

# **Impact of combined live and cloud-based tele-ophthalmology system on referral patterns and disease identification at community eye centers in Nepal**

Dr. Raba Thapa MD, PhD<sup>1</sup>, Dr. Sean Collon MD<sup>2</sup>, Dr. Eric Hansen MD<sup>2</sup>, Dr. Geoffrey Tabin MD<sup>3</sup>

<sup>1</sup>Tilganga Institute of Ophthalmology, Kathmandu, Nepal

<sup>2</sup>Moran Eye Center, University of Utah, USA

<sup>3</sup>Byer Eye Institute, Stanford University, California, USA

## **Abstract**

**Background:** The use of tele-ophthalmology service is rapidly increasing over the recent years. Currently Tilganga Institute of Ophthalmology (TIO) is using a number of tele-ophthalmology systems in its community eye centers (CECs), each with some challenges in terms of quality of pictures and human resources.

**Methodology:** To address these challenges, we propose to study the effects of a standardized, combined tele-ophthalmology system at two CECs: A structured protocol provided a simple algorithm for use of the various aspects of the tele-ophthalmology system. Live consultation was provided by fellows of vitreo-retina and cloud based consultation by the retina consultant. We assessed how this system changes utilization of tele-ophthalmology services, types of pathology detected using this system, rate of referral completion.

**Results:** The pre and post intervention observational type of study was conducted. A total of 600 patients were screened using the tele-consultation at post intervention. The mean age was 62.3

years with SD 13.0. Male and female comprised of 220 (36.7%) and 380 (63.3%). Diabetes mellitus and hypertension was found in 29.8% and 54.5% of the participants respectively. Blurring of vision was the major chief complains in both the eyes in nearly half of the study participants. Overall, 89% of the participants had some form of ocular problems. Anterior segment ocular problems comprised of 44.8% and posterior segment problems in 64.6%. After the tele-consultation, one fourth of the participants presented within the one month to three months for further evaluation at tertiary eye care center. In pre-intervention, a total of 380 participants were enrolled. Among these 203 (53.4%) were from the Nuwakot district CEC and 177 (46.6%) were from the Dhading district CEC. Out of the total cases, those needing referrals were 113 (46.89%) from Nuwakot and 128 (53.11%) were from the Dhading. Among the referral cases, those patients visiting TIO were 52 (46.85%) from the Nuwakot and 59 (53.15%) were from the Dhading within two years of follow up.

**Conclusion:** Tele-ophthalmology service has proved to be an effective method for detection, referrals and treatment of vision threatening cases to avoid the blindness. Combined both the live and cloud based tele-ophthalmology system could be effective modality to provide the eye care services in remote parts of Nepal and similar other settings.

**Key words:** Tele-ophthalmology, Cloud-based consultation, Live-based consultation. Diseases identification, Impact

## Background

Tele-ophthalmology involves the acquisition and transfer of patient data, either in real-time or through cloud-based systems, to provide high-level eye care for patients in areas where limited access to in-person eye care services exist. As internet connectivity improves throughout the world, and as imaging technology and artificial intelligence becomes increasingly accessible and capable, teleophthalmology can be leveraged to maximize the impact of ophthalmologists. A fundamental consideration in any teleophthalmology system is that it must accommodate the specific needs of the facility in which it is being implemented, which includes providers, staff, and patients. Therefore, a functional tele-ophthalmology system must effectively identify pathology and, equally, lack thereof; be user-friendly, and minimally disrupt clinic flow and other services provided by the facility; and most of all provide a patient-centered service that improves outcomes while minimizing patient costs.

Recent studies have demonstrated a prevalence of retinal pathology in some Nepali populations of greater than 50% for individuals over 60 years old.<sup>1</sup> Another study evaluating patients at rural cataract screening events with best corrected visual acuity 6/18 or worse identified nearly 50% of patients who required additional workup for non-cataract pathology.<sup>2</sup> Numerous studies have demonstrated the potential utility of tele-ophthalmology programs for leveraging limited physician resources in the outreach, community eye center, and primary care settings both in Nepal and other parts of the world.<sup>2-6</sup> As the prevalence of diabetes increases<sup>7</sup>, and the population ages, retinal pathology and glaucoma will become an increasingly important source of visual impairment to address. Mid-level ophthalmic personnel and even residents may lack sufficient training and resources to be able to diagnose, manage, and refer this pathology effectively, though improved diagnosis and decision making can be made possible through the use of tele-ophthalmology with

physician input.<sup>2,8</sup> Studies have demonstrated an excellent ability to accurately diagnose and triage anterior segment disorders using real-time tele-ophthalmology consultation services with a remote ophthalmologist.<sup>9</sup>

### **Rational / justification:**

Tele-ophthalmology holds great promise for areas where few ophthalmologists are tasked with managing a large burden of eye disease spread across a large geographic area, as is the case in Nepal. Current tele-ophthalmology systems at TIO have met with some success and have preserved vision for several patients. There are however some limitations, resulting in some unneeded referrals that cost patients significant time and money. To improve the process for staff, providers, and patients, we must characterize and analyze the effectiveness of the current system and then measure the impacts of interventions targeted at addressing the specific complaints of the stakeholders in the current system.

### **Objectives:**

#### **a) General Objective:**

To assess the impact of combined live and cloud-based tele-ophthalmology system on referral patterns and disease identification at community eye centers in Nepal

#### **b) Specific Objectives :**

1. To assess the types of ocular pathology identified using a standardized, combined tele-ophthalmology model

2. To assess referral follow-up rates for patients identified as needing referral through a standardized, combined teleophthalmology model
3. To assess appropriateness and effectiveness of referrals generated through standardized tele ophthalmology program by reviewing services rendered at TIO to patients referred from CECs
4. To assess staff and provider opinions on the effectiveness of a standardized, combined tele-ophthalmology model

## **Research Methodology**

**Study design:** This is a pre-post interventional study.

Observation of impact was assessed with the intervention of equipment of fundus camera and anterior segment photo in the study.

### **Study site and its Justification:**

Nuwakot Community Eye Center (CEC): Already has functioning real-time tele-ophthalmology capabilities, does not have high quality fundus camera

Dhading CEC: Already has functioning real-time tele-ophthalmology capabilities, does not have high quality fundus camera

**Description of Research design:**

In pre-interventional phase, all patients' records receiving tele ophthalmology service from electronic medical records (EMR) were evaluated for the diagnosis, and their follow up at TIO for further treatment from 2020 till the installation of new fundus camera having anterior segment photo. In post intervention phase, there was addition of fundus camera (Right Medical PVT. LTD) having both anterior segment and posterior segment photographs.

. All patients who had met the inclusion criteria were requested to involve in the tele-ophthalmology service. Written informed consent was taken for those who want to involve in the study. Detailed history was documented. Both presenting and best corrected visual acuity were taken. Anterior segment photo and fundus photo were taken. Live and fundus photo were displayed to the tele-ophthalmology unit at TIO, Kathmandu. Feedback was provided by the MD ophthalmologist (vitreo-retinal fellows). Those who need referral for further evaluation and treatment were suggested to visit TIO at the earliest. Fundus photographs were further verified in offline by the fellowship trained retina specialist for accurate diagnosis. Further feedback were provided to patients as needed. Feedback were also taken from the MD residents, Ophthalmologist, ophthalmic technicians for the ease and effectiveness of tele-ophthalmology techniques of the existing method and new method adding anterior segment and fundus photographs. Diagnosis of the patient and referral were evaluated.

**Study Population**

Study population included were patients presenting to Nuwakot and Dhading CECs for eye check at the age 19 years old or above with BCVA 6/18 or worse, new or longstanding visual field deficit,

diagnosis of Type 1 or Type 2 diabetes, systemic hypertension and all patients 60 years of age or older visiting CECs, regardless of BCVA or comorbidities.

### **Sample Size**

All consecutive patients receiving tele-ophthalmology service from pre-intervention tele-ophthalmology encounters from Nuwakot and Dhading CECs

Six hundred patients with 300 patients each of the two CECs meeting inclusion criteria.

### **Number of participants and justification:**

Sample size of 600 tele-ophthalmology encounters post-intervention and all consecutive cases of pre intervention were expected to provide adequate power to detect difference of 5% in referral rates at a 95% confidence interval.

### **Sampling Technique**

All consecutive patients visiting participating CECs and fulfilling the inclusion criteria were enrolled in the study.

### **Criteria for Sample selection**

#### **Inclusion Criteria:**

1. All patients 19 years old or above visiting participating CECs with BCVA 6/18 or worse
2. All patients 19 years old or above visiting participating CECs with new or longstanding visual field deficit

3. All patients 19 years old or above visiting CECs with diagnosis of Type 1 or Type 2 diabetes
4. All patients 19 years old or above visiting CECs with diagnosis of systemic hypertension
5. All patients 60 years of age or older visiting CECs, regardless of BCVA or comorbidities

**Exclusion Criteria:**

1. The presence or history of any ocular disorder or condition that would likely interfere with the interpretation of the study results or patient safety
2. Patients identified by technicians as having cataracts or other media opacities that preclude clear imaging of the posterior segment

**Data Collection Technique**

All patients meeting inclusion criteria were received fundus photography and anterior segment photography. Inability to image the posterior segment were specifically noted on a case-by-case basis.

Patients meeting inclusion criteria were received real-time anterior and posterior segment imaging and consultation with ophthalmologist (Vitreoretinal fellows) were done.

In post intervention phase, there was addition of fundus camera (Right Medical Device PVT. LTD) having both anterior segment and posterior segment photographs.

Patients were assessed for inclusion in study on arrival based on brief questionnaire including age, diagnosis of diabetes, hypertension, visual symptoms, and visual acuity. Details of anterior segment and posterior segment findings were recorded. Advice of patients during tele consultation



were noted. Patient were traced for their followed up at TIO as recommended in the tele-consultation.

Provider and staff opinions of the tele-ophthalmology program were assessed with a short questionnaire utilizing a modified likert scale.

Data regarding identified pathology and referral follow-up were recorded in detail. Staff and provider impressions were assessed using a modified likert scale. Sample size of 600 tele-ophthalmology cases were enrolled in post intervention phase. Appropriateness of referral were determined.

Whether or not patients received treatment, counseling, or other intervention at TIO that could not have been provided at CEC, as determined by ophthalmologist providing care were recorded.

### **Data management and analysis**

Data regarding identified pathology and referral follow-up were descriptive. Staff and provider impressions were assessed using a modified likert scale. Sample size of 600 tele-ophthalmology encounters pre- and post-intervention were provided adequate power to detect difference of 5% in referral rates at a 95% confidence interval. Appropriateness of referral were determined by whether or not patients received treatment, counseling, or other intervention at TIO that could not have been provided at CEC, as determined by ophthalmologist providing care

## **Results**

A total of 600 study participants were enrolled in the study during the post intervention. The mean age of study participants was 62.3 years with SD 13.0. The mean age of participants from Nuwakot and Dhading was same of 62.3 years. Male and female comprised of 220 (36.7%) and 380 (63.3%). Majority of the participants were at the age group 61 to 70 years (34.2%). Agriculture (22.8%) was the most common occupation followed by housewife (21.3%). Half of the total participants (50.8%) were illiterate. Table 1.

During the pre-intervention, the EMR showed a total of 380 participants were enrolled. Among these 203 (53.4%) were from the Nuwakot district CEC and 177 (46.6%) were from the Dhading district CEC.

Table 1. Demographic characteristics of study participants in post intervention

|                            | Dhading |            | Nuwakot |            | Total     | Total      |
|----------------------------|---------|------------|---------|------------|-----------|------------|
| <b>Age group</b>           | count   | percentage | count   | percentage | frequency | percentage |
| <30 years                  | 3       | 1.0        | 4       | 1.3        | 7         | 1.2        |
| 31-40 years                | 18      | 6.0        | 18      | 6.0        | 36        | 6.0        |
| 41-50 years                | 39      | 13.0       | 35      | 11.7       | 74        | 12.3       |
| 51-60 years                | 59      | 19.7       | 58      | 19.3       | 117       | 19.5       |
| 61-70 years                | 102     | 34.0       | 103     | 34.3       | 205       | 34.2       |
| 71-80 years                | 64      | 21.3       | 65      | 21.7       | 129       | 21.5       |
| ≥81 years                  | 15      | 5.0        | 17      | 5.7        | 32        | 5.3        |
| Total                      | 300     | 100.0      | 300     | 100.0      | 600       | 100.0      |
|                            |         |            |         |            |           |            |
| <b>Gender</b>              |         |            |         |            |           |            |
| Male                       | 103     | 34.3       | 117     | 39.0       | 220       | 36.7       |
| Female                     | 197     | 65.7       | 183     | 61.0       | 380       | 63.3       |
| Total                      | 300     | 100.0      | 300     | 100.0      | 600       | 100.0      |
|                            |         |            |         |            |           |            |
| <b>Occupation</b>          |         |            |         |            |           |            |
| Agriculture                | 51      | 17.8       | 86      | 28.7       | 137       | 22.8       |
| business                   | 10      | 3.5        | 2       | 7          | 12        | 2.0        |
| Government/private service | 23      | 8.0        | 38      | 12.7       | 61        | 10.2       |
| Household/housewife        | 77      | 26.8       | 51      | 17.0       | 128       | 21.3       |
| Retired service            | 5       | 1.7        | 1       | .3         | 6         | 1.0        |
| Self employed              | 35      | 12.2       | 12      | 4.0        | 47        | 7.8        |
| No job                     | 84      | 29.3       | 109     | 36.3       | 193       | 32.2       |

|                   |     |       |     |       |     |       |
|-------------------|-----|-------|-----|-------|-----|-------|
| Others            | 2   | .7    | 1   | .3    | 3   | .5    |
| Total             | 287 | 100.0 | 300 | 100.0 | 587 | 97.8  |
| Not mentioned     | 13  |       |     |       | 13  | 2.2   |
| Total             | 300 | 100.0 | 300 | 100.0 | 600 | 100.0 |
| <b>Education</b>  |     |       |     |       |     |       |
| Illiterate        | 130 | 43.3  | 175 | 58.3  | 305 | 50.8  |
| Up to SLC         | 126 | 56.3  | 125 | 41.7  | 226 | 37.7  |
| Intermediate      | 24  | 8.0   | 16  | 5.3   | 40  | 6.7   |
| Bachelor          | 12  | 4.0   | 7   | 2.3   | 19  | 3.2   |
| Masters and above | 8   | 2.7   | 2   | .7    | 10  | 1.7   |
| Total             | 300 | 100.0 | 300 | 100.0 | 600 | 100.0 |

Overall 179 (29.8%) of the participants had underlying diabetes mellitus. In Dhading district, diabetes comprised of 37% and in Nuwakot, 22.7%. Type 1 diabetes comprised of 6% and rest were of type 2 diabetes. Among the total participants, 56.4% were having systemic hypertension and 6.2% were having hyperlipidaemia. Among the other systemic problems, asthma was found in 1.7%, cardiac problems was found in 5%, neurological diseases in 5%, renal problems in 2%, mental problems in 3%, gastrointestinal problems in 2%, thyroid problems in 1.3%, and lung problems in 3%. Table 2.

Table 2. Pattern of systemic diseases among the study participants in post intervention

|                        | Dhading |            | Nuwakot |            | Total     |            |
|------------------------|---------|------------|---------|------------|-----------|------------|
|                        | count   | percentage | count   | percentage | frequency | percentage |
| Diabetes mellitus      |         |            |         |            |           |            |
| Yes                    | 111     | 37.0       | 68      | 22.7       | 179       | 29.8       |
| No                     | 189     | 63.0       | 232     | 77.3       | 421       | 70.2       |
| Total                  | 300     | 100.0      | 300     | 100.0      | 600       | 100.0      |
|                        |         |            |         |            |           |            |
| Diabetes mellitus type |         |            |         |            |           |            |
| Type 1                 | 4       | 3.6        | 7       | 10.3       | 11        | 6.1        |
| Type 2                 | 107     | 96.4       | 61      | 89.7       | 168       | 93.9       |
| Total                  | 111     | 100.0      | 68      | 100.0      | 179       | 100.0      |
|                        |         |            |         |            |           |            |
| Hypertension           |         |            |         |            |           |            |
| Yes                    | 147     | 49.0       | 182     | 60.7       | 329       | 54.8       |
| No                     | 153     | 51.0       | 118     | 39.3       | 271       | 45.2       |
| Total                  | 300     | 100.0      | 300     | 100.0      | 600       | 100.0      |

|                |     |       |     |       |     |      |
|----------------|-----|-------|-----|-------|-----|------|
|                |     |       |     |       |     |      |
| Hyperlipidemia |     |       |     |       |     |      |
| Yes            | 18  | 6.0   | 19  | 6.3   | 37  | 6.2  |
| No             | 282 | 94.0  | 281 | 93.7  | 563 | 93.8 |
| Total          | 300 | 100.0 | 300 | 100.0 | 600 | 93.8 |

Among the total study participants, in right eye, 47.5% were presented for poor vision. Among the two centres, in Dhading, 58.3% were presented for the poor vision while in Nuwakot, 36.7% were presented for the poor vision. In left eye, the complaint of poor vision was found in 48.2%. The complaint of poor vision was highest in Dhading (58.3%) while in Nuwakot it was in 37%. Floaters was found in 4.7% in RE and 4.3% in LE. History of flashes was found in 1.3% each in RE and LE. Table 3.

Table 3. Chief complains among the study participants in post intervention

| Chief complains    | Dhading |       | Nuwakot |       | Frequency | Percentage |
|--------------------|---------|-------|---------|-------|-----------|------------|
| Poor vision RE     |         |       |         |       |           |            |
| yes                | 175     | 58.3  | 110     | 36.7  | 285       | 47.5       |
| No                 | 125     | 41.7  | 190     | 63.3  | 315       | 52.5       |
| Total              | 300     | 100.0 | 300     | 100.0 | 600       | 100.0      |
|                    |         |       |         |       |           |            |
| Poor vision LE     |         |       |         |       |           |            |
| Yes                | 178     | 59.3  | 111     | 37.0  | 289       | 48.2       |
| No                 | 122     | 40.7  | 189     | 63.0  | 311       | 51.8       |
| Total              | 300     | 100.0 | 300     | 100.0 | 600       | 100.0      |
|                    |         |       |         |       |           |            |
| Distorted image RE |         |       |         |       |           |            |
| NO                 | 300     | 100.0 | 300     | 100.0 | 600       | 100.0      |
|                    |         |       |         |       |           |            |
| Distorted image LE |         |       |         |       |           |            |
| NO                 | 300     | 100.0 | 300     | 100.0 | 600       | 100.0      |
|                    |         |       |         |       |           |            |

|             |     |       |     |       |     |       |
|-------------|-----|-------|-----|-------|-----|-------|
| Floaters RE |     |       |     |       |     |       |
| Yes         | 19  | 6.3   | 9   | 3.0   | 28  | 4.7   |
| No          | 281 | 93.7  | 291 | 97.0  | 572 | 95.3  |
| Total       | 300 | 100.0 | 300 | 100.0 | 600 | 100.0 |
|             |     |       |     |       |     |       |
| Floaters LE |     |       |     |       |     |       |
| Yes         | 19  | 6.3   | 7   | 2.3   | 26  | 4.3   |
| No          | 281 | 93.7  | 293 | 97.7  | 574 | 95.7  |
| Total       | 300 | 100.0 | 300 | 100.0 | 600 | 100.0 |
|             |     |       |     |       |     |       |
| Flashes RE  |     |       |     |       |     |       |
| Yes         | 7   | 2.3   | 1   | .3    | 8   | 1.3   |
| No          | 293 | 97.7  | 299 | 99.7  | 592 | 98.7  |
| Total       | 300 | 100.0 | 300 | 100.0 | 600 | 100.0 |
|             |     |       |     |       |     |       |
| Flashes LE  |     |       |     |       |     |       |
| Yes         | 8   | 2.7   | 0   | 0.0   | 8   | 1.3   |
| No          | 292 | 97.3  | 300 | 100.0 | 592 | 98.7  |
| Total       | 300 | 100.0 | 300 | 100.0 | 600 | 100.0 |
|             |     |       |     |       |     |       |
| Others RE   |     |       |     |       |     |       |
| Yes         | 46  | 15.3  | 113 | 37.7  | 159 | 26.5  |
| No          | 254 | 84.7  | 187 | 62.3  | 441 | 73.5  |
| Total       | 300 | 100.0 | 300 | 100.0 | 600 | 100.0 |
|             |     |       |     |       |     |       |
| Others LE   |     |       |     |       |     |       |
| Yes         | 42  | 14.0  | 99  | 37.5  | 141 | 25.0  |
| No          | 257 | 86.0  | 165 | 62.5  | 422 | 75.0  |
| Total       | 299 | 100.0 | 264 | 100.0 | 563 | 100.0 |

RE: Right eye, LE: Left eye

Among the total participants with diabetes, 10% were under only diet restriction, 60.7% with oral hypoglycaemic agents, 5% with insulin and rest having mixed types of treatment. Among the participants with hypertension, 49% were under the oral medications. Table 4.

Table 4. Pattern of systemic disease medication among the study participants in post intervention

|                  | Dhading |             | Nuwakot |             | Total     | Total      |
|------------------|---------|-------------|---------|-------------|-----------|------------|
| <b>DM</b>        | count   | Percentage% | count   | Percentage% | frequency | percentage |
| OHA              | 99      | 89.2        | 45      | 66.17       | 144       | 80.4       |
| Insulin          | 1       | .9          | 8       | 11.76       | 9         | 5.02       |
| Diet only        | 9       | 8.1         | 9       | 13.23       | 18        | 10.05      |
| OHA with insulin | 2       | 1.8         | 6       | 8.82        | 8         | 4.46       |
| total            | 111     | 100.0       | 68      | 100.0       | 179       | 100.0      |

|                     |     |       |     |       |     |       |
|---------------------|-----|-------|-----|-------|-----|-------|
|                     |     |       |     |       |     |       |
| <b>Hypertension</b> |     |       |     |       |     |       |
| Oral                | 135 | 91.84 | 159 | 87.36 | 294 | 89.36 |
| Diet                | 12  | 8.16  | 23  | 12.64 | 35  | 10.64 |
| total               | 147 | 100.0 | 182 | 100.0 | 329 | 100.0 |

DM: Diabetes mellitus, OHA: Oral hypoglycaemic agents

Overall, 47.5% were smokers. Majority were past smokers (37.3%). Alcohol consumption was found in 49.5%. Majority were also had past history of alcohol consumption (28.2%). Table 5.

Table 5. Prevalence of smoking and Alcohol history of the study participants

|         |         |             |         |             |           |            |
|---------|---------|-------------|---------|-------------|-----------|------------|
|         | Dhading |             | Nuwakot |             | Total     |            |
| Smoking | count   | Percentage% | count   | Percentage% | Frequency | Percentage |
| Never   | 102     | 34.0        | 159     | 53.0        | 261       | 43.5       |
| Past    | 131     | 43.7        | 93      | 31.0        | 224       | 37.3       |
| Present | 67      | 22.3        | 48      | 16.0        | 115       | 19.2       |
| Total   | 300     | 100.0       | 300     | 100.0       | 600       | 100.0      |
|         |         |             |         |             |           |            |
| Alcohol |         |             |         |             |           |            |
| Never   | 146     | 48.7        | 163     | 54.3        | 309       | 51.5       |
| Past    | 87      | 29.0        | 82      | 27.3        | 169       | 28.2       |
| Present | 67      | 22.3        | 55      | 18.3        | 122       | 20.3       |
| Total   | 300     | 100.0       | 300     | 100.0       | 600       | 100.0      |

Among the smokers, 97.3% consume cigarettes. Only home-made (local) alcohol was consumed by 64% of the participants. Table 6.

Table 6. Pattern of smoking and alcohol consumption among the study participants

|                      |         |             |         |             |           |            |
|----------------------|---------|-------------|---------|-------------|-----------|------------|
|                      | Dhading |             | Nuwakot |             | Total     |            |
| <b>Smoking</b>       | Count   | Percentage% | Count   | Percentage% | Frequency | percentage |
| cigarette            | 185     | 95.4        | 139     | 100.0       | 324       | 97.3       |
| tobacco              | 7       | 3.6         | 0       | 0.0         | 7         | 2.1        |
| hukkah               | 2       | 1.0         | 0       | 0.0         | 2         | .6         |
| total                | 194     | 100.0       | 139     | 100.0       | 333       | 100.0      |
|                      |         |             |         |             |           |            |
| <b>Alcohols</b>      |         |             |         |             |           |            |
| All kinds/ any kinds | 9       | 5.9         | 83      | 61.9        | 92        | 32.2       |

|                     |     |       |     |       |     |       |
|---------------------|-----|-------|-----|-------|-----|-------|
| Homemade/local      | 137 | 90.1  | 46  | 34.3  | 183 | 64.0  |
| Beer/ wine/ whiskey | 6   | 3.9   | 5   | 3.7   | 11  | 3.8   |
| Total               | 152 | 100.0 | 134 | 100.0 | 286 | 100.0 |

Among the total participants, 71% had presbyopia. The distance refractive error was found in 20.7% in RE and 20.4% in LE. Table 7.

Table 7. Prevalence of refractive error among the study participants

| <b>Types<br/>Refractive error</b> | Dhading |       | Nuwakot |       | Total     |            |
|-----------------------------------|---------|-------|---------|-------|-----------|------------|
|                                   | COUNT   | %     | COUNT   | %     | Frequency | Percentage |
| Presbyopia RE                     |         |       |         |       |           |            |
| Yes                               | 170     | 56.7  | 260     | 86.7  | 430       | 71.7       |
| No                                | 130     | 43.3  | 40      | 13.3  | 170       | 28.3       |
| Total                             | 300     | 100.0 | 300     | 100.0 | 600       | 100.0      |
| Refractive error RE               |         |       |         |       |           |            |
| Yes                               | 2       | .7    | 122     | 40.7  | 124       | 20.7       |
| No                                | 298     | 99.3  | 178     | 59.3  | 476       | 79.3       |
| Total                             | 300     | 100.0 | 300     | 100.0 | 600       | 100.0      |
| Presbyopia LE                     |         |       |         |       |           |            |
| Yes                               | 170     | 56.7  | 260     | 87.0  | 430       | 71.8       |
| No                                | 130     | 43.3  | 39      | 13.0  | 169       | 28.2       |
| Total                             | 300     | 100.0 | 299     | 100.0 | 599       | 100.0      |
| Refractive error LE               |         |       |         |       |           |            |
| Yes                               | 2       | .7    | 120     | 40.1  | 122       | 20.4       |
| No                                | 298     | 99.3  | 179     | 59.9  | 477       | 79.6       |
| Total                             | 300     | 100.0 | 299     | 100.0 | 599       | 100.0      |

RE: Right eye, LE: Left eye

Among the total participants, 8.3% of RE and 6.7% of LE were pseudophakic. Table 8.

Table 8. Prevalence of psudophakia among the study participants

|  |         |  |         |  |       |  |
|--|---------|--|---------|--|-------|--|
|  | Dhading |  | Nuwakot |  | Total |  |
|--|---------|--|---------|--|-------|--|

| Psudophakia RE | COUNT | %     | COUNT | %     | Frequency | Percentage |
|----------------|-------|-------|-------|-------|-----------|------------|
| Yes            | 2     | .7    | 48    | 40.7  | 50        | 8.3        |
| No             | 281   | 93.7  | 269   | 89.7  | 550       | 91.7       |
| Total          | 300   | 100.0 | 300   | 100.0 | 600       | 100.0      |
|                |       |       |       |       |           |            |
| Psudophakia LE |       |       |       |       |           |            |
| Yes            | 22    | 7.3   | 18    | 6.0   | 40        | 6.7        |
| No             | 278   | 92.7  | 281   | 94.0  | 559       | 93.3       |
| Total          | 300   | 100.0 | 299   | 100.0 | 599       | 100.0      |
|                |       |       |       |       |           |            |

RE: Right eye, LE: Left eye

Overall, 89% of the participants had some ocular complains in either eyes. Among the total, 93.1% had bilateral involvement and 6.9% had unilateral involvement. Table 9.

Table 9. Prevalence of overall ocular problems among the study participants

|         |         | ocular problems in person |       |            |       |           |       |       |        |
|---------|---------|---------------------------|-------|------------|-------|-----------|-------|-------|--------|
|         |         | ocular problems in person |       | Unilateral |       | Bilateral |       | Total |        |
|         |         | Count                     | %     | Count      | %     | Count     | %     | Count | %      |
| ADDRESS | DHADING | 238                       | 79.3% | 26         | 10.9% | 212       | 89.1% | 238   | 100.0% |
|         | NUWAKOT | 296                       | 98.7% | 11         | 3.7%  | 285       | 96.3% | 296   | 100.0% |
|         | Total   | 534                       | 89.0% | 37         | 6.9%  | 497       | 93.1% | 534   | 100.0% |

Anterior segment ocular problems was found in 44.8% of the participants. In Dhading, it was 57.7% while in Nuwakot, 44.8%. However, majority (98.2%) were of bilateral involvement. Table 10.

Table 10. Prevalence of overall anterior segment ocular problems among the study participants

|         |         | anterior segment ocular problems in person |       |            |       |           |        |       |         |
|---------|---------|--------------------------------------------|-------|------------|-------|-----------|--------|-------|---------|
|         |         | ocular problems in person                  |       | Unilateral |       | Bilateral |        | Total |         |
|         |         | Count                                      | %     | Count      | %     | Count     | %      | Count | %       |
| ADDRESS | DHADING | 173                                        | 57.7% | 4          | 2.30% | 169       | 97.70% | 173   | 100.00% |
|         | NUWAKOT | 96                                         | 32%   | 4          | 1.40% | 274       | 98.60% | 278   | 100.00% |
|         | Total   | 269                                        | 44.8% | 8          | 1.80% | 443       | 98.20% | 451   | 100.00% |



Retinal problems were found in 64.6 % of the participants. Out of these, bilateral involvement was found in 41.8% of the participants. Table 11

Table 11. Prevalence of overall retinal problems among the study participants

|         |         | Retinal Disease Person |       |            |       |           |       |       |        |
|---------|---------|------------------------|-------|------------|-------|-----------|-------|-------|--------|
|         |         | Retinal Disease        |       | Unilateral |       | Bilateral |       | Total |        |
|         |         | Count                  | %     | Count      | %     | Count     | %     | Count | %      |
| ADDRESS | DHADING | 188                    | 62.6% | 48         | 16.0% | 111       | 37.0% | 300   | 100.0% |
|         | NUWAKOT | 200                    | 66.6% | 45         | 15.0% | 140       | 46.7% | 300   | 100.0% |
|         | Total   | 388                    | 64.6% | 93         | 15.5% | 251       | 41.8% | 600   | 100.0% |

Among the study participants, in RE, 33.2% were having cataract. Conjunctival problems were found in 0.7%, corneal problems in 0.3%, pterygium and pinguecula in 1.7%, and NLD obstruction in 3%. In LE, cataract comprised of 35.2%, conjunctival disease in 0.5%, pinguecula, pterygium in 1%.

Among the posterior segment problems, among all the cases with diabetes, the DR was found in 20.67% in RE and 24.58% in LE. CSME was found in 8.37% in RE and 8.94% in LE. Among the cases with hypertension, hypertensive retinopathy was found in 24.31% in RE and 25.53% in LE. Intermediate AMD was found in 16.8% in RE and 6% in LE. CRVO was found in 0.7% in RE and 0.8% in LE. Macular hole was found in 0.3% in RE and 0.5% in LE. Table 12.

Table 12. Diagnosis of ocular pathologies among the study participants (in eye) in overall lives and cloud based tele-ophthalmology system.

| Ocular diseases                      | Dhading |      | Nuwakot |      | Total     |            |
|--------------------------------------|---------|------|---------|------|-----------|------------|
| Anterior segment disease (Right eye) | COUNT   | %    | COUNT   | %    | Frequency | Percentage |
| Cataract                             | 127     | 42.3 | 72      | 24.0 | 199       | 33.2       |
| Conjuntival disease                  | 0       | 0.0  | 4       | 1.3  | 4         | .6         |
| Corneal disease                      | 2       | .7   | 1       | .3   | 3         | .5         |
| Pterygium/pingcula                   | 2       | .7   | 8       | 2.7  | 10        | 1.7        |

|                                             |     |       |     |       |     |       |
|---------------------------------------------|-----|-------|-----|-------|-----|-------|
| NLD obstruction                             | 0   | 0.0   | 2   | .7    | 2   | .3    |
| Others                                      | 6   | 2     | 9   | 3     | 15  | 2.5   |
| No Problem                                  | 163 | 54.3  | 204 | 68    | 367 | 61.2  |
| Total                                       | 300 | 100.0 | 300 | 100.0 | 600 | 100.0 |
| <b>Anterior segment disease (Left eye)</b>  |     |       |     |       |     |       |
| <b>Anterior segment disease (Right eye)</b> |     |       |     |       |     |       |
| Cataract                                    | 124 | 41.3  | 87  | 29.1  | 211 | 35.2  |
| Conjunctival disease                        | 0   | 0.0   | 3   | 1.0   | 3   | .5    |
| Corneal disease                             | 0   | 0.0   | 0   | 0.0   | 0   | 0.0   |
| Iris                                        | 0   | 0.0   | 6   | 2.0   | 6   | 1.0   |
| Diabetic retinopathy                        | 0   | 0.0   | 1   | .3    | 1   | .2    |
| NLD obstruction                             | 12  | 4.0   | 7   | 2.3   | 19  | 3.2   |
| Mild NPDR                                   | 3   | 1.0   | 9   | 3.0   | 12  | 2.0   |
| Others                                      | 3   | 1.0   | 3   | 1.0   | 6   | 1.0   |
| Moderate NPDR                               | 173 | 57.6  | 194 | 64.6  | 367 | 61.1  |
| No problem                                  | 5   | 1.7   | 3   | 1.0   | 8   | 1.3   |
| Severe NPDR                                 | 300 | 100.0 | 300 | 100.0 | 600 | 100.0 |
| Very severe NPDR                            | 0   | 0.0   | 0   | 0.0   | 0   | 0.0   |
| PDR                                         | 0   | 0.0   | 2   | 0.7   | 2   | 0.3   |
| Overall DR                                  | 22  | 7.3   | 15  | 5.0   | 37  | 6.2   |
| No DR                                       | 89  | 29.7  | 53  | 17.7  | 142 | 23.8  |
| CSME                                        | 7   | 2.3   | 8   | 2.7   | 15  | 2.5   |
| Total DM                                    | 111 | 36.9  | 68  | 22.7  | 179 | 29.7  |
| <b>HTN Retinopathy</b>                      |     |       |     |       |     |       |
| Grade 1                                     | 20  | 6.7   | 26  | 8.7   | 46  | 7.7   |
| Grade 2                                     | 13  | 4.3   | 19  | 6.3   | 32  | 5.3   |
| Grade 3                                     | 2   | 0.7   | 0   | 0.0   | 2   | 0.3   |
| Overall HTN Retinopathy                     | 35  | 11.7  | 45  | 15.0  | 80  | 13.3  |
| Total HTN                                   | 147 | 49.0  | 182 | 60.7  | 329 | 54.4  |
| Macular hole                                | 2   | 0.7   | 0   | 0.0   | 2   | 0.3   |
| AMD                                         |     |       |     |       |     |       |
| Mild ARMD                                   | 32  | 10.7  | 23  | 7.7   | 55  | 9.2   |
| Intermediate ARMD                           | 42  | 14.0  | 59  | 19.7  | 101 | 16.7  |
| Wet ARMD                                    | 1   | 0.3   | 0   | 0.0   | 1   | 0.2   |
| Geographic atrophy                          | 4   | 1.3   | 8   | 2.7   | 12  | 2.0   |
| Macular scar                                | 6   | 2.0   | 6   | 2.0   | 12  | 2.0   |
| BRVO                                        | 4   | 1.3   | 5   | 1.7   | 9   | 1.5   |
| CRVO                                        | 4   | 1.3   | 0   | 0.0   | 4   | 0.7   |
| Epiretinal membrane                         | 2   | 0.7   | 2   | 0.7   | 4   | 0.7   |
| RPE changes                                 | 9   | 3.0   | 13  | 4.3   | 22  | 3.7   |
| TRD                                         | 1   | 0.3   | 0   | 0.0   | 1   | 0.2   |
| RRD                                         | 2   | 0.7   | 0   | 0.0   | 2   | 0.3   |
| Optic atrophy                               | 3   | 1.0   | 9   | 3.0   | 12  | 2.0   |

|                                             |     |       |     |       |     |              |
|---------------------------------------------|-----|-------|-----|-------|-----|--------------|
| Vitreous hemorrhage                         | 2   | .7    | 3   | 1.0   | 5   | .83          |
| Retinitis pigmentosa                        | 3   | 1.0   | 0   | 0.0   | 3   | .5           |
| Asteroid hyalosis                           | 1   | .3    | 0   | 0.0   | 1   | .2           |
| Chorioretinal scar                          | 2   | .7    | 2   | .7    | 4   | .7           |
| Dilated tortuous vessels                    | 3   | 1.0   | 2   | .7    | 5   | .83          |
| Old uveitis                                 | 1   | .3    | 0   | 0.0   | 1   | .2           |
| No pathologies                              | 112 | 37.3  | 100 | 33.3  | 212 | 35.3         |
| Total                                       | 300 | 100.0 | 300 | 100.0 | 600 | 100.0        |
| <b>Posterior segment disease (Left eye)</b> |     |       |     |       |     |              |
|                                             |     |       |     |       |     |              |
| Diabetic retinopathy                        |     |       |     |       |     |              |
| Mild NPDR                                   | 14  | 12.6  | 8   | 11.76 | 22  | 12.29        |
| Moderate NPDR                               | 6   | 5.4   | 3   | 4.41  | 9   | 5.02         |
| Severe NPDR                                 | 5   | 4.5   | 2   | 2.94  | 7   | 3.9          |
| Very severe NPDR                            | 0   |       | 0   |       | 0   | 0            |
| PDR                                         | 2   | 1.8   | 4   | 5.88  | 6   | 3.35         |
| Overall DR                                  | 27  | 24.32 | 17  | 25    | 44  | <b>24.58</b> |
| CSME                                        | 11  | 9.9   | 5   | 7.35  | 16  | <b>8.94</b>  |
| No DR                                       | 84  | 75.68 | 51  | 75    | 135 | 75.41        |
| Overall DM                                  | 111 |       | 68  |       | 179 |              |
| HTN Retinopathy                             |     |       |     |       |     |              |
| Types of retinopathy                        |     |       |     |       |     |              |
| Grade 1                                     | 20  | 13.6  | 27  | 14.83 | 47  | 14.28        |
| Grade 2                                     | 17  | 11.56 | 18  | 9.89  | 35  | 10.63        |
| Grade 3                                     | 1   | 0.68  | 1   | 0.55  | 2   | 0.61         |
| Overall HTN Retinopathy                     | 38  | 25.85 | 46  |       | 84  | <b>25.53</b> |
| Overall HTN                                 | 147 |       | 182 |       | 329 |              |
| Macular hole                                | 0   | 0.0   | 3   | 1.0   | 3   | .5           |
| AMD                                         |     |       |     |       |     |              |
| Mild ARMD                                   | 21  | 7     | 33  | 11    | 54  | 9            |
| Intermediate ARMD                           | 17  | 5.7   | 19  | 6.4   | 36  | 6            |
| Wet ARMD                                    | 2   | .7    | 1   | .3    | 3   | .5           |
| Geographic atrophy                          | 2   | .7    | 6   | 2     | 8   | 7.0          |
| Macular scar                                | 7   | 2.3   | 7   | 2.4   | 14  | 2.3          |
| BRVO                                        | 2   | .7    | 5   | 1.7   | 7   | 1.2          |
| CRVO                                        | 2   | .7    | 3   | 1.0   | 5   | .8           |

|                                 |     |       |     |       |     |       |
|---------------------------------|-----|-------|-----|-------|-----|-------|
| Epiretinal membrane             | 2   | .7    | 5   | 1.7   | 7   | 1.2   |
| RPE changes                     | 9   | 3.0   | 17  | 5.7   | 26  | 4.3   |
| Glaucoma suspected/<br>Glaucoma | 5   | 1.7   | 25  | 8.4   | 30  | 5.0   |
| Retinal detachment              |     |       |     |       |     |       |
| TRD                             | 2   | .7    | 1   | .3    | 3   | .5    |
| RD                              | 0   | 0.0   | 2   | .7    | 2   | .3    |
| Optic atrophy                   | 4   | 1.3   | 15  | 5.0   | 19  | 3.2   |
| Vitreous hemorrhage             | 3   | 1.0   | 2   | .7    | 5   | .83   |
| Retinitis pigmentosa            | 2   | .7    | 0   | 0.0   | 2   | .3    |
| Others                          |     |       |     |       |     |       |
| Asteroid hyalosis               | 0   | 0.0   | 2   | .7    | 2   | .3    |
| Chorioretinal scar              | 8   | 2.7   | 5   | 1.7   | 13  | 2.2   |
| Dilated tortuous vessels        | 3   | 1     | 3   | 1     | 6   | 1     |
| No problems                     | 133 | 44.3  | 81  | 27    | 214 | 35.7  |
| Total                           | 300 | 100.0 | 300 | 100.0 | 600 | 100.0 |

NLD: Nasolacrimal duct, NPDR: Non proliferative Diaabetic Retinopathy, PDR: Proliferative diabetic retinopathy

Among the study participants, the prevalence of DR on live and cloud based tele-ophthalmology system reported 19.5% and 20.1% respectively. Table 13.

Table 13. Pattern of diabetic retinopathy on live and cloud based tele-ophthalmology (Eyes)

| Diagnosis            | Types       | Cloud Count | %      | Live Count | %      |
|----------------------|-------------|-------------|--------|------------|--------|
| DIABETIC RETINOPATHY |             |             |        |            |        |
|                      | Yes         | 70          | 19.5%  | 72         | 20.1%  |
|                      | No          | 288         | 80.5%  | 286        | 79.9%  |
|                      | Total       | 358         | 100.0% | 358        | 100.0% |
| IF YES, TYPE         |             |             |        |            |        |
|                      | NPDR        | 52          | 74.3%  | 65         | 89.0%  |
|                      | PDR         | 18          | 25.7%  | 8          | 11.0%  |
|                      | Total       | 70          | 100.0% | 73         | 100.0% |
| NPDR TYPES           |             |             |        |            |        |
|                      | Mild        | 29          | 55.8%  | 41         | 56.2%  |
|                      | Moderate    | 15          | 28.8%  | 17         | 23.3%  |
|                      | Severe      | 8           | 15.4%  | 15         | 20.5%  |
|                      | Very severe | 0           | 0.0%   | 0          | 0.0%   |

|      |       |     |        |     |        |
|------|-------|-----|--------|-----|--------|
|      | Total | 52  | 100.0% | 73  | 100.0% |
| CSME |       |     |        |     |        |
|      | Yes   | 38  | 10.61% | 31  | 2.6%   |
|      | No    | 320 | 89.39% | 327 | 91.34% |
|      | Total | 358 | 100.0% | 358 | 100.0% |

The presenting and uncorrected visual acuity of 6/6 to 6/12 was found in 41.4%. After the best correction, the same visual acuity of 6/6 to 6/12 was found in 73.5%. Table 14.

Table 14. Visual acuity among the study participants

| Visual acuity  | Dhading |             | Nuwakot |             | Total     |             |
|----------------|---------|-------------|---------|-------------|-----------|-------------|
| Presenting VA  | count   | Percentage% | count   | Percentage% | Frequency | Percentage% |
| 6/6-6/12       | 117     | 39.1        | 131     | 43.7        | 248       | 41.4        |
| 6/12-6/18      | 81      | 27.1        | 94      | 31.3        | 175       | 29.2        |
| 6/18- 6/60     | 82      | 27.4        | 60      | 20.0        | 142       | 23.7        |
| 6/60 – 3/60    | 15      | 5.0         | 2       | 7           | 17        | 2.8         |
| 3/60 - PL      | 4       | 1.3         | 13      | 4.3         | 17        | 2.8         |
| NPL            | 0       | 0.0         | 0       | 0.0         | 0         | 0.0         |
| Total          | 299     | 100.0       | 300     | 100.0       | 599       | 100.0       |
| Uncorrected VA |         |             |         |             |           |             |
| 6/6-6/12       | 117     | 39.1        | 131     | 43.7        | 248       | 41.4        |
| 6/12-6/18      | 81      | 27.1        | 94      | 31.3        | 175       | 29.2        |
| 6/18- 6/60     | 82      | 27.4        | 60      | 20.0        | 142       | 23.7        |
| 6/60 – 3/60    | 15      | 5.0         | 2       | 7           | 17        | 2.8         |
| 3/60 - PL      | 4       | 1.3         | 13      | 4.3         | 17        | 2.8         |
| NPL            | 0       | 0.0         | 0       | 0.0         | 0         | 0.0         |
| Total          | 299     | 100.0       | 300     | 100.0       | 599       | 100.0       |
| BCVA           |         |             |         |             |           |             |
| 6/6-6/12       | 211     | 70.3        | 230     | 76.7        | 441       | 73.5        |
| 6/12-6/18      | 66      | 22.0        | 35      | 11.7        | 101       | 16.8        |
| 6/18- 6/60     | 21      | 7.0         | 25      | 8.3         | 46        | 7.7         |
| 6/60 – 3/60    | 1       | .3          | 0       | 0.0         | 1         | .2          |
| 3/60 - PL      | 1       | .3          | 10      | 3.3         | 11        | 1.8         |
| NPL            | 0       | 0.0         | 0       | 0.0         | 0         | 0.0         |
| Total          | 300     | 100.0       | 300     | 100.0       | 600       | 100.0       |

VA: Visual acuity, BCVA: Best corrected visual acuity

A total of 60.3% of study participants in post intervention group needed referral. Among the two districts, referral were higher in Nuwakot (62%) as compared to the Dhading (58.7%).

Out of the referred cases, one fourth (25%) visited the tertiary hospital within one to three months. Table 15.

Table 15. Prevalence of referral from Tele-screening sites in person.

|                             |       | ADDRESS |        |         |        |       |        |
|-----------------------------|-------|---------|--------|---------|--------|-------|--------|
|                             |       | DHADING |        | NUWAKOT |        | Total |        |
|                             |       | Count   | %      | Count   | %      | Count | %      |
| Referral                    | Yes   | 176     | 58.7%  | 186     | 62.0%  | 362   | 60.3%  |
|                             | No    | 124     | 41.3%  | 114     | 38.0%  | 238   | 39.7%  |
|                             | Total | 300     | 100.0% | 300     | 100.0% | 600   | 100.0% |
| Live                        | Yes   | 91      | 30.3%  | 80      | 26.7%  | 171   | 28.5%  |
|                             | No    | 209     | 69.7%  | 220     | 73.3%  | 429   | 71.5%  |
|                             | Total | 300     | 100.0% | 300     | 100.0% | 600   | 100.0% |
| Cloud                       | Yes   | 85      | 28.3%  | 106     | 35.3%  | 191   | 31.8%  |
|                             | No    | 215     | 71.7%  | 194     | 64.7%  | 409   | 68.2%  |
|                             | Total | 300     | 100.0% | 300     | 100.0% | 600   | 100.0% |
| Common Referral             | Yes   | 81      | 27.0%  | 69      | 23.0%  | 150   | 25.0%  |
|                             | No    | 219     | 73.0%  | 231     | 77.0%  | 450   | 75.0%  |
|                             | Total | 300     | 100.0% | 300     | 100.0% | 600   | 100.0% |
| REFERAL PT<br>COME TO TIO   | Yes   | 54      | 30.7%  | 37      | 19.9%  | 91    | 25.1%  |
|                             | No    | 122     | 69.3%  | 149     | 80.1%  | 271   | 74.9%  |
|                             | Total | 176     | 100.0% | 186     | 100.0% | 362   | 100.0% |
| PATIENT SELF<br>COME TO TIO | yes   | 9       | 3.0%   | 8       | 2.7%   | 17    | 2.8%   |
|                             | no    | 291     | 97.00% | 292     | 97.30% | 583   | 97.20% |
|                             | Total | 300     | 100.0% | 300     | 100.0% | 600   | 100.0% |

TIO: Tilganga Institute of Ophthalmology

During the pre-intervention, a total of 63.42% need referral. Out of these, 46% patients visited to tertiary eye care for their problems during the two years of follow up. Table 15. The referral patients visiting TIO were higher from the Dhading (53.15%) as compared to the Nuwakot (46.85%). Table 16.

Table 16. Pre-intervention total screening and referral (2 year follow up) from CEC

|  | Total patient screening | Total referral | Referral patient come to TIO |
|--|-------------------------|----------------|------------------------------|
|--|-------------------------|----------------|------------------------------|

| CEC     | Frequency | %       | Frequency | %       | Frequency | %       |
|---------|-----------|---------|-----------|---------|-----------|---------|
| Nuwakot | 203       | 53.40%  | 113       | 46.89%  | 52        | 46.85%  |
| Dhading | 177       | 46.60%  | 128       | 53.11%  | 59        | 53.15%  |
| Total   | 380       | 100.00% | 241       | 100.00% | 111       | 100.00% |

Among the two districts, the ocular problems was higher significantly in Nuwakot district (61.7%) as compared to the Dhading (53%) with p value of 0.032. Among the illiterates, the ocular problems were significantly higher (P=0.006). There was no significant difference of ocular problems with age, gender, occupation, systemic hypertension and diabetes. Table 17.

Tables 17. Factors associated with ocular problems among the study participants

| Factors                     | No    |      | Yes   |      | Total |       | P value |
|-----------------------------|-------|------|-------|------|-------|-------|---------|
|                             | Count | %    | count | %    | count | %     |         |
| <b>Address</b>              |       |      |       |      |       |       |         |
| Dhading                     | 141   | 47.0 | 159   | 53.0 | 300   | 100.0 | 0.032   |
| Nuwakot                     | 115   | 38.3 | 185   | 61.7 | 300   | 100.0 |         |
| Total                       | 256   | 42.7 | 344   | 57.3 | 600   | 100.0 |         |
|                             |       |      |       |      |       |       |         |
| <b>Age:</b>                 |       |      |       |      |       |       |         |
| <50                         | 43    | 42.2 | 59    | 57.8 | 102   | 100.0 | 0.909   |
| 50 and above                | 213   | 42.8 | 285   | 57.2 | 498   | 100.0 |         |
| Total                       | 256   | 42.7 | 344   | 57.3 | 600   | 100.0 |         |
|                             |       |      |       |      |       |       |         |
| <b>Gender</b>               |       |      |       |      |       |       |         |
| male                        | 97    | 44.1 | 123   | 55.9 | 220   | 100.0 | 0.591   |
| female                      | 159   | 41.8 | 221   | 58.2 | 380   | 100.0 |         |
| Total                       | 256   | 42.7 | 344   | 57.3 | 600   | 100.0 |         |
|                             |       |      |       |      |       |       |         |
| <b>Education</b>            |       |      |       |      |       |       |         |
| illiterate                  | 114   | 37.3 | 192   | 62.7 | 306   | 100.0 | 0.006   |
| literate                    | 142   | 48.3 | 152   | 51.7 | 294   | 100.0 |         |
| Total                       | 256   | 42.7 | 344   | 57.3 | 600   | 100.0 |         |
|                             |       |      |       |      |       |       |         |
| <b>Occupation</b>           |       |      |       |      |       |       |         |
| Agriculture                 | 58    | 42.3 | 79    | 57.7 | 137   | 100.0 | 0.201   |
| Business                    | 4     | 33.3 | 8     | 66.7 | 12    | 100.0 |         |
| Government/ private service | 35    | 57.4 | 26    | 42.6 | 61    | 100.0 |         |
| Household/housewife         | 56    | 43.8 | 72    | 56.3 | 128   | 100.0 |         |
| Self employed               | 22    | 46.8 | 25    | 53.2 | 47    | 100.0 |         |
| Not working/ retired        | 75    | 37.7 | 124   | 62.3 | 199   | 100.0 |         |

|                                |     |      |     |      |      |       |       |
|--------------------------------|-----|------|-----|------|------|-------|-------|
| Others                         | 1   | 33.3 | 2   | 66.7 | 3    | 100.0 |       |
| Total                          | 251 | 42.8 | 336 | 57.2 | 587  | 100.0 |       |
| <b>Systemic disease</b>        |     |      |     |      |      |       |       |
| Diabetes mellitus              |     |      |     |      |      |       | 0.232 |
| Yes                            | 83  | 46.4 | 96  | 53.6 | 179  | 100.0 |       |
| No                             | 173 | 41.1 | 248 | 58.9 | 421  | 100.0 |       |
| Total                          | 256 | 42.7 | 344 | 57.3 | 600  | 100.0 |       |
| Hypertension                   |     |      |     |      |      |       |       |
| Yes                            | 143 | 43.5 | 186 | 56.5 | 329  | 100.0 | 0.663 |
| No                             | 113 | 41.7 | 158 | 58.3 | 271  | 100.0 |       |
| Total                          | 256 | 42.7 | 344 | 57.3 | 600  | 100.0 |       |
| Hyperlipidemia                 |     |      |     |      |      |       |       |
| Yes                            | 14  | 37.8 | 23  | 62.2 | 37   | 100.0 | 0.54  |
| No                             | 242 | 43.0 | 321 | 57.0 | 563  | 100.0 |       |
| Total                          |     |      |     |      |      |       |       |
| <b>Vision</b>                  |     |      |     |      |      |       |       |
| <b>UCVA_WHO</b>                |     |      |     |      |      |       |       |
| <b>_Classification</b>         |     |      |     |      |      |       |       |
| 6/6-6/18                       | 182 | 43.0 | 241 | 57.0 | 423  | 100.0 | 0.727 |
| < 6/18                         | 73  | 41.5 | 103 | 58.5 | 58.5 | 100.0 |       |
| Total                          | 255 | 42.6 | 344 | 57.4 | 599  | 100.0 |       |
| <b>BCVA_WHO_Classification</b> |     |      |     |      |      |       |       |
| 6/6-6/18                       | 237 | 43.7 | 305 | 56.3 | 542  | 100.0 | 0.108 |
| <6/18                          | 19  | 32.8 | 39  | 67.2 | 58   | 100.0 |       |
| Total                          | 256 | 42.7 | 344 | 57.3 | 600  | 100.0 |       |

BCVA: Best corrected visual acuity, WHO: World Health Organization

Among the study participants, 30% of the participants from Dhading and 27% from Nuwakot that need to be further evaluation at higher center were out of contact because of improper contact numbers. About 12% mentioned, they can't come for follow up at higher center. Likewise, 7% from Dhading and 5% from Nuwakot mentioned their inability to go higher center due to financial problems, 4% from Dhading and 5% from Nuwkaot mentioned their inability due to no accompanying persons. However, 16% from each district mentioned they will come later within a month. Table 18.

Table 18. Reason of patient who will not come to TIO

| S.N | Reason                                  | Dhading   |    | Nuwakot   |     |  |
|-----|-----------------------------------------|-----------|----|-----------|-----|--|
|     |                                         | Frequency | %  | Frequency | %   |  |
| 1   | Number doesn't exist                    | 10        | 8% | 15        | 10% |  |
| 2   | Will not come                           | 6         | 5% | 8         | 5%  |  |
| 3   | Will operate in next OMEC will not come | 10        | 8% | 8         | 5%  |  |
| 4   | Will come if possible patient is week   | 10        | 8% | 12        | 8%  |  |



|    |                                           |     |      |     |      |  |
|----|-------------------------------------------|-----|------|-----|------|--|
| 5  | Unreachable                               | 7   | 6%   | 8   | 5%   |  |
| 6  | Wrong number                              | 6   | 5%   | 8   | 5%   |  |
| 7  | Doesn't want to go                        | 9   | 7%   | 11  | 7%   |  |
| 8  | Patient can't go due to financial reasons | 8   | 7%   | 8   | 5%   |  |
| 9  | Mobile switched off                       | 8   | 7%   | 10  | 7%   |  |
| 10 | Doesn't have any friends so will not come | 5   | 4%   | 8   | 5%   |  |
| 11 | Reached Kathmandu but didn't want to go   | 1   | 1%   | 1   | 1%   |  |
| 12 | Will not come due to family problems      | 7   | 6%   | 5   | 3%   |  |
| 13 | Will come after a month                   | 10  | 8%   | 12  | 8%   |  |
| 14 | Didn't pick up phone                      | 5   | 4%   | 7   | 5%   |  |
| 15 | Not sure                                  | 8   | 7%   | 9   | 6%   |  |
| 16 | Patient will not come due to sickness     | 4   | 3%   | 6   | 4%   |  |
| 17 | Patient will come in 5 to 6 month         | 8   | 7%   | 13  | 9%   |  |
|    | Total                                     | 122 | 100% | 149 | 100% |  |

Among the study participants, ocular problems were higher in Nuwakot ( $p=0.032$ ). Illiterates were found to have significantly more ocular problems ( $P=0.006$ ). On the other hand, among the study participants, age, gender, systemic hypertension, diabetes mellitus, uncorrected and best corrected visual acuity of 6/6 to 6/18 were not significantly associated with presence of ocular problems. Table 19.

Tables 19. Factors associated with ocular problems among the study participants

| Factors          | No    |      | Yes   |      | Total |       | P value |
|------------------|-------|------|-------|------|-------|-------|---------|
|                  | Count | %    | count | %    | count | %     |         |
| <b>Address</b>   |       |      |       |      |       |       |         |
| Dhading          | 141   | 47.0 | 159   | 53.0 | 300   | 100.0 | 0.032   |
| Nuwakot          | 115   | 38.3 | 185   | 61.7 | 300   | 100.0 |         |
| Total            | 256   | 42.7 | 344   | 57.3 | 600   | 100.0 |         |
| <b>Age:</b>      |       |      |       |      |       |       |         |
| <50              | 43    | 42.2 | 59    | 57.8 | 102   | 100.0 | 0.909   |
| 50 and above     | 213   | 42.8 | 285   | 57.2 | 498   | 100.0 |         |
| Total            | 256   | 42.7 | 344   | 57.3 | 600   | 100.0 |         |
| <b>Ganders</b>   |       |      |       |      |       |       |         |
| Male             | 97    | 44.1 | 123   | 55.9 | 220   | 100.0 | 0.591   |
| Female           | 159   | 41.8 | 221   | 58.2 | 380   | 100.0 |         |
| Total            | 256   | 42.7 | 344   | 57.3 | 600   | 100.0 |         |
| <b>Education</b> |       |      |       |      |       |       |         |
| illiterate       | 114   | 37.3 | 192   | 62.7 | 306   | 100.0 | 0.006   |
| literate         | 142   | 48.3 | 152   | 51.7 | 294   | 100.0 |         |
| Total            | 256   | 42.7 | 344   | 57.3 | 600   | 100.0 |         |

|                                  |     |      |     |      |      |       |       |
|----------------------------------|-----|------|-----|------|------|-------|-------|
|                                  |     |      |     |      |      |       |       |
| <b>Occupation</b>                |     |      |     |      |      |       | 0.201 |
| Agriculture                      | 58  | 42.3 | 79  | 57.7 | 137  | 100.0 |       |
| Business                         | 4   | 33.3 | 8   | 66.7 | 12   | 100.0 |       |
| Government/ private service      | 35  | 57.4 | 26  | 42.6 | 61   | 100.0 |       |
| Household/housewife              | 56  | 43.8 | 72  | 56.3 | 128  | 100.0 |       |
| Self employed                    | 22  | 46.8 | 25  | 53.2 | 47   | 100.0 |       |
| Not working/ retired             | 75  | 37.7 | 124 | 62.3 | 199  | 100.0 |       |
| Others                           | 1   | 33.3 | 2   | 66.7 | 3    | 100.0 |       |
| Total                            | 251 | 42.8 | 336 | 57.2 | 587  | 100.0 |       |
|                                  |     |      |     |      |      |       |       |
| <b>Systemic disease</b>          |     |      |     |      |      |       | 0.232 |
| <b>Diabetes mellitus</b>         |     |      |     |      |      |       |       |
| Yes                              | 83  | 46.4 | 96  | 53.6 | 179  | 100.0 |       |
| No                               | 173 | 41.1 | 248 | 58.9 | 421  | 100.0 |       |
| Total                            | 256 | 42.7 | 344 | 57.3 | 600  | 100.0 |       |
|                                  |     |      |     |      |      |       |       |
| <b>Hypertension</b>              |     |      |     |      |      |       | 0.663 |
| Yes                              | 143 | 43.5 | 186 | 56.5 | 329  | 100.0 |       |
| No                               | 113 | 41.7 | 158 | 58.3 | 271  | 100.0 |       |
| Total                            | 256 | 42.7 | 344 | 57.3 | 600  | 100.0 |       |
|                                  |     |      |     |      |      |       |       |
| <b>Hyperlipidemia</b>            |     |      |     |      |      |       | 0.54  |
| Yes                              | 14  | 37.8 | 23  | 62.2 | 37   | 100.0 |       |
| No                               | 242 | 43.0 | 321 | 57.0 | 563  | 100.0 |       |
| Total                            |     |      |     |      |      |       |       |
|                                  |     |      |     |      |      |       |       |
| <b>Vision</b>                    |     |      |     |      |      |       |       |
| <b>UCVA_ WHO_ Classification</b> |     |      |     |      |      |       | 0.727 |
| 6/6-6/18                         | 182 | 43.0 | 241 | 57.0 | 423  | 100.0 |       |
| < 6/18                           | 73  | 41.5 | 103 | 58.5 | 58.5 | 100.0 |       |
| Total                            | 255 | 42.6 | 344 | 57.4 | 599  | 100.0 |       |
|                                  |     |      |     |      |      |       |       |
| <b>BCVA_ WHO_ Classification</b> |     |      |     |      |      |       | 0.108 |
| 6/6-6/18                         | 237 | 43.7 | 305 | 56.3 | 542  | 100.0 |       |
| <6/18                            | 19  | 32.8 | 39  | 67.2 | 58   | 100.0 |       |
| Total                            | 256 | 42.7 | 344 | 57.3 | 600  | 100.0 |       |

Assessing the doctor's and technician's opinion on effectiveness of tele-ophthalmology system, in pre-intervention, the working hours was less as compared to the post intervention group. The satisfaction was better in post intervention group for both the anterior segment photo and fundus photo. The benefit to the patients was felt higher among the post intervention group. The disruption of daily work flow was almost similar in both the groups. It was neutral response. Many suggestions were there for the pre-intervention group especially for the fundus photo quality,

addition of anterior segment photo, fixed time of tele-consultation. The post intervention group, the improvement of anterior segment photo and wider coverage of retina by the fundus photo and dedicated time for tele-consultation were the suggestion. Overall satisfaction was better with the post-intervention group as compared with the pre-intervention group. Table 20.

Table 20. Assessing doctors and technicians opinions on the effectiveness of a standardized, combined Tele-ophthalmology model (pre and post)

| S.N | Questionnaires                                               | Technician                     | PRE FREQUENCY         | POST FREQUENCY |
|-----|--------------------------------------------------------------|--------------------------------|-----------------------|----------------|
| 1   | Hours per week spent by doctors.                             | <1 hrs                         | 3                     |                |
|     |                                                              | (1-5)                          | 2                     | 1              |
|     |                                                              | (5-10)                         |                       | 3              |
|     |                                                              | (10-15)                        |                       |                |
|     |                                                              | (15-20)                        |                       |                |
| 2   | Satisfaction Fundus/posterior segments imaging               |                                |                       |                |
|     |                                                              | 1( all image un satisfactory ) |                       |                |
|     |                                                              | 2                              | 1                     |                |
|     |                                                              | 3                              | 3                     | 2              |
|     |                                                              | 4                              | 1                     | 2              |
|     |                                                              | 5(( all image satisfactory)    |                       |                |
|     | Satisfaction on anterior segment imaging                     | 1( all image un satisfactory ) |                       |                |
|     |                                                              | 2                              | 2                     |                |
|     |                                                              | 3                              | 2                     | 1              |
|     |                                                              | 4                              | 1                     | 3              |
|     |                                                              | 5(( all image satisfactory)    |                       |                |
| 4   | Benefit to patient from service provider expect              | 1( no benefit)                 |                       |                |
|     |                                                              | 2                              |                       |                |
|     |                                                              | 3                              | 1                     |                |
|     |                                                              | 4                              | 2                     | 4              |
|     |                                                              | 5( very large benefits)        | 2                     |                |
| 5   | Disruptions of daily workflow by teleophthalmology services. | 1( not at all)                 |                       |                |
|     |                                                              | 2                              | 2                     | 2              |
|     |                                                              | 3                              | 2                     | 2              |
|     |                                                              | 4                              | 1                     |                |
|     |                                                              | 5( extremely disruptive)       |                       |                |
|     |                                                              | 1.                             | -Better image quality |                |

|   |                              |   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                    |
|---|------------------------------|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6 | Largest areas of improvement | 2 | <p>-Very good appreciative effort part forward by the TIO for patient care.</p> <p>- Wider coverage of remote areas and better photo and images acquitting can be more helpful.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <p>-special training to the technician about taking photographs in all gazes</p> <p>- time allocation for doctors for Tele-ophthalmology</p>                                                                                       |
|   |                              | 3 | <p>- When a doctor is posted in telemedicine, if we stay in the telemedicine room, there are days where we have wait and if we stay on call and the patient to wait while the arrive from the clinic sometimes the patient might have left the CEC by the time we arrive . This aspect if made efficient would benefit by the patient as well as time utilized by the doctors would also be well used time as well skill. Maybe we can fix this by giving an appointment few hours before to consult the doctor and a lot the doctor on duty that a patient head consultation and to arrange their schedule accordingly.</p> <p>- The fundus picture are of good quality relatively but anterior segment it is</p> | <ul style="list-style-type: none"> <li>- Separation of dedicated time for telemedicine not hampering hospital work.</li> <li>- More area of coverage/ across Nepal</li> <li>- Telemedicine for ROP cases not available.</li> </ul> |

|  |  |   |                                                                                                                                                                                                                              |                                                                                                                                                                                                                           |
|--|--|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  |  |   | difficult to excess even basic pathologies.                                                                                                                                                                                  |                                                                                                                                                                                                                           |
|  |  | 4 | <ul style="list-style-type: none"> <li>- Waiting time for doctor or patient during the telemedicine in sometime very long.</li> <li>- The ratio of no. of patient attended to time spent for telemedicine in low.</li> </ul> | <ul style="list-style-type: none"> <li>- The image quality of posterior</li> </ul>                                                                                                                                        |
|  |  | 5 |                                                                                                                                                                                                                              | <ul style="list-style-type: none"> <li>- Improvement in anterior segment photo is much needed so that sometimes when posterior fundus looks healthy and patient poor vision might be due to anterior segments.</li> </ul> |
|  |  |   |                                                                                                                                                                                                                              | -                                                                                                                                                                                                                         |

## Discussion

Overall the combined live/cloud based tele-ophthalmology system implemented in two CECs of TIO detected a significant number of ocular pathologies and resulted in a high rate of referral to TIO, a tertiary eye care center.

The mean age of study participants among the post intervention group was 62.3 years (S.D 13 years). This showed that majority of the people who seek support at CECs are the elderly. This could also be affected by the enrollment of all the patients at the age 60 years and above visiting CEC besides those with all known cases of diabetes and hypertension. The mean age was slightly higher than the population based study conducted at high altitude and lower than the population based study conducted at Bhaktapur district located at Kathmandu valley, Nepal.<sup>1,10</sup> In post intervention group, over three fifth were the females. This showed that females have difficulty going far distance, so seeking the eye care services closer to their home. Like in our series, the female preponderance were found in other studies.<sup>1,10,11</sup> Nearly half of the study participants were involved in household works and in agriculture. Nearly half (49.5%) were literate. This is quite lower as compared to the national literacy rate at present (72%). This could be due to the enrollment of the majority of elderly people. There was very limited access to the education in the past especially in the rural and remote areas. However, in pre-intervention group, there was no definite inclusion criteria. The mean age of the study participants was 55.7 years (S.D 17.7 years). There were limited information regarding the other socio-demographic characteristics.

Among the participants in post intervention group, 29.8% were known case of diabetes, while 54.8% had systemic hypertension. The self-reported hyperlipidemia was found in 6.2% of the study participants. These are the systemic diseases where ocular complications especially the retinal problems are common manifestations. This shows that even in the remote areas, the systemic diseases like diabetes and hypertension are emerging public health problems. This could be due to change in dietary habits and more sedentary lifestyles. The high rate of hypertension was consistent with the other study.<sup>10</sup> However, in pre intervention group, details of systemic diseases

were missing among the majority. Nearly half of the study participants were smokers (47.5%) and consume alcohol (49.5%). These findings were consistent with other studies.<sup>1</sup>

Nearly halves of the study participants were presented at the CEC for poor vision in either right eye or the left eye. However, few cases each (1.3%) also presented for the floaters and flashes of light, indicating some posterior segment pathologies. Nearly half the study participants consumed alcohol either in the past or present however, nearly two thirds were smokers. Especially the smoking could be the risk factors of many ocular problems. Almost one fifth of the study participants had distance refractive error. However over two thirds had presbyopia. The more presbyopia could be due to the enrollment of more elderly people in the post intervention group. Overall, 89% of the participants had some ocular problems in either eyes. This high prevalence of ocular problems could be due to the practices of seeking eye care services when they had some symptoms. The anterior segment ocular problems were found in nearly half (44.8%) of the study participants which were bilateral involvement in nearly all the cases (98.2%). Cataract was the most common anterior segment problem comprising in one third of the cases (33.2%). This was consistent with the other studies.<sup>10,11</sup> The pinguecula and pterygium were found in 1.7% of the study participants. These conditions could be due to the exposure on the sunlight and dust. There has been no practice of using sunglass or other protecting devices.

On the other hand, retinal problems were found in nearly two thirds (64.6%) of the cases, out of these, 41.8% had bilateral involvement. The high rate of the retinal problems could be due to the study participants having more elderly people, those suffering from the diabetes and systemic hypertension. These are the major risk factors for many sight threatening retinal problems as in other studies.<sup>1,10,12-14</sup> So, routine eye check-up is very important in this population. Diabetic retinopathy (DR) was found in one fifth (20.67%) of cases with diabetes in right eye and 24.58% in left eye. The prevalence was consistent with the other studies.<sup>10,12,13</sup> Among the DR cases, majority were having moderate to severe non-proliferative diabetic retinopathy (NPDR). CSME was found in 8.37% in RE and 8.94% in LE. The finding was similar to the previous population based studies.<sup>1</sup> The prevalence of DR was almost similar in cloud based grading (19.5%) and live consultation (20.1%). This showed that fellows of vitreo-retina are quite confident with the DR classification and diagnosis. However, there was some variation in diagnosis of other retinal problems.

Almost one fifth of the patients with hypertension were having hypertensive retinopathy. This prevalence was higher than the previous population based study.<sup>10</sup> This could be due to uncontrolled blood pressure or prolonged duration. However, as in the previous study, grade 1 hypertension retinopathy was the most common.<sup>15</sup> Among the study participants, 28% of the study participants had AMD. Intermediate dry AMD was the most common among the AMD. The high prevalence of AMD could be due to the ageing, where mean age was 62 years in our study participants. Increase in age has been the most common risk factor associated with AMD.<sup>1,14</sup> Timely detection of AMD could help for proper dietary advice, antioxidant use and high risk sign of wet AMD for timely consultation. The high rate of AMD could be due to dietary consumption of less green leafy vegetables, fruits and high rate of hypertension among the study participants which is also a risk factor for AMD.<sup>14</sup>

Retinal vein occlusion was found in 2.6% in RE and 2.2% in LE. RVO is another important sight threatening condition. The prevalence of RVO was similar to the previous studies conducted among the elderly population.<sup>16</sup> This high prevalence of RVO could be due to more cases with elderly people, and those having systemic hypertension, diabetes mellitus and hyperlipidaemia which are considered as the risk factors for RVO. Early detection, regular follow up and timely treatment are very important to save the vision. Other vision threatening conditions like macular hole, retinal detachment, epiretinal membranes etc which are mostly age related change were also diagnosed during the tele-ophthalmology services. The uncorrected vision of two fifth of the cases had normal vision while after best correction, 73.5% had normal vision. So refractive error was quite common among the study participants.

During the pre-intervention tele-ophthalmology services, the cases were seen by the ophthalmology residents. So, definitive diagnosis was missed in majority. So, we couldn't compare the disease pattern pre and post intervention group.

In post intervention, overall, one fifth of the study participants need referral in both cloud and live tele-ophthalmology consultation. The referral cases were slightly higher among the cloud based tele-consultation as compared to the live tele-consultation. Among these, one fifth of the referred cases visited the tertiary eye care center (TIO) within one to three months follow up. While 2.8% of the study participants self- reported to the TIO for further opinion of the eye condition after their tele-consultation for further evaluation. In pre-intervention group, a total of 63.42% were



referred to tertiary eye care center for further consultation. Out of these, 46% visited TIO within two years of follow up.

In post intervention, the duration of follow up limited for the study period only one to three months. However, in pre-intervention group, the referrals seems higher but cases were followed up until two years. So, there is limitation of short follow up in post-intervention group. The lower rates of referral in post intervention could be due to grading of the pictures by the fellowship trained retina specialist and also with the consultation by the fellows from vitreo-retina department who have enough exposure on the detection of retinal pathologies besides the comprehensive ophthalmology knowledge regarding the cases that need definite referrals. One fifth of the cases were reviewed to TIO in post intervention. This seems high but in post intervention, the follow up was very short (one to three months follow up). So, the referral findings couldn't be compared between the two groups due to variation in follow up period. For post intervention group, the longer follow up is recommended.

Among the study participants, 30% of the participants from Dhading and 27% from Nuwakot that need to be further evaluation at higher center were out of contact because of improper contact numbers, some had wrong numbers, some provided the number that doesn't exist and some had mobile switched off. This showed that in rural and remote areas, not all had their phone numbers and due to illiteracy, many people don't remember the exact phone number. So, live consultation of the needy patients with the consultant could minimize this communication gap. Another 5% each had financial issues and lack of accompanying person. Like-wise, 16% of the study participants from each district want to come later due to ill health at the present or busy with other works. So, confirmation of the correct contact number of all participants seems mandatory before leaving the CECs. The counselling during the live consultation could enhance the follow up at higher center.

Among the factors associated with ocular diseases, geographical location and literacy were significantly associated with ocular problems among the study participants in post intervention group.

From the providers (doctors and technicians) perspectives, the overall satisfaction was better with the post-intervention group as compared with the pre-intervention group in terms of utility to the patients, and photo quality. The dedicated time for the tele-ophthalmology service and

improvement of photo quality besides the wider coverage of the retina were the major suggestion for further improvement of the tele-ophthalmology services. However, the sample size was small and there was minimal change in any metrics assessed. Based on qualitative feedback, there continues to be issues with both patient and provider wait times, and anterior segment imaging remains of mediocre quality. These represent areas for potential continued improvement in the tele-ophthalmology system as it expands to additional CECs.

## **Conclusion**

Tele-ophthalmology service has been the effective modality of eye care service in remote areas for the detection of large number of patients having both anterior and posterior segment diseases, timely referral for prompt treatment of sight threatening cases in reducing the blindness. It has reduced the cost of the patients besides the travel time of both patient and visitor. The live consultation involving the consultants and proper contact address will help for referral patients follow up at tertiary eye care centers. As part of a continual quality improvement process, findings from this study will help to make further adjustments and refinements in tele-ophthalmology system, scaling up the modality and further integration of artificial intelligence model in grading of DR, AMD etc.

## **Acknowledgements**

1. Moran Eye Center, University of Utah, USA
2. Tilganga Institute of Ophthalmology (TIO)
3. Nuwakot CEC/ Dhading CEC

### **VR Fellows from TIO involved for the live consultation:**

4. Dr. Gunjan Prasai
5. Dr. Nim Lhamu Sherpa

6. Dr. Bikram Shrestha
7. Dr. David Chanthan

## References

1. Thapa R, Khanal S, Tan HS, Thapa SS, van Rens GHMB. Prevalence, pattern and risk factors of retinal diseases among an elderly population in Nepal: The Bhaktapur Retina Study. *Clinical Ophthalmology* 2020;14:2109-2118. PMID:32801619
2. Collon, S., et al. "Utility and Feasibility of Teleophthalmology Using a Smartphone-Based Ophthalmic Camera in Screening Camps in Nepal." *Asia Pac J Ophthalmol (Phila)* 2020,9(1): 54-58.
3. Hong, K., et al. "Teleophthalmology through handheld mobile devices: a pilot study in rural Nepal." *J Mob Technol Med* 8(1).
4. Mathenge, W., et al. "Impact of Artificial Intelligence Assessment of Diabetic Retinopathy on Referral Service Uptake in a Low-Resource Setting: The RAIDERS Randomized Trial." *Ophthalmol Sci* 2022,2(4): 100168.
5. Bhattarai, M. D., et al. "Fundus Photography as the Base of Three-Tier Diabetic Retinopathy Care System to Its Wider Roles: Learning from a Case Experience." *JNMA J Nepal Med Assoc* 2021,59(233): 100-107.
6. Prathiba, V. and M. Rema. "Teleophthalmology: a model for eye care delivery in rural and underserved areas of India." *Int J Family Med* 2011: 683267.
7. Hills, A. P., et al. "Epidemiology and determinants of type 2 diabetes in south Asia." *Lancet Diabetes Endocrinol* 2018, 6(12): 966-978.
8. Joshi, P. L., et al. "Referral parameters for diagnosis of glaucoma in general eye clinic at Tilganga Institute of Ophthalmology." *Nepal J Ophthalmol* 2019, 11(21): 33-39.
9. Blomdahl, S., et al. (2001). "Tele-ophthalmology for the treatment in primary care of disorders in the anterior part of the eye." *J Telemed Telecare* 7 Suppl 2001, 1: 25-26.
10. Thapa R, Ruit S, Poudel MP, Neupane P, Banjara P, Duwal S, Gurung E, Tabin G. Population Prevalence, Pattern and Associated Factors for Retinal Diseases at High Altitude in Nepal. *Clinical Ophthalmology*. 2024 Dec 31:2555-65.
11. [https://nnjs.org.np/files/uploads/survey-data/RAAB%20Survey%20final\\_compressed.pdf](https://nnjs.org.np/files/uploads/survey-data/RAAB%20Survey%20final_compressed.pdf)

12. Thapa R, Twyana S, Paudyal G, Khanal S, van Nispen R, Tan S, Thapa SS, van Rens GHMB. Prevalence and risk factors of diabetic retinopathy among an elderly population with diabetes in Nepal: The Bhaktapur Retina Study. *Clinical Ophthalmology* 2018, 12:561-568. PMID: 29615832.
13. Paudyal G, Shrestha MK, Meyer JJ, Thapa R, Gurung R, Ruit S. Prevalence of diabetic retinopathy following a community screening for diabetes. *Nepal Medical College Journal* 2008;10(3); 160-163.
14. Thapa R, Bajimaya S, Paudyal G, Khanal S, Tan S, Thapa SS, van Rens GHMB. Prevalence of and risk factors for age related macular degeneration in Nepal: The Bhaktapur Retina Study. *Clinical Ophthalmology* 2017, 11:963-972. PMID: 28579747
15. Thapa R, Khanal S, Tan H, Thapa S, vanRens GHMB. Prevalence, Associated Factors and Awareness of Hypertensive Retinopathy among an Elderly Population with Hypertension in Nepal: The Bhaktapur Retina Study. *Nepal J Ophthalmol* 2022;14(27):49-58.
16. Thapa R, Bajimaya S, Paudyal G, Khanal S, Tan S, Thapa SS, Van rens GHMB. Prevalence, pattern and risk factors of retinal vein occlusion in an elderly population in Nepal: The Bhaktapur Retina Study. *BMC Ophthalmology* 2017;17:162. PMID: 28865424