart from the above said, ISRO has also supported eye hospitals like Aravind Eye Hospital & Sankara Nethralaya by providing VSAT connectivity to their mobile vans that helps in reaching rural population. Ophthalmic field is also undergoing dramatic changes with introduction of newer technology which is becoming more and more image based. Nowadays most of the ophthalmic equipment is integrated to computer that has led to digital imaging. Even otherwise, computers can be attached to all the stand alone ophthalmic instruments to capture images, making it much easier to adopt Teleophthalmology. The infrastructure required for real time consultation is Videoconferencing Unit, ISDN connectivity and ophthalmic equipments. For store and forward, a Computer, a digital camera, and dial-up Internet connectivity and ophthalmic equipments are all that is needed. Thus the scope for Tele-ophthalmology is tremendous and appropriate implementation will readily benefit people in need of such interventions.

Advantages of Tele-Ophthalmology

For the Patients:

- People at remote areas get access to tertiary care from reputed hospitals and doctors.
- Reduces travel cost and saves time for patients.
- Local ophthalmologists can retain their patient base

For the Hospitals:

- Hospitals can reach remote villages and serve local population without much investment on the infrastructure.
- Primary diagnosis can be done through tele-ophthalmology that facilitates patients to come to the tertiary care centre only for physical interventions like surgeries/procedures.
- Hospitals can have CME programs with other hospitals and doctors.
- Hospitals can run training programs to other the staff of other hospitals in a structured way
- Instant sharing of knowledge either a surgery or diagnostic technique by

broadcasting it to other hospitals

- Primary care doctors can learn newer/latest techniques by interacting with reputed institutions worldwide

- Facilitates to seek consultations and second opinion from reputed consultants across the world.

Challenges in Tele-Ophthalmology

The success of this Teleophthalmology concept majorly depends on the following factors.

- Connectivity

  These days, connectivity charges have come down considerably making it affordable to all types of organisation. However, real challenge today is stability of the connectivity and also availability of affordable broadband connectivity across the country.

- Availability of trained and experienced personnel

- Security and confidentiality

  Standards/protocols are yet to evolve assuring privacy and confidentiality of patients. The transaction of the patient details over internet has to be rightly protected by deploying appropriate security protocol.

- Sustainability

  The idea of seeking consultations through tele-ophthalmology/Telemedicine is relatively new. There is considerable investment done to seek and provide tele-consultations in terms of equipment, manpower and other resources. Charging for tele-consultations is one of the important aspects in this process. Like any other services, tele-ophthalmology services should also be a sustainable both to the clients who seek services and to the service providers who offer such services. It would take some time to evolve an appropriate payment protocols.

Conclusion

In the coming years technological advances in medicine would definitely play a very constructive role in delivering eye care to remote areas that cannot afford to have tertiary care treatment facilities. "Emerging technologies in virtual reality and micro-machines will transform the eye care scenario (patient consultations and ophthalmic education) in the country, resulting in providing world class eye care to everybody.