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Access to Eye Health Care at Tertiary Hospital in Sierra Leone

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Access to Eye Health Care at Tertiary Hospital in Sierra Leone

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Higher Diploma in Community Health and Clinical Studies

Njala University

2010

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An abstract of a thesis submitted to the Faculty of the Rollins School of Public Health of Emory University in partial fulfillment of the requirements for the degree of Master of Public Health in Hubert Department of Global Health, 2019.

Abstract

Access to Eye Health Care at Tertiary Hospital in Sierra Leone

By Imurana Conteh

Abstract

Background: National data (2017) show that Sierra Leone has an estimated prevalence of 0.7% blindness. Up to 90% or more of all blindness is due to onchocerciasis, cataract refractive errors, trachoma and other ocular complications in Sierra Leone; these are preventable conditions if access to appropriate care is available. Ebola survivors frequently have ocular complications including uveitis, glaucoma, cataract, and retinal disease.

Objective: This study seeks to assess the burden of eye disease in three tertiary eye care facilities in Sierra Leone, to determine the difference in eye disease for Ebola survivors and the general population using the three tertiary eye care facilities, and to evaluate the feasibility of a telemedicine approach to identify patients with ocular disease in Sierra Leone.

Methods: One hundred and thirty-five patients were recruited from three tertiary hospitals in Sierra Leone - Connaught Hospital (n=30), UMC Kissy Hospital (n =56) and Makeni Hospital (49). An in-person questionnaire was administered to each patient. After informed consent was obtained, an exam was given for visual acuity. Photographic imaging was also taken of both anterior and posterior segments of the eye. Questionnaire responses were analyzed using SAS 9.4 while photographic images were graded, converted into log mar visual acuity, and finally converted into Snellen visual acuity.

Results: The top 3 clinically diagnosed conditions across the health facilities were uveitis (36.3%), glaucoma (34.1%) and cataract (13.4%). Ebola survivors had a high prevalence of uveitis (51.9%) followed by glaucoma (33.3%). There was an observed significant relationship in worse eye between the general eye care population 20/166 and Ebola survivors 20/48 (p-value: 0.0090). The top four diagnoses from the anterior segment imaging were cataract (21.9%), pterygium (11.8%), posterior synechiae (7.9%), and uveitis (5.6%).

Discussion: Based on our assessment of the ocular disease burden at the three tertiary facilities, we concluded that there is a high burden of eye disease in Sierra Leone. Uveitis was more common among Ebola survivors, whereas glaucoma was more common among the general population. Telemedicine is a promising model for improving access to high-quality eye care for many Sierra Leoneans who cannot afford access to tertiary facilities in urban areas.

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Abbreviations

AIDS- Acquire immune deficiency syndrome

BPEHS-Basic Package of Essential Health Services

CDC- Center for Disease Control

DAILY- Disability adjusted life years

ENT-Ear Nose Throat

EVD- Ebola virus disease

EHSA- Eye Health Assessment Approach

FHCI-Free Health Care Initiative

GOSL-Government of Sierra Leone

HCWs-Healthcare workers

HIV- Human immune virus

IAPB-International Agency for the Prevention of Blindness

ICEH-International Center for Eye Health

IQR-Inter quantile range

JSI -John Snow Institution

KAP- Knowledge, Attitude and Practice

LMIC- Low middle-income countries

MDGs- Millennium Development Goal

MOHS -Ministry of Health and Sanitation

MSF -Medicine San Frontiers

MSVI- Moderate or Severe Visual Impairment

NIH-National Institutes of Health

NTDs- Neglected tropical disease

NHSSP-National Sector Strategic Plans

NEHP-National Eye Health Program

NGO- Non governmental organization

PHC- Primary Health Care

SLDHS-Sierra Leone demographic and health survey data

SLEHSA-Sierra Leone eye health system assessment

SAFE- Surgery Antibiotic Face washing Environment change

SD- Standard deviation

UMC- United Methodist Church

UNDP- United Nations Development program

UNFPA- United Nations Population fund

URE- Uncorrected refractive error

UNICEF- United Nations International Children Emergency Fund

UEHC-Universal Eye Health Care

VA -Visual acuity

WHO -World Health Organization

Chapter 1: Introduction

1.1 Background

Sierra Leone is a small West African country with an estimated population of 7.72 million. The country has 16 ethnic groups, each speaking a different language[1], with the Temne 35% and Mende 31% representing the largest ethnic groups. The majority of people live in rural areas with 64% living outside of cities. Among those living in these rural regions, 42% of the population are under the age of 15[1]. Islam is the dominant religious group, 71% of the total population, while Christianity is 27% of the population. The remaining fraction of the population includes indigenous religious groups. Sierra Leone has never experienced religious violence[1].

This country is one of the poorest nations in the world with many health challenges, including malaria, HIV/AIDS, malnutrition, visual impairment, protozoal diarrhea, acute respiratory infection, cholera, and Ebola[2]. In addition to these high disease burdens, there are high rates of youth unemployment, low rates in adult literacy (age 15 years and above) and lack of health infrastructure systems[2]. Before the Ebola outbreak, Sierra Leone was ranked as having the highest maternal mortality ratio and infant mortality rate globally, with an adjusted maternal mortality ratio of 1,360 maternal deaths per 100,000 live births and infant mortality rate of 87 infant deaths per 1,000 live births in 2015[3]. Sixty percent of the population lives below the poverty line and it was reported just after the Ebola outbreak that 77.5% of the population suffers from poverty[4].

Three out of the eight Millennium Development Goals (MDGs) enacted in 2000 by the United Nations clearly stressed the need for public health improvement in the area of maternal and child mortality, HIV/AIDS and malaria[5]. Achieving these goals, especially in low resource countries, is particularly challenging with competing social, political, health and developmental priorities. In

such situations, governments choose to prioritize health resources to only those they can afford, even among diseases that are of significant burden to the population. There has been research on why and how different health issues receive different political consideration and importance at the national level in low middle income countries (LMICs), such that some become entrenched within national health policy and some do not[6].

These challenges became very serious during the 10-year civil war in Sierra Leone (1991-2000), as much health and economic infrastructure was destroyed. Many people migrated from the rural villages into the urban cities, which added more burden to the already poor health and sanitation infrastructures. The country is still recovering from the consequences of the civil conflict today[7]. Since the civil conflict in Sierra Leone, the country has struggled to rebuild its health infrastructure especially in rural communities. One particular health issue that is often overlooked is the burden of eye care particularly in rural communities. Other concerns are the scarcity of healthcare workers and lack of trained eye care professionals to manage patients that present with eye problems at the health facilities[8]. It was against this background that the government of Sierra Leone launched the free health care initiative in 2010 for the most vulnerable people including pregnant women, lactating mothers and children under five years of age. The purpose of this program was to increase universal access to healthcare for all citizens, including the most vulnerable populations[9]. Free eye care services was part of the free healthcare package but only for the targeted group, though it is still the primary responsibility of the government to address the health needs of its citizens[10]. Despite the huge gains made from the free health initiative, the country was enveloped by an Ebola epidemic in 2014[11]. It was the largest and worst of its kind, endangering the fragile health system and the country's weak economy. Sierra Leone registered a total of 8706 confirmed cases of Ebola, 3956 confirmed Ebola deaths and 4750 Ebola

survivors[12]. Survivors from Ebola report a range of sequelae including ocular complications, most often uveitis and conjunctivitis, abdominal pain, hearing loss, impotence, weakness and arthralgia[13]. The Ebola epidemic was a significant hindrance to the progress made by the government since the end of the civil war in 2002 in terms of health care access and infrastructure. Importantly, Ebola infection and sequelae have important ramifications for eye care disease.

Access to eye care has been a major challenge from time immemorial for the citizens of Sierra Leone, especially in rural communities. A sample survey in 1981 estimated the prevalence of blindness as 1.3% of the entire population, with the highest prevalence in rural communities and settlements close to rivers[14]. Before the Ebola outbreak in 2014, there was no available data from the government for prevalence and incidence of vision impairment in Sierra Leone[15]. However, data are available from the WHO or from non-governmental agencies providing eye care services in Sierra Leone. Analyses of these data suggest that vision impairment and blindness is on the rise[15]. Prior to the Ebola epidemic in 2014, visual impairment or blindness was caused by ocular onchocerciasis, vitamin A deficiency, neonatal conjunctivitis, trachoma, cataract, primary glaucoma, and measles keratitis among other causes. These diseases are preventable or easily treated if they are detected early. By providing inclusive and focused eye care services, Sierra Leone can help reduce the burden of eye disease, blindness and visual impairment.

1.2 Problem Statement

Sierra Leone does not have sufficient healthcare resources to support interventions or programs that can mitigate major causes of blindness or visual impairment. Most blindness and visual impairments are largely preventable or at least can be managed through effective medical treatment to circumvent functional limitation. Unfortunately, access to eye health care services and trained health staff is especially lacking in rural communities[16].

With the aim is to eliminate 80% of preventable blindness by 2020, the right to sight was launched by VISION 2020[17]. The burden of visual impairment globally has increased from 12,858,000 disability adjusted life years (DALYs) in 1990 to 18,837,000 DALYs in 2010[18]. Results from several studies have indicated that visual impairment and blindness is a serious public health threat and impedes socio-economic development in countries with high disease concentrations[19]. The impact of visual impairment and blindness does not only affect the individual, but also the family, caregivers and community, resulting in a substantial community cost burden. Persons with vision disorders are often stigmatized by the community and children in school are at high risk of dropout due to blindness[18]. Persons with visual impairment and blindness are frequently under or unemployed.

Like many other countries in sub-Saharan Africa, Sierra Leone has a huge deficit of ophthalmologists to serve a population of over seven million. There are presently 6 ophthalmologists and 8 cataract surgeons and approximately 40 ophthalmic nurses in the country[1]. Ophthalmic services are provided by six tertiary hospitals (four governmental and two faith-based hospitals situated in Freetown, Bo, Makeni, Kenema and Lunsar[20]. National data (2017) show that Sierra Leone has an estimated prevalence of 0.7% blindness affecting 43,842 individuals, while prevalence for persons over 50 years of age with blindness is estimated to be 5.9%[21]. Up to 90% or more of all blindness is due to onchocerciasis, cataract refractive errors, trachoma and other ocular complications in Sierra Leone, all of which can be prevented if access to appropriate care is available[21]. Because of this, there is need to improve access to the existing eye healthcare system in Sierra Leone. This could be achieved through the Sierra Leone's primary health system at community centers where early detection of eye disease and prompt referrals could lead to better outcomes[22]. According to the global eye health plan 2014-2019, it aims to

reduce preventable visual impairment globally and to provide access to rehabilitation services for persons visually impaired[23]. The purpose of this study is to focus on: 1) access to eye care for patients with eye problems in Sierra Leone, including Ebola survivors; 2) characteristics of eye care patients using an intake questionnaire; and 3) preliminary assessment of a telemedicine-based approach to screen patients with eye symptoms in three tertiary facilities in Freetown (Connaught and UMC Kissy Hospitals) and Makeni Makeni Government Hospital), Sierra Leone.

1.3 Purpose Statement

Access to eye health facilities and cultural beliefs associated with eye diseases are challenging issues in Sierra Leone. As such most patients with eye complaints who visit tertiary facilities are mostly chronic cases compared to those seen at local level facilities. Lack of infrastructure, insufficient trained ophthalmic staff in most rural and some urban settings forces individuals with visual impairment to seek medical consultation at tertiary facilities. This increases pressure on health staff at the tertiary level. This study will be able to track and identify the burden of visual impairment from patients at tertiary facilities.

It is important to note that, prior to the Ebola crisis in Sierra Leone, unemployment and poverty were tremendously high and even self-employed workers earned substantially low incomes. This socio-economic challenge limited patients with vision disorders to access a health facility, compounded by the high cost of drugs to treat eye diseases. The impact of the Ebola outbreak will remain substantial for Ebola survivors and the general population. The present economic situation in Sierra Leone is a challenge for the government to understand which groups and sectors need to be prioritized. Most Ebola survivors have ocular complications including uveitis, glaucoma, cataract, retinal disease and many others. Findings from this study will compare the different eye

diagnoses for Ebola survivors and the general population that visit a tertiary health facility for eye consultation.

In most countries in Africa, the use of telemedicine approach to quickly detect and treat patients with vision disorders has proven to be useful for healthcare delivery services[24]. The goal of telemedicine is to improve treatment outcomes, as patients with eye diseases can be diagnosed earlier and can help persons with eye disorders to break barriers of distance, transport and stigma associated with their condition/disease. The application of telemedicine in this study is the first of its kind in Sierra Leone. Photographic images from the anterior and posterior segment of the patient's eye are assessed to detect and diagnose eye diseases. The diagnoses could prompt referrals and quicker/better treatment of patients.

1.4 Research Questions

- What is the burden of eye disease in three eye care tertiary referral centers in Sierra Leone?
- What is the difference in eye diagnoses for Ebola survivors compared to the general population who use the three tertiary eye care facilities?
- Is telemedicine a feasible and appropriate approach to evaluate patients with eye conditions in Sierra Leone that require urgent referral and evaluation with risk of vision loss?

1.5 Definition

Pseudophakia: It is a post-surgical condition that occurs were a cataract lens has been replaced by an artificial implant lens.

Visual Impairment: WHO categorizes visual impairment as mild, moderate, severe and blindness[25].

- Mild represent visual acuity >6/12

- Moderate represent visual acuity >6/18
- Severe represent visual acuity >6/60
- Blindness represent visual acuity >3/60

Snellen Visual Acuity Measurement: Measurement of Snellen visual acuity is a process where the visual acuity is represented as a fraction. The numerator is the distance from the patient to the Snellen chart and the denominator is the distance the eye can read the smallest Snellen letter within 5 minutes. Snellen Visual Acuity represents a geometric ratio that represents the angle subtended by a Snellen visual acuity letter. For example, 6/60 indicates that the patient is able to visualize a Snellen Visual acuity letter at 6 meters (numerator) what an individual with "normal" vision can recognize at 60 meters.

Uveitis: Is a disorder that develops as a result of inflammation of the middle layer of the eye called the uvea.

Onchocerciasis: Is a severe disease caused by parasitic worm *onchocerca volvulus* and is transmitted by the bite of blackflies. It is typically characterized by subcutaneous nodules and ocular lesions that can lead to blindness.

Vitamin A deficiency: This deficiency occurs as a result of the lack of vitamin A in the food we consume. The body cannot produce vitamin A by itself. Vitamin A plays a vital role in our vision.

Neonatal conjunctivitis: Is a congenital disease triggered by bacteria present in the genital track of the mother transmitted to the child during vaginal delivery and consequently infects the eye.

Trachoma: It is caused by an exposure to a bacterial infection through hand contact and flies. The disease flourishes especially where there is poor sanitation, lack of water and overcrowded community.

Cataract: It occurs when a typically clear lens of the eye becomes cloudy. This stops the lens from transferring clear images to the retina. Cataracts progress slowly and sometimes only in one eye but can end up affecting both eyes. Cataracts are most commonly seen in older people.

Glaucoma: It occurs as a result of an increase in the intraocular pressure of the eye due to excess fluid in the front of the eye. This disorder damages the optic nerve of the eye and eventually leads to vision loss.

Measles Keratitis: It is a viral disease transmitted through contact with infected saliva and mucus. Keratitis is the inflammation of the cornea, which is a serious complication of the eye and it is characterized by blurred vision, tearing, redness, and pain.

Chapter 2: Literature Review

2.1 Introduction

Countries all over the world have challenges in meeting the health needs of their population, especially in low- and middle-income countries. Constraints in human resources, financing and infrastructure, mitigate the ability of a health system to respond to the burden of communicable and non-communicable diseases. Eye diseases and conditions are often not a priority in the health system but recently there have been efforts to reconcile an increasing investment in the relationship between the eye health system and the general health system. With effective eye care service, visual impairment is 80% preventable or manageable. Consensus from the global eye care community is that effective eye care interventions can only be improved through better understanding of how health systems function[26].

Sierra Leone remains one of the world's poorest nations, with a ranking of 184 out 189 countries on the human development index (HDI) in 2018[27]. Decades of economic decline and 11 years

of community and health crises, civil war, the Ebola virus disease outbreak, and a recent mudslide, provide context to the poor HDI. There is also a low life expectancy of 47 years, an infant mortality rate of 92 per 1,000 live births, an under-five mortality rate of 156 per 1,000 live births with a maternal mortality ratio of 857 per 100,000 births that have had dramatic consequences on the economy and advancement of Sierra Leone[28]. Major causes of morbidity and mortality in Sierra Leone are preventable, with most mortality attributable to malaria, acute respiratory tract infection, nutritional deficiencies, anemia, tuberculosis, HIV/AIDS, pneumonia, and diarrheal diseases. The highest burden of these diseases are found in rural communities[28]. According to Sierra Leone demographic and health survey data (SLDHS) malaria remains the most common cause of illness and death in the country, with over 24% of children under five diagnosed with malaria in the two weeks preceding the latest household survey in 2013. Disparity in access to government supported health care facilities constitutes a major and persistent health inequality in Sierra Leone. Ensuring equal access for all will require further strengthening of the country's health care system[29]. The population largely depends on the government for health services delivery. Public health facilities provide 70% of the services in the country, while private and mission facilities provide the remaining 30%[30]. The severe shortage of healthcare workers (HCWs) in rural communities of low-income countries is a global crisis, driving poor health outcomes by reducing access to medical care and quality of health service delivery[31]. With insufficient numbers of well-equipped and motivated HCWs in rural areas, Sierra Leone's health system cannot meet the essential health needs of the majority of the country's population that lives in the rural region (62%). Adding to this challenge, the country has very few medical doctors (only 0.3 per 10 000 population), and the few doctors work exclusively in urban or peri-urban areas[32]. As Sierra Leone still ranks as an unsafe place for pregnant women to deliver, it is estimated that one in every

32 women die during pregnancy and childbirth[33] with many others prone to risk of pregnancy related complications and permanent health consequences. Adding to poor maternal health indicators, another cause of concern is the high child morbidity and mortality indicators. It is estimated that child, infant and neonatal mortality is 182, 117 and 50 per 1000 live births respectively[34]. The causes of high rates of maternal and child mortality in Sierra Leone are multiple and complex, compounded by the fact that the country is still emerging from the effects of a decade-long civil conflict and the effects of the most recent Ebola epidemic.

A robust political decision by the government and the Ministry of Health and Sanitation (MOHS) Sierra Leone, announced the Free Health Care Initiative (FHCI) in April 2010. Pregnant women or lactating mothers, children, and the elderly were entitled to receive essential free health services, including antenatal, delivery and postnatal care for mothers as well as preventive and curative interventions for common childhood illness[35]. As an important step toward improving maternal and child health, this initiative was welcomed by the population. The impact of the initiative was quick to start producing a positive health outcome. Health facilities saw an increasing number of women and children accessing the health facilities, women requiring emergency care started attending health facilities, surgical cases of children and the diagnoses of common childhood infection including malaria, pneumonia and diarrhea increased by over 200%[36].

2.1.1 Challenges of the Free Health Care Initiative

The launch of FHCI in the country constituted a leap forward and inspired hope for many Sierra Leoneans. According to reports from MOHS, there was an increase in utilization by women and children at health facilities in the first year of the initiative, but sustainability of the FHCI still remained a big challenge. Only three obstetricians were registered in 2012 with the MOHS[37]. Medical supplies were often not enough to address the increasing demands of patients at the health

facilities, which resulted in sending patients to buy medicines elsewhere or referring patients to buy cost recovery drugs which are more expensive. It is clear that drugs and medical supplies leak out of the free health care system and are re-routed as drugs for sale[38]. The poor management of drugs for the FHCI created several opportunities for corruption in Sierra Leone, with huge consequences for beneficiaries of FHCI (Amnesty International, 2011). Lack of active monitoring and accountability mechanisms are a central challenge to the FHCI. There were no robust measures to detect or prevent corruption[39]. In addition, mission and private hospitals were left out of the FHCI package, as such there was no access to FHCI even if the individual was eligible for service at these health facilities.

Eye services were not included in the original FHCI initiative. The disparity in availability of and accessibility to eye care in government hospitals will continue to be an issue if eye care is not incorporated into FHCI package. Government eye clinics are not equitably distributed in all districts in Sierra Leone, especially in the Northern Province[22].

2.2 Global Eye Burden

Blindness is a global public health problem that not only affects quality of life, but also is linked with other health outcomes, such as depression, falls, and even mortality[40]. Visual impairment affects ordinary life as a disability, increases susceptibility to injuries or accidents, impacts negatively on productivity and national progress, increases economic and social costs, and burdens the health care system. It is estimated that 32.4 million people are blind and 191 million have moderate or severe visual impairment (MSVI) globally[41]. 60% of global blindness affects women and 57% of global MSVI are women[41]. The prevalence of blindness and MSVI overall among those 50 years of age or older from 1990 to 2010 declined from 3% to 1.9% and from 14.3% to 10.4%, respectively[42]. The reason for the decrease was because of the establishment

of strong surveillance systems to provide accurate information concerning the prevalence and causes of visual impairment, establishing programs that prioritize and utilize the limited resources provided for eye care, especially in low income countries[43]. The prevalence of blindness in low income countries was 25% greater than in high-income countries[44]. Many cases of blindness in the developing countries are essentially treatable or preventable if the resources and staff are available. Globally cataract is the leading cause of blindness followed by trachoma, glaucoma, onchocerciasis, diabetes retinopathy, vitamin A deficiency, and uveitis[45]. Over the past two decades cataract and uncorrected refractive error have been the leading causes of blindness and MSVI globally. Recently there has been a significant decrease in trachoma and cataract as causes of blindness and MSVI. Also, there was a significant decrease in the prevalence of blindness and MSVI due to refractive error, glaucoma, macular degeneration and diabetic retinopathy[46].

According to WHO approximately 80% of blindness can be avoided, but significant effort is still needed to increase access to eye care[47]. In most developing countries, eye care is isolated from other health sectors. The World Health Organization has proposed that integrating eye care with other health sector programs should be promoted rather than having a vertical program. In doing so, it will help strengthen eye care[43]. Hence, the WHO global health plan for universal eye health for 2014-2019 for member states is meant to sustain and expand efforts with international partners. This integration will further improve eye care with the aim of reducing blindness as a public health problem and to ensure access to comprehensive eye care[43].

2.2.1 Genesis of Vision 2020

A global Right to Sight initiative was launched in February 1999 by WHO and through collective efforts by other international agencies to eliminate avoidable blindness by 2020. It was projected that by 2020, if nothing was done to address the burden of blindness, there would be an increase

of 75 million people who would be blind[48]. The goal was to reduce the projection of 75 million blind individuals to 25 million by the year 2020[48]. Despite many pledges from the international health community to support the vision 2020 campaign, vision problems in poor countries still receive only a small portion of support and attention. The initial global blindness prevention programs were focused on causes that are largely in the domain of public health programs, such as trachoma, onchocerciasis, and vitamin A deficiency[49]. This program has contributed significantly to the decline in the burden of visual impairment 18 years after the launch of VISION 2020. The initiative focuses on blind conditions with the aim to eliminate avoidable blindness and visual impairment[50]. Primary health care was the cornerstone for the VISION 2020 Roadmap. The roadmap includes promotion of eye health and the provision of basic preventive and curative treatment for common eye disorders. Primary eye care plays an integral part in the identification of those blind and visually impaired, assessment and diagnosis for referral, consultation and encouragement for follow up[51]. As suggested by WHO a primary health care (PHC) approach will help to address problems of access to eye care services, especially appropriate clinical management of eye conditions at primary health care facilities with referrals of complicated cases to the secondary or tertiary levels[52].

2.2.2 Challenges of Universal Eye Health Coverage

According to WHO, Universal Health Coverage is a process where all people have equal access to needed preventive, curative and rehabilitative services of sufficient quality to be effective while also ensuring that people do not suffer financial hardship when paying for these services[53]. This implies that all people should have access to the best quality of eye health care without the risk of impoverishment. Previously, addressing eye health conditions including cataract and URE, were conducted with a vertical approach instead of integrating eye care with other health sectors

programs. With the recent epidemic of non-communicable eye disease, the problem of non-integration has become more complex. Bourne and colleagues stated that most visual impairment occurs in older age. Consequently, the number of people affected increased from an estimated 31 million to 36 million for blindness, and from 160 million to 217 million for moderate and severe visual impairment due to population growth and general aging of the population[54]. Key barriers to achieving universal eye health are persistent inequity of prevalence of blindness between global regions, and the excess blindness and visual impairment occurring in women compared with men in all regions, even after accounting for women's increased life expectancy[54]. The effects of unmet eye care needs in Africa is compromised by barriers to accessing eye health services, inadequate community engagement, lack of trained health personnel and lack of support from health systems. For greater integration of eye care into national health systems, more attention is needed at the primary health care level[49] .

2.3 Eye Health Services in Sierra Leone

In the past few years, there has been an increasing effort to explore the relationship between the eye health care and the general health care system. Sierra Leone is estimated to have over 100,000 blind people, many of whom are treated with neglect by the community subsequently exposing them to economic hardship and discrimination[55]. This leads to individuals begging in streets and marketplaces for survival. A group of eye care experts and health experts developed the Eye Health Assessment approach (EHSA), which was funded by Sightsavers. This assessment was coordinated by the International Centre for Eye Health (ICEH) at the London School of Hygiene and Tropical Medicine[56]. Sierra Leone was selected as one of the first countries to pilot the EHSA as agreed by the National Eye Health Program (NEHP) of the Ministry of Health and Sanitation (MOHS), Sightsavers, and ICEH. Findings from the assessment provide a basis for

activities to strengthen the eye health system in Sierra Leone and to improve outcomes for eye conditions[56]. Until recently, the Freetown eye clinic was the only government funded facility. In 2013, the Sierra Leone eye health system assessment (SLEHSA) stated that there are at least eye care staff member in 8/14 health districts even if the district only has a single ophthalmic nurse[22]. Since the end of the civil war in 2001 the government and Sightsavers have increased provision of public eye care services including refurbishment of eye departments at Connaught Hospital, western region, Bo Hospital in the southern region, Kenema Hospital in the eastern region and Makeni in northern region. Connaught Hospital which serves as the central referral hospital in the country is staffed by two ophthalmologist supported by a cataract surgeon and ophthalmic nurses; Bo and Kenema hospitals are staffed by cataract surgeons supported by ophthalmic nurses, and Makeni hospital is staffed by one ophthalmic doctor supported by few ophthalmic nurses[22]. Sierra Leone has six ophthalmologists, eight ophthalmic surgeons and over eighty ophthalmic nurses for over seven million people. There is still a huge gap in terms of ophthalmologists and trained support staff to address the high burden of visual impairment in the country[57].

Eye health services are provided by four government owned hospitals out of the twelve-government hospitals, three private or mission optical centers at UMC Eye Hospital in Freetown, Serabu Eye Clinic in the south, and Lunsar Eye Hospital in the North[57]. Vision Aid Overseas is also funding three public optical centers in Bo, Kenema and Freetown. Five schools for the blind funded by the government with help from NGOs are located in Freetown, Bo, Makeni, Kono and Kabala[22]. The population has limited access to eye clinics because of cost, lack of ophthalmologists, location, scarcity of transport of access to eye health services and traditional beliefs such as the use of herbal medications to treat eye diseases[57]. To address the problem of

blindness or visual impairment, the government and other partners should train more ophthalmologists and other health staff, create equal distributions of eye health facilities across the country, establish an eye health financial scheme, and embark on nationwide health education. For countries like Sierra Leone to achieve universal eye health coverage, there needs to be political will by the government as well as commitment by technical leadership. Hence, one can implement a clear national plan, commit resources and formulate activities to achieve UEHC[58]. Human resources are a key element in achieving comprehensive eye care using a health systems approach. Eye care services provided by ophthalmologists are limited because of both availability and maldistribution of ophthalmologists across the country. Some health staff at the Peripheral Health Units are trained to recognize and treat basic eye conditions. Therefore, human resources can be planned by looking at the regional differences in the prevalence and the magnitude of the burden of visual impairment as future projections of these conditions in that region[59].

2.3.1 Causes of Blinding and Visual Impairment in Sierra Leone

According to WHO, blindness is when an individual is not able to count fingers at 3 meters with the better eye. The 2013 SLEHSA stated the prevalence of eye diseases among patients visiting eye facilities, and found that 39% of cases of blindness are caused by cataract, 30% onchocerciasis, 23% corneal scars, 8% glaucoma and other causes[22]. An estimated prevalence of blindness was found to be 1.3%, visual impairment was 4.3% and unilateral blindness was 3.4% of the entire population[57]. Anterior segment disease like chronic uveitis, sclerosing keratitis and cataracts are responsible for most of the vision loss followed by posterior segment disease in Sierra Leone. Overall, a significant proportion of visual loss is a combination of both anterior and posterior segment pathology[57]. A study was conducted from 1989 to 1992 to assess the causes of blindness and visual impairment among patients who visited eye care hospitals in Sierra Leone.

In this study cataract was the leading cause of blindness followed by uveitis, onchocerciasis, glaucoma, trachoma, and other causes[60]. This 1992 study highlighted a significant increase of 10% of patients with uveitis from non onchocercal origin. It was suggested that reduction of non-onchocercal uveitis could be achieved if peripheral hospitals could obtain more accurate diagnoses in patients[60].

Prior to the Ebola outbreak in Sierra Leone, a pre-rapid assessment survey was undertaken in 2010 to assess the prevalence and incidence of blindness and low vision. One percent of the population was found to have blindness and 3% had low vision[22]. The last epidemiological studies completed in 2010, showed that onchocerciasis is prevalent in 12 districts in Sierra Leone. Trachoma, trauma, vitamin A deficiency, measles, congenital cataract, cerebral malaria, orbital ocular tumor and traditional treatment by untrained health staff account for other causes of vision loss, particularly in children[22]. In 2008, a cohort of 16,780 in five northern districts, was assessed to examine the prevalence of trachoma and to determine whether a specific component of the SAFE (Surgery Antibiotic Face washing Environment change) strategy should be initiated. It was concluded that in four of the districts, the prevalence of trachomatous trichiasis was higher than the WHO recommended elimination threshold. This signified the need to perform surgery on 1016 patients to prevent blindness[61].

2.3.2 Attitudes about Blindness in Sierra Leone

Misconceptions about blindness are widespread in Sierra Leone. Generally, the public treat blindness with suspicion. Onchocerciasis is the most common cause of blindness in communities along fast flowing rivers in Sierra Leone, but inhabitants in this region usually associate blindness with witch craft[62]. Perception of Vitamin A deficiency from traditional beliefs can cause

complication of measles leading to blindness[62]. The country director for Helen Keller International Sierra Leone, Dr. Mary Hodges, said the circumstances surrounding the various misconceptions are deeply rooted in rural settlements. She said though Sierra Leone is highly dominated by Muslim and Christian beliefs, there are still a large percentage of people who identify themselves as traditional believers and this significantly overlaps with Muslim and Christian beliefs[62]. Helen Keller International in collaboration with local and international organizations is working to change people's perception and attitude towards blindness. In 2014, a Knowledge, Attitude and Practice (KAP) survey was conducted to better understand the level of awareness and understanding of eye health needs and services. The survey interviewed people across the country to identify barriers for seeking eye care services: 84.5% said they see no need to seek eye care services, 38.5% said distance to eye care facility and 5% lack of money for eye services[63].

2.4 Ebola virus in Sierra Leone

West Africa and the world were massively hit by a shocking outbreak of Ebola virus disease in 2014, that left Sierra Leone, Liberia and Guinea struggling to gain control[64]. This was the largest Ebola outbreak in history, affecting over 28,000 people, and causing over 11,000 deaths[65]. In 2013, Guinea registered the first case of Ebola, which spread through villages to neighboring countries before escalating out of control. In August 2014, the WHO declared the outbreak as a public health emergency of international concern[66]. The Ebola virus in Sierra Leone claimed approximately 4,000 lives[65].

While the outbreak left many survivors with tremendous personal and economic loss, the effects after surviving from Ebola were not over. Post Ebola syndrome emerged and is a constellation of complications for survivors that includes overall deterioration of health, diffuse joint, muscle and various body pains, ENT disorders(ear-nose -throat) such as hearing loss, tinnitus and vertigo, and

neurocognitive and ophthalmologic disorders[67]. Common post Ebola complications for survivors are ophthalmic manifestations and systemic sequelae including abdominal pain, psychosocial stressors, arthralgia and the persistence of virus in immune privileged sites[68]. Up to 88% of survivors experience arthralgia and back pain that can hinder the ability to work[69]. Ocular complications in Ebola patients were observed during the early stages of the disease and convalescence. A bilateral viral conjunctivitis with or without subconjunctival hemorrhage is typical and is observed during the active phase of Ebola virus infection and acute vision loss was also experienced in some patients[70]. During the Kikwit outbreak in 1995, ocular manifestations in Ebola survivors were first reported during convalescence. In four Ebola survivors, a range of uveitis from anterior to posterior disease developed 34 -72 days after Ebola onset[70]. Survivors from Ebola suffer from a range of complications including eye inflammation called uveitis and if not treated can cause permanent blindness[71]. Uveitis diseases from viral etiology can lead to substantial visual morbidity and blindness[72]. Evidence has proven the Ebola virus can persist in immune privileged sites including the aqueous humor and cerebrospinal fluid, leading to severe uveitis and meningoencephalitis respectively during Ebola convalescence[73]. A cross sectional study conducted in Port Loko district by Mattia *et al* stated that arthralgia, ocular complications and auditory symptoms were frequently observed among survivors 3-4 months post discharge[67]. A similar study conducted at 34 Military Hospital, Freetown, by Scott *et al* observed musculoskeletal pain, headache and ocular symptoms in patients who saw a practitioner 2-3 weeks post discharge[13].

2.4.1 Ebola Disease Ocular Complication (Uveitis)

Uveitis occurs because of inflammation of the uvea and if not treated, can cause irreversible damage to the eye. About 30% of the etiological factors of uveitis cases are unknown[45]. The

uvea plays a vital role in the ocular immunological defense mechanism, and its association with systemic disease is well known. Frequencies in uvea have been described in the northern hemisphere ranging from 19% to 46%[74]. Uveitis in tropical countries is linked with systemic infection, and may be influenced by autoimmune disease, trauma, and malignancy[45]. However, due to the absence of diagnostic equipment in local hospitals in most low-income countries, etiologies of non-onchocercal uveitis are likely unknown. This can lead to increased blindness and morbidity, which can impact life expectancy[75]. A cohort of 277 surviving Ebola patients was examined in Sierra Leone in which 18% presented with uveitis. In the study, 46% of uveitis was anterior and 26% were posterior uveitis[67]. Screening Ebola survivors for eye symptoms should start during admission at the treatment centers, and early treatment as soon as possible. It is simple and inexpensive to treat uveitis but requires specific equipment such as slit lamps and trained staff to identify disease and other health conditions that could contraindicate the use of steroids[76]. In one Ebola survivor who was treated in the United States, Ebola virus was isolated from the aqueous humor when he presented with panuveitis 14 weeks after Ebola virus disease (EVD) onset. This may further complicate treatment[76]. It has also been proven that cataracts may develop as a complication of uveitis in survivors, although through cataract surgery sight may improve. The occurrence of infectious virus in the anterior segment would make such a procedure dangerous[67].

2.5 Telemedicine in Eye Care

Telemedicine is the exchange of valid medical information from one medical professional to another through electronic communication with the goal to improve the health status of patients in remote or distant locations[77]. This approach enables patients in hard to reach areas to access medical services quickly, efficiently and without travel[78]. In developed countries, this

technology has transformed health services to be more accessible and effective, particularly when distance is a major concern. Moreover, to overcome health disparities, the discipline of telemedicine has emerged to improve healthcare delivery globally[79]. Telemedicine can be used in a wide range of healthcare, including prevention, diagnosis, treatment, education, and information sharing between health staff and research[80]. Ophthalmology can benefit greatly from telemedicine services in developing countries such as Sierra Leone. This technology can be used to gain access to eye care especially in remote locations[81]. Due to lack of eye health services in these areas and high prevalence of eye diseases, many people in the community may suffer from low vision or blindness[78]. The use of telemedicine can reduce this burden by increasing the speed and quality of healthcare eye services and limit unnecessary appointments to healthcare facilities[82]. In Iran, studies have shown that the main causes of visual impairment are cataract and uncorrected refractive errors. Telemedicine has been recommended for use at primary healthcare settings in screening for visual impairment, especially for patients that live in remote communities with limited access to eye care services and also those who are economically disadvantaged[83]. In the developed world, telemedicine practices have provided health care in non-traditional settings to significantly increase access to professional eye care[84]. This approach has a greater benefit for patients living in difficult and hard to reach settlements, as well as disadvantaged patients who cannot afford specialty services[83]. Diabetic retinopathy is the leading cause of new onset blindness in the developed world and telemedicine using digital retinal imaging has shown promising outcomes for screening and detection of diabetic retinopathy in the primary healthcare facilities without requiring the need of any retinal specialist on site[85]. Currently there are approximately 30 million people with visual threatening diabetic retinopathy and according to research, this prevalence will continue to rise[86]. In the United States, there has

been a high demand to increase access to diabetic eye screening by the use of teleophthalmology programs, because studies have projected the prevalence of diabetes to increase to 15 cases per 1,000 by 2050[87]. Boucher *et al* reported that telemedicine can efficiently lower barriers to eye care screening for individuals living in urban settlements[88]. Teleophthalmology programs are an evidence-based cost-effective approach used in diabetic eye examination. Using stored images and forward retinal photographs to provide high quality diabetic eye screening in order to improve access to care and to reduce blindness[89]. Studies have found telemedicine imaging screening in the developed world to be cost effective for patients and to increase access to eye care[90]. Many studies have identified this model of eye care to be feasible for screening, triage, consultation and remote supervision across a range of ophthalmic conditions, which can be done using local clinicians capturing images and transmitting this information to an ophthalmologist for assessment[91].

In parts of Africa telemedicine has played a vital role to improve access to eye care. In Zimbabwe the retinopathy telemedicine project was used to screen hospital patients in an urban settlement. It was concluded that the telemedicine method increased access to eye care services and specialists in places that previously had low access to eye care. This approach enabled the detection of 5% cataract, 6% glaucoma, 11% non-macular diabetic retinopathy and 5% diabetic macular oedema among patients screened[78]. In South Africa, telemedicine approach was used to decrease patient teleradiology aided consultation of inappropriate inter hospital transfers while maintaining appropriate patient care and improving outcome[92]. Similar research in Malawi used a telemedicine approach to equip clinicians on fundoscopic examination to ensure quality care and prevent permanent vision loss[93]. A telemedicine approach can lead to early detection and treatment of eye diseases and can decrease the burden of opportunistic infections with eye

manifestations were possible at primary health care facilities by a trained clinician with support from an ophthalmologist[94]. In order to improve access to eye care and to prevent blindness in Sierra Leone, there is a need to assess the feasibility of a telemedicine approach. The limited availability and accessibility to eye care services in Sierra Leone, compounded by the specific eye care needs of EVD survivors, offers an opportunity to explore the use of telemedicine as a strategy to increase access for the general population and EVD survivors.

2.6 Gaps in the Literature

The literature has highlighted the following factors as driving the eye care burden in Sierra Leone: access, poverty, trained staff. While efforts are underway to train more staff, there is a need to assess the feasibility of a telemedicine approach which can help reduce the financial burden of patients and provide increased access to patients. Much of the current literature surrounding access to healthcare services of patients with eye diseases has identified belief and misconception as barriers to access in the Sierra Leone[62]. While there are limited trained health staff to address the burden of eye diseases in the country, there are plans to train more staff on eye care across Sierra Leone[22]. The literature has highlighted poverty as one of the hindrances to access to eye care services in Sierra Leone. People who cannot afford the cost for eye care treatment at health facilities tend to seek treatment from other sources like the drug peddler or the use of herbal medication[27]. The lack of equipment to diagnose patients with eye disease is a big challenge at health facilities in Sierra Leone, especially to ascertain the causes of anterior segment diseases of the eye. There is currently no practice of telemedicine in Sierra Leone. This is an approach used to diagnose eye disease and has proven to be feasible in other countries.

Chapter 3: Methods

3.1 Overview

In the human body, the eye is one of the most complex organ systems. It is considered an extension of the brain, and functions to give us one of our main senses, sight. Ophthalmology requires subspecialty care and services that can lead to more complex care for patients with ocular disease. Some patients with eye diseases who visit tertiary hospitals are identified as high risk for losing their sight and these complexities in care are made more apparent in resource limited settings. The disparities in care arise from a lack of knowledge of eye care services in both rural and urban health facilities, high cost of eye drugs, insufficient health facilities, and a lack of ophthalmologist and ophthalmic nurses in the country. As a result, patients present at health facilities with chronic eye conditions which can eventually lead to vision loss, if interventions are not immediately carried out. Routine eye exams are critical to detecting diseases but access to eye appointments are a challenge, especially for the elderly and rural patients. For this and various other reasons, access to eye care in rural and urban Sierra Leone is very limited as few people can afford the cost to seek treatment for eye complaints. Early detection and treatment of high-risk eye disease can prevent vision loss. To address this gap in access to eye care for eye disease in Sierra Leone, this project has three objectives.

- To assess the burden of eye disease in three tertiary eye care facilities in Sierra Leone.
- To determine the difference in eye disease for Ebola survivors and the general population who use the three tertiary eye care facilities.
- To evaluate the feasibility of a telemedicine approach to identify patients with ocular disease in Sierra Leone.

Data for this study will come from the Ministry of Health and Sanitation Sierra Leone data base, from the three tertiary hospitals where the study was conducted, and from photographic images from Ebola survivors and general population of both the anterior and posterior segment of eye.

3.2 Population and Sample Size

Study participants were recruited from two districts, western and northern districts in Sierra Leone. A random sample from the general eye care population was selected from three tertiary hospitals. However, Ebola survivors were recruited only from UMC Kissy and Makeni Hospitals based on the number of individuals present at the hospital. After informed consent was obtained for each participant, and an exam was given for visual acuity, participants were brought to the investigator to perform all components of the study protocol including a structured face-to -face interview, and imaging of both anterior and posterior segment of the eye. The ophthalmic nurses were responsible for conducting the visual acuity examination on the patients. Participant responses were recorded for each encounter. Participants were recruited from Connaught Hospital (n=30), UMC Kissy Hospital (n=56), and Makeni Hospital (n=49). For inclusion into the study, participants were either an Ebola survivor or in the general eye care population who presented to one of the tertiary hospitals with one or more eye complaints. The Department of Ophthalmology, Emory University, supported the study in collaboration with JSI (John Snow Institute). Primary recruitment of participants was done in UMC Hospital and Makeni Hospital, due to the presence of a JSI screening program. The JSI screening program screened Ebola survivors from June 18 to June 29, 2018, for eye complications and patients were referred from rural and urban communities for this screening exercise. We also recruited participants from general eye care patients at the outpatient department from June 6 to July 25, 2018, with vison loss and any other eye complaints.

3.3 Research design

This study is a cross-sectional study of patients reporting to three tertiary hospitals with eye complaints from June 6 to July 25, 2018, in Sierra Leone. Table 3.1 below shows the name of hospital, location and duration spent at each facility to conduct the study.

Table 3. 1: location and duration at each tertiary facility

Name of Hospital	**Location**	**Duration**
Connaught Hospital	Lightfoot Boston Street - Freetown	June 6-June 18, 2018
UMC Kissy Hospital	Bai Bureh Road -Freetown	June 19-July 10, 2018
Makeni Hospital	Makama Road -Makeni	July 11- July 25, 2018

The study took place on the same day the patients came for self-referral for eye complaints at the tertiary facility or as an Ebola survivor referred from the community with eye complications.

3.4 Procedures and Data Collection

This is a cross-sectional study and data were collected using an intake questionnaire and telemedicine approach to evaluate the demographic information (age, sex, location, distance to clinic etc.) and ocular vitals (visual acuity, motility, eye pressure etc.). Slit lamp eye examination, present clinical complaints, as well as historical information: past medical history, past ophthalmic history was collected and barriers to care for patients in urban (Freetown) and rural (Makeni) Sierra Leone. The telemedicine approach involved photographic images taken on both anterior and posterior segment of the eye for all patients. Images were captured using the android phone to image the anterior segment and a Zeiss Visuscout fundus camera to image the posterior segment.

The investigator received training on using the camera and analyzing the photographs from the Department of Ophthalmology, Emory University.

Out of the 135 patients recruited for the study, 89 patients consented for photographic imaging of the eye. The intake questionnaires were administered in person to 135 patients (Male = 59 and Female =76) by a trained investigator. These questionnaires were developed in English after a thorough review of the literature to identify relevant questions pertinent to this research study. While the questionnaires were in English, participants could speak in their preferred language to answer the questionnaire, which was then translated to the study staff by a native-speaking clinical nurse. The questionnaires took an average of 45 minutes to complete at the various locations. The intake questions included a mix of open-ended and close ended questions, with a total of 24 questions concerning demographics, ocular vitals, present complaints, past ophthalmic history, distance cover to tertiary hospital, knowledge on previous diagnose, and knowledge on herbal intake.

3.5 Plans for data analysis

Descriptive and statistical analyses were conducted on demographic data, ocular complaints, differences in visual acuity and eye diagnosis in Ebola survivors and general eye care population. The visual acuity was converted into decimal numbers and log Mar before inputted into SAS for analysis. The results from SAS were converted into Snellen visual acuity (Table 3.2). The anterior image sets of the eye were uploaded as original files from the iPhone camera into a drop box. Images were graded by two ophthalmologists and a non-ophthalmologist. Descriptive statistics were used to determine age, male/ female, major complaints, Ebola survivor / general eye care population participants, barriers to care, distance traveled, districts represented. Inferential

statistics were performed using SAS software. Descriptive analysis were completed on the anterior segment imaging of the eye to assess feasibility of telemedicine.

Table 3. 2: Distance visual acuity conversion table[95]

MAR*	LogMAR	VAR	Snellen (metric)	Snellen (imperial)	Decimal*
0.50	–0.30	115	6/3	20/10	2.0
0.63	–0.20	110	6/3.8	20/12.5	1.60
0.80	–0.10	105	6/4.8	20/16	1.25
1.00	0.00	100	6/6	20/20	1.00
1.25	0.10	95	6/7.5	20/25	0.80
1.60	0.20	90	6/9.5	20/32	0.63
2.0	0.30	85	6/12	20/40	0.50
2.5	0.40	80	6/15	20/50	0.40
3.2	0.50	75	6/19	20/63	0.32
4.0	0.60	70	6/24	20/80	0.25
5.0	0.70	65	6/30	20/100	0.20
6.3	0.80	60	6/38	20/125	0.16
8.0	0.90	55	6/48	20/160	0.125
10.0	1.00	50	6/60	20/200	0.10
20	1.30	35	6/120	20/400	0.05
40	1.60	20	6/240	20/800	0.025
100	2.00	0	6/600	20/2000	0.01

3.6 Ethics

This study was approved by the Sierra Leone ethics review committee in Freetown, Sierra Leone, and Emory University Institutional Review Board in Atlanta, Georgia. Informed consent was read and translated verbally by a native-speaking clinical nurse to each participant. No compensation was given to patients for taking part in the study. Participant privacy was maintained throughout the process.

Chapter 4: Results

The goal of this study is to investigate access to eye care at three tertiary Hospitals in Sierra Leone. The study has three objectives.

- To assess the burden of eye disease in three tertiary eye care facilities in Sierra Leone.
- To determine the difference in eye diagnoses for Ebola survivors and the general population who use the three tertiary eye care facilities.
- To evaluate the feasibility of a telemedicine approach to identify patients with ocular disease in Sierra Leone.

4.1 Demographic characteristics of the study population

A total of 135 patients were recruited for the screening and treatment of eye disease at three tertiary Hospitals in Freetown and Makeni, Sierra Leone. Table 4.1 describes the demographic characteristics of the study population. Most patients were enrolled at the UMC Kissy Hospital, 56 (41.5%), followed by Makeni Hospital, 49 (36.3%), and Connaught Hospital 30, (22.2%). The age of participants ranged from 3 to 80 years, with a mean of 40.4(SD=17.6) and a median age of 40(IQR=26-56). It was observed that more female patients participated in the study 76(56.3%) than male patients 59(43.7%). Two sets of patients were enrolled into the study, Ebola survivors 27(20%) and the general eye care population who visited the eye clinics at one of the three Hospitals 108(80%). Patients from these three Hospitals presented with ocular symptoms, with most patients complaining of light sensitivity 94(69.6%), blurred vision 92(68.2%), itching 76(56.3%), eye pain 72(53.3%), redness (31(23.0%), tearing 29(21.5%), sand sensation 14(10.4%) and floaters 1(0.7%). The assessment revealed that patients were clinically diagnosed with the following conditions: uveitis 49(36.3%), glaucoma 36(34.1%), cataract 18(13.4%), pseudophakia 14(10.4%) and cornea scar 13(9.6%). The mean Snellen visual acuity for all patients suggested

that more patients had good right visual acuity of 20/68 compare to left visual acuity 20/80, and the visual acuity also revealed that the better eye vision mean was 20/43 and worse eye had mean 20/129. Twenty (14.8%) patients reported that they took herbal medication before seeking eye medical care. Fifty-six (41.5%) patients recruited for the study had a non-ocular past medical history; 48(35.6%) had a past ocular history.

Table 4. 1: Demographic characteristics of the study population

Patient Characteristic (n=135)		
Age		
Mean (SD)	40.53(17.55)	
Median (IQR)	40(26.00-56.00)	
Visual Acuity	**Log Mar**	**Snellen Visual Acuity**
Mean VA OD (SD)	0.53(0.78)	20/68
Median VA OD (IQR)	0.18(0.00-0.60)	20/30
Mean VA OS (SD)	0.60(0.83)	20/80
Median VA OS (IQR)	0.30(0.00-0.78)	20/40
Better Eye		
Mean (SD)	0.33(0.50)	20/43
Median (IQR)	0.18(0.00-0.54)	20/30
Worse Eye		
Mean (SD)	0.81(0.96)	20/129
Median (IQR)	0.52(0.18-1.00)	20/66

Gender	
Male (%)	59 (43.70)
Female (%)	76 (56.30)
Distance to clinic	
Mean (SD)	13.60(27.49)
Median (IQR)	3.00(2.00-12.00)
Category of Patients	
General eye care population (%)	108 (80.00)
Ebola survivor (%)	27(20.00)
Name of Clinic	
Connaught (%)	30 (22.22)
UMC Clinic (%)	56 (41.48)
Makeni Hospital (%)	49 (36.30)
Ocular Symptoms	
Itching (%)	76 (56.30)
Light Sensitivity (%)	94 (69.63)
Floater(%)	1 (0.74)
Sand sensation (%)	14 (10.37)
Tearing (%)	29 (21.48)
Redness (%)	31 (22.96)
Blurred Vision (%)	92 (68.15)
Painful (%)	72 (53.33)

Past medical Hx (non-ocular Hx) **(%)**	56 (41.48)
Clinical Diagnoses	
Glaucoma (%)	46 (34.07)
Uveitis (%)	49 (36.30)
Cataract (%)	18 (13.43)
Pseudophakia (%)	14 (10.37)
Cornea Scar (%)	13 (9.63)
Past ocular Hx (%)	48 (35.56)
Medications Prescribe	
Antibiotic (%)	58 (42.96)
Corticosteroid (%)	50 (37.04)
Eye drops (%)	128 (94.81)
Herbal Medication (%)	20(14.81)
A known family Hx of eye disease (%)	58(42.96)

4.2 Objective 1: To assess the burden of eye disease in three tertiary eye care facilities in Sierra Leone

Table 4.2 shows results of the burden of eye disease by tertiary health facility. Results are shown for the entire study sample. The sample size for each health facility is too small to do meaningful comparisons between Ebola survivors and the general eye care population. There is no statistical difference in age (p=0.7957) and sex (p=0.4484) across the three health facilities. Similarly, there

is no significant relationship for both right (p=0.7799) and left (p=0.4784) Snellen visual acuity for patients across the three health facilities. Although there is not a significant difference in the better(p=0.7604) and worse (p=0.4484) vision between the three different facilities, the results suggest that there is a better vision in the worse eye Snellen visual acuity of patients at Connaught Hospital 20/37 than patients presenting to UMC Kissy Hospital 20/62 and Makeni Hospital. There is a significant difference in distance traveled to the clinic (p=0.0005) across the three health facilities. The result for all patients clinically diagnosed for eye diseases across the three facilities suggested no significant difference between the three facilities, except for pseudophakia with p-value of 0.0458 and more cases of uveitis (37.5%), glaucoma (32.1%) and cataract (19.6%) were diagnose at UMC Kissy Hospital than the other two health facilities. However, there is a statistical difference in past ocular history (p=0.0006) for patients with eye disease at the different facilities.

Table 4. 2: General Analysis by Health Facility

	Connaught Hospital (n=30)		**UMC Kissy Hospital (n=56)**		**Makeni Hospital (n=49)**		**p-value**
Age Mean (SD)	41.1(19.34)		39.3(18.06)		41.6(16.04)		0.7957
Median Age (IQR)	40.5(25.0-61.0)		36.0(25.5-57.0)		42.0(28.0-51.0)		
Visual Acuity	**Log Mar**	**Snellen Visual Acuity**	**Log Mar**	**Snellen Visual Acuity**	**Log Mar**	**Snellen Visual Acuity**	

Mean VA OD (SD)	0.45(0.80)	20/56	0.57(0.82)	20/74	0.55(0.72)	20/71	0.7799
Median VA OD (IQR)	0.18(0.00-0.56)	20/30	0.24(0.00-0.78)	20/35	0.40(0.00-0.60)	20/50	
Mean VA OS (SD)	0.53(0.81)	20/68	0.71(0.98)	20/103	0.53(0.64)	20/68	0.4784
Median VA OS (IQR)	0.18(0.00-0.78)	20/30	0.30(0.00-0.77)	20/40	0.48(0.00-0.78)	20/60	
Better Eye							
Mean (SD)	0.27(0.43)	20/37	0.35(0.56)	20/45	0.34(0.49)	20/44	0.7604
Median (IQR)	0.00(0.00-0.53)	20/20	0.18(0.00-0.52)	20/30	0.18(0.00-0.56)	20/30	
Worse Eye							
Mean (SD)	0.71(1.01)	20/103	0.94(1.07)	20/174	0.74(0.78)	20/109	0.4484
Median (IQR)	0.24(0.00-1.00)	20/35	0.49(0.18-1.37)	20/62	0.58(0.18-1.00)	20/76	
Gender							
Male (%)	16(53.33)		24(42.86)		19(38.78)		0.4484
Female (%)	14(46.67)		32(57.14)		30(61.22)		
Distance to clinic							
Mean (SD)	4.33(3.25		24.25(38.48)		7.10(13.32)		0.0005

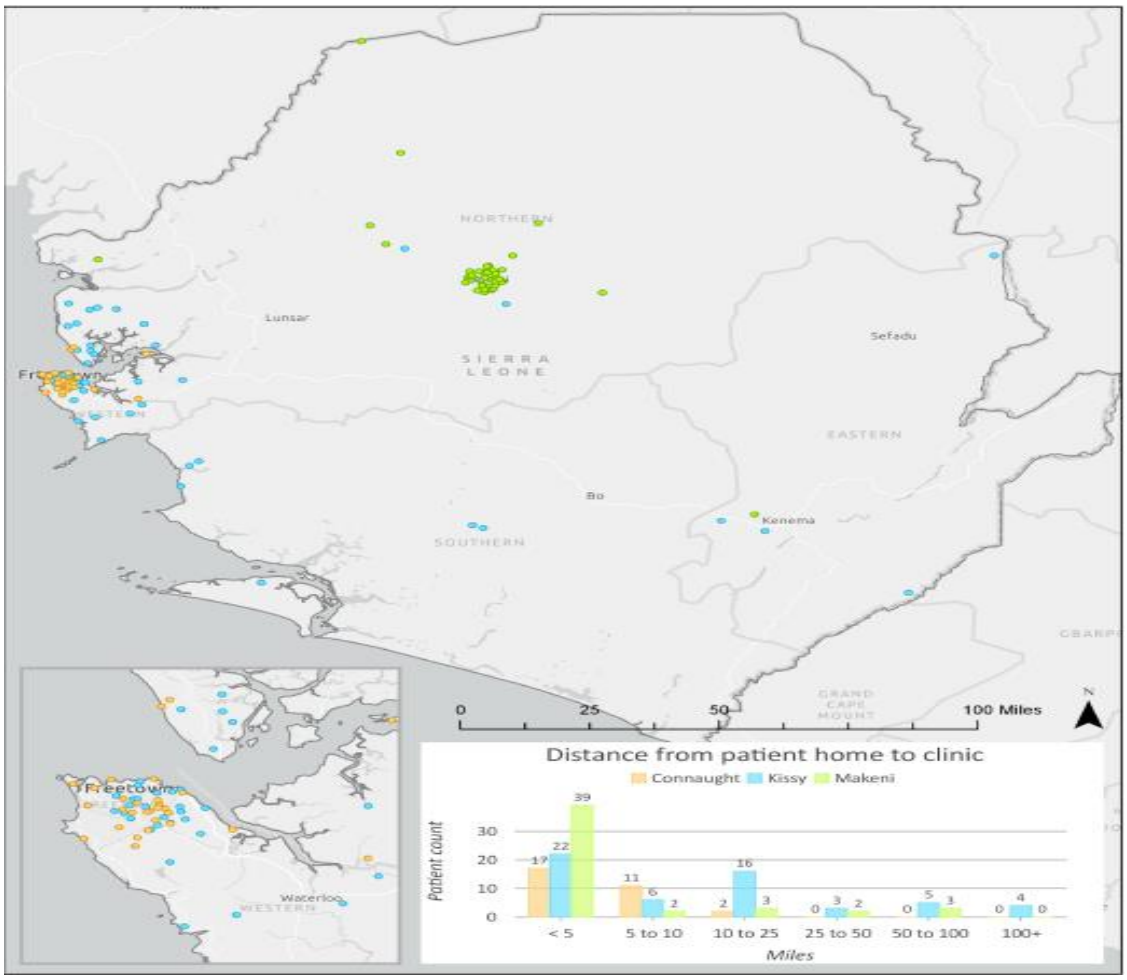
Median (IQR)	3(2-6)	9.5(3.0-18.0)	2(1-4)	
Ocular Symptom				
Itching (%)	19(63.33)	31(55.36)	26(53.06)	0.6649
Light Sensitivity (%)	18(60.00)	43(76.79)	33(67.35)	0.2517
Floater(%)	0(0.00)	1(1.79)	0(0.00)	0.4973
Sand Sensation (%)	7(23.33)	5(8.93)	2(4.08)	0.0215
Tearing (%)	0(0.00)	16(28.57)	13(26.53)	0.0045
Redness (%)	11(36.67)	13(23.21)	7(14.29)	0.0721
Blurred Vision (%)	16(53.33)	43(76.79)	33(67.35)	0.0840
Painful (%)	11(36.67	31(55.36)	30(61.22)	0.0981
Past medical Hx (non-ocular Hx) **(%)**	11(36.67)	29(51.79)	16(32.65)	0.1175
Clinical Diagnosis				
Glaucoma (%)	10(33.33)	18(32.14)	18(36.73)	0.8828
Uveitis (%)	10(33.33)	21(37.50)	18(36.73)	0.9279

Cataract (%)	4(13.33)	11(19.64)	3(6.12)	0.1284
Pseudophakia (%)	3(10.00)	2(3.57)	9(18.37)	0.0458
Cornea Scar (%)	4(13.33)	6(10.71)	3(6.12)	0.5436
Past ocular Hx (%)	11(36.67)	29(51.79)	8(16.33)	0.0006
Medication Prescribe				
Antibiotic (%)	11(36.67)	23(41.07)	24(48.98)	0.5304
Corticosteroid (%)	12(40.00)	21(37.50)	17(34.69)	0.8921
Eye drop (%)	28(93.33)	55(98.21)	45(91.84)	0.2620
Herbal Medication (%)	6(20.00)	9(16.07)	5(10.20)	0.4702
A known family Hx of eye disease (%)	17(56.67)	21(37.50)	20(40.82)	0.2188

4.2.1 Distance traveled from patient home to Hospital

Figure 1 is a map of Sierra Leone that shows the three tertiary facilities where the study was conducted. There are two facilities located in Freetown, Connaught and UMC Kissy Hospital. More patients used the UMC Kissy Hospital which is a faith-based facility compared to Connaught Hospital, which is a government sponsored facility. The patient catchment area for UMC Kissy is more geographically scattered than the other two Hospitals. Makeni Hospital which is the regional referral hospital for the Northern province, shows a dense patient population from the Bombali district and other districts close to Bombali district in the Northern province. In general, most patients travel within a 5-mile radius to access an eye care health facility, especially for patients at the Makeni Hospital. Within the capital of Freetown, more patients traveled in a 5 -10 miles radius to seek eye health at the Connaught Hospital. This is quite different for the UMC Kissy Hospital and Makeni Hospital where we see patients traveling to seek eye care within 10- 100 miles radius in these two facilities. Some patients travel over 100 miles to access eye health services at the UMC Kissy Hospital.

Figure 4. 1 Showing distance travel from patient home to Hospital



4.3 Objective 2: To determine the difference in eye diagnoses for Ebola survivors and the general population who use the three tertiary eye care facilities

Two tests were performed to compare difference in eye diagnoses in the general eye care population and Ebola survivors. The first one is test for all continuous variables and the second is the chi- square test for all categorical variables. The age mean for Ebola survivors is 33.15(13.37) and the general eye care population is 42.37(18.03) with p-value of 0.0140. The Snellen visual acuity for the left eye of Ebola survivors is 20/36 and for the general eye care population is 20/98 with a small p-value 0.0124, which also explains a significant difference in left visual acuity between the general eye care population and Ebola survivors. But there is no statistical difference

between the general population and Ebola survivors in the right Snellen visual acuity with a p-value of 0.0902. The Table 4.3 further compares patients with better eye among the general eye care population with an expected value of 20/46 and the Ebola survivors 20/31 with a p-value of 0.1113. There was an observed significant relationship in worse eye between the general eye care population 20/166 and Ebola survivors 20/48 (p-value: 0.0090). There is significant difference between the general eye care population 29(26.85) and Ebola survivors 27(100) for the non-ocular past medical history (p-value: <.0001). The expected value for patients with past ocular history in the general eye care population is 21(19.59) and Ebola survivors is 27(100), (p-value: <.0001). Finally, the results for clinical diagnoses of eye diseases among the general eye care population and Ebola survivor suggested high uveitis cases in both Ebola survivors and the general population, followed by glaucoma, cataract, pseudophakia, and cornea scar. However, there is no significant difference between the two groups for eye diseases except for pseudophakia, which was greater in the general population (p-value: 0.0481).

Table 4. 3: Comparing Ebola Survivor and the general eye care population

	General eye care population (n=108)		Ebola survivors (n=27)		p-value
Age mean (SD)	42.37(18.03)		33.15(13.37)		0.0140
Median Age (IQR)	41.50(27.50-60.00)		30.00(24.00-42.00)		
Visual Acuity	Log Mar	Snellen Visual Acuity	Log Mar	Snellen Visual Acuity	
Mean VA OD (SD)	0.59(0.84)	20/78	0.31(0.40)	20/41	0.0902

Median VA OD (IQR)	0.35(0.00-0.75)	20/45	0.18(0.00-0.48)	20/30	
Mean VA OS (SD)	0.69(0.89)	20/98	0.25(0.39)	20/36	0.0124
Median LVA OS (IQR)	0.48(0.00-0.94)	20/60	0.18(0.00-0.30)	20/30	
Better Eye					
Mean (SD	0.36(0.54)	20/46	0.19(0.32)	20/31	0.1113
Median (IQR)	0.18(0.00-0.60)	20/30	0.18(0.00-0.18)	20/30	
Worse Eye					
Mean (SD)	0.92(1.03)	20/166	0.38(0.44)	20/48	0.0090
Median (IQR)	0.57(0.18-1.00)	20/74	0.18(0.00-0.60)	20/30	
Gender					
Male (%)	49(45.37)		10(37.04)		0.4349
Female (%)	59(54.63)		17(62.96)		0.4349
Distance to clinic					
Mean (SD)	14.73(30.17)		9.07(11.07)		0.3407
Median (IQR)	3.00(2.00-10.00)		3.00(2.00-17.00)		
Ocular Symptom					
Itching (%)	61(56.48)		15(55.48)		0.9309
Light Sensitivity (%)	72(66.67)		22(81.48)		0.1343
Floater(%)	1(0.93)		0(0.00)		0.6158
Sand Sensation (%)	10(9.26)		4(14.81)		0.3971
Tearing (%)	23(21.30)		6(22.22)		0.9169
Redness (%)	28(25.93)		3(11.11)		0.1016

Blurred Vision (%)	70(64.81)	22(81.48)	0.0964
Painful (%)	58(53.70)	14((51.85)	0.8630
Past Medical Hx (non-ocular Hx) **(%)**	29(26.85)	27(100)	<.0001
Clinical Diagnosis			
Glaucoma (%)	37(34.26)	9(33.33)	0.9277
Uveitis (%)	35(32.41)	14(51.85)	0.0602
Cataract (%)	16(14.95)	2(7.41)	0.3042
Pseudophakia (%)	14(12.96)	0(0.00)	0.0481
Cornea Scar (%)	8(7.41)	5(18.52)	0.0800
Past ocular Hx (%)	21(19.44)	27(100)	<.0001
Medication			
Antibiotic (%)	45(41.67)	13(48.15)	0.5428
Corticosteroid (%)	43(39.81)	7(25.93)	0.1813
Eye drop (%)	102(94.44)	26(96.30)	0.0637
Herbal Medication (%)	19(17.59)	1(3.70)	0.0692
A known family Hx of eye disease (%)	50(46.30)	8(29.63)	0.1176

4.4 Objective 3: To evaluate the feasibility of a telemedicine approach to identify patients with ocular disease in Sierra Leone

From the three sites 89 patients consented for photographic imaging. Anterior segment images were graded by two different measures: 1. Quality and Artifacts present; 2. Ocular Diagnosis (Corneal Opacity, Cataract). Figure 4.2 and Figure 4.3 include the quality and artifact schemes and grading system. Ocular diagnosis was graded by the following: 1=probably no, 2=definitely no, 3=probably yes, 4=definitely yes, 0=not gradable. Based on the grading, 35.4% of the total images were satisfactory quality, 18.5% were good and 15.2% were excellent, while 29.2% of patients had poor quality images. The assessment of the eye reveals that 54% of the eyes had white spot artifacts, 36% had glare artifact and 3.4% had no artifact. Across the sample for anterior segment imaging, 54.5% of the patient had probably no corneal opacity, but 15.2 % had definitely yes corneal opacity on their eyes. Some eyes were not gradable for corneal opacity (5.1%). The top four diagnoses from the anterior segment imaging are, cataract 21.9%, pterygium 11.8%, posterior synechiae 7.9% and uveitis 5.6%. Theses diagnoses would prompt referral in a telemedicine screening program.

Table 4. 4: Anterior Segment Eye Imaging

Quality	**Eye OD (Right) (n=89)**	**Eye OS (Left) (n=89)**	**Total Eyes (n=178)**
Excellent (%)	12 (13.5)	15 (16.9)	27 (15.2)
Good (%)	19 (21.4)	14 (15.7)	33 (18.5)
Satisfactory (%)	32 (36.0)	31 (34.8)	63 (35.4)
Poor (%)	26 (29.2)	26 (29.2)	52 (29.2)

Unreadable (%)	0 (0.0)	3 (3.4)	3 (1.7)
Artifact			
Absent	4 (4.5)	2 (2.3)	6 (3.4)
Dark patches	8 (9.0)	4 (4.5)	12 (6.7)
Glare	25 (28.1)	39 (43.8)	64 (36.0)
White spots	52 (58.4)	44 (49.4)	96 (54.0)
Corneal Opacity			
Probably No (%)	50 (56.2)	47 (52.8)	97 (54.5)
Definitely No (%)	19 (21.4)	18 (20.2)	37 (20.8)
Probably Yes (%)	2 (2.3)	5 (5.6)	7 (3.9)
Definitely Yes (%)	15 (16,9)	13 (14.6)	28 (15.7)
Not Gradable (%)	3 (3.4)	6 (6.7))	9 (5.1)
Diagnosis			
Uveitis (%)	7 (7.9)	3 (3.4)	10 (5.6)
Cataract (%)	23 (25.8)	16 (18.0)	39 (21.9)
Pterygium (%)	16 (18.0)	5 (5.6)	21 (11.8)
Arcus Senilis (%)	2 (2.3)	1 (1.1)	3 (1.7)
Conjunctivitis (%)	3 (3.4)	1 (1.1)	4 (2.3)
Pigmented Lens (%)	5 (5.6)	2 (2.3)	7 (3.9)
Posterior Synechiae (%)	10 (11.2)	4 (4.5)	14 (7.9)
Uveal Prolapse (%)	2 (2.3)	0 (0.0)	2 (1.1)
Fibrotic Plaque (%)	1 (1.1)	0 (0.0)	1 (0.6)
Pseudophakia (%)	1 (1.1)	0 (0.0)	1 (0.6)

Exotropia (%)	1 (1.1)	0 (0.0)	1 (0.6)
Pinguecula (%)	0 (0.0)	1 (1.1)	1 (0.6)
Corneal Ulcer (%)	0 (0.0)	1 (1.1)	1 (0.6)

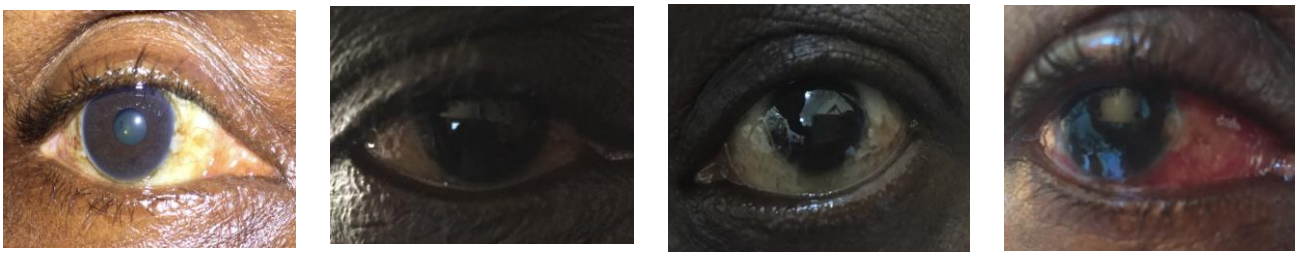
4.4.1 Anterior Segment Grading Scheme

Figure 4.2 to Figure 4.4 below explain how the anterior eye was graded by quality, artifact, and corneal opacity. Similarly, Figure 4.5 shows the different diagnoses of the anterior imaging of the eye that would prompt referral for treatment of eye diseases.

Figure 4. 2 Anterior Segment Grading Scheme-Quality

1 = Excellent 2 = Good 3 = Satisfactory 4 = Poor 5 =Ungradable

Figure 4. 3 Anterior Segment Grading Scheme- Artifacts



0 = Absent 1 = Dark Spots 2 = Glare 3 = White Spots

Figure 4. 4 Anterior Segment Grading Scheme-Corneal Opacity

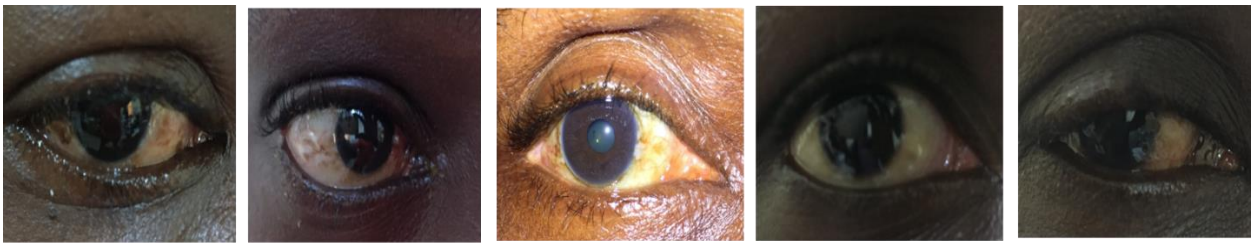
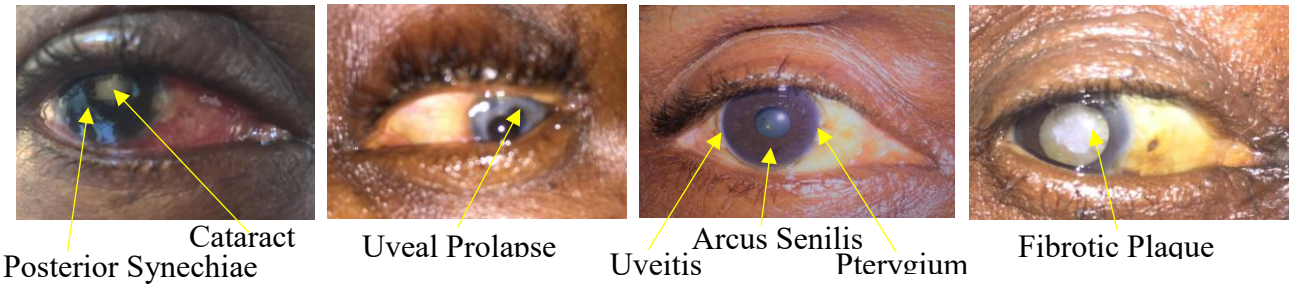


Figure 4. 5 Anterior Segment Diagnosis



4.5 Summary

In general, Table 4.1 summarizes the overall demographics of the study population at three tertiary Hospital, including Connaught Hospital (22.2%), UMC Kissy Hospital (41.5%) and Makeni Hospital 36.3%). The median age for the sample population is 40. More females consented (56.3%) to participate in the study, while the male participation was 43.7%. Using the Snellen visual acuity, the result shows a good vision on the better eye 20/43 as compare to the worse eye 20/129. Among patients presenting at the tertiary facilities for ocular conditions, top three most frequent diagnoses are uveitis (36.3%), glaucoma (34.1%) and cataract (13.4%). Ebola survivors constituted 20% of the study population, while 80% of the sample was comprised of the general eye care population. Table 4.2 summarizes the burden of eye disease in three tertiary hospital in Sierra Leone. Across the health facilities, though patients have a good vision with the better eye Snellen visual acuity than the worse Snellen visual acuity. However, we also observed at Connaught hospital that patients had a better vision in the worse eye Snellen visual acuity than

UMC Kissy Hospital and Makeni Hospital. Patients were diagnosed with several ocular diseases at the tertiary Hospital, with uveitis the most common disease burden followed by glaucoma and cataract. Pseudophakia was a significant ocular disease (p-value=0.0458) at all tertiary Hospital. However, results from patients with eye disease at the tertiary Hospital shows a significant relationship in past ocular history (p-value= 0.0006). Figure 4.1 summarizes distance travel by patients to access tertiary health facilities. Patients at Connaught and Makeni Hospitals are densely distributed whiles patients at UMC Kissy Hospital are sparsely distributed. Though UMC Kissy and Connaught Hospitals are in Freetown but more patients across the country access eye healthcare services at UMC Kissy Hospital than Connaught Hospital. Table 4.3 summarizes the difference in eye care needs for Ebola survivors and the general eye care population at the tertiary Hospitals. Most of Ebola survivors were diagnosis of uveitis (51.9%), followed by glaucoma (33.3%) and cataract (7.4%). While in the general eye care population, most were diagnosed with glaucoma (34.3%) followed by uveitis (32.4%) and cataract (15%). There is a significant difference in the relationship in the worse eye between general eye care population and Ebola survivors (p-value=0.0090). Both Ebola survivors and general eye care population have a significant relationship in non-ocular past medical history (p-value <.0001) and past ocular history (p-value <.0001). Table 4.4 summarizes the feasibility of a telemedicine technique to identify patients with ocular disease. About 89 patients consented for anterior eye photographic imaging form the total sample size. Images were analyzed by two different measures including quality and artifact, ocular diagnosis. Top four diagnoses from the anterior eye image grading are cataract 21.9%, pterygium11.8%, posterior synechie7.9% and uveitis 5.6%. The grading reveals that patients eye had 54% white spot artifact, 36% glare artifact and 3.4% of patients had no artifact on

the eye. The assessment of the anterior segment imaging reveals that 35.4% of patients eye had a satisfactory quality, 18.5% good quality, 15.2% excellent quality and 29.2% poor quality.

Chapter 5: Discussion, Public Health Implications and Recommendations

5.1 Discussion

In this study we evaluated the burden of eye disease across three referral centers in Sierra Leone, specifically comparing eye disease among Ebola survivors and the general eye-care population. We also piloted a telemedicine approach to assess feasibility of anterior segment and fundus photography to provide remote eye care service in regions with limited eye care coverage. These research questions were investigated to evaluate the epidemiology of eye disease, visual acuity impact, and referral patterns. The evaluation of Ebola survivors is timely because of an ongoing screening program at Makeni and UMC Kissy Hospitals. The telemedcine approach addresses issues of access driven by inadequate health staff and health infrastructure.

Based on our findings, the most common diagnoses across the three health care facilities were uveitis, glaucoma and cataract, supporting several studies conducted[57] [60] [22] in Sierra Leone that uveitis, glaucoma and cataract are the most common causes of blindness in Sierra Leone. Unfortunately, it appears that not much progress has been made to date to address the issue of visual impairment in Sierra Leone. There was no significant difference across the tertiary facilities for the clinical diagnoses of patients, although there is a significant difference in distance traveled for patients to access tertiary health facilities. As indicated in Figure 1, though Connaught Hospital and UMC Kissy Hospital are in Freetown, more patients traveled from other parts of the country to access eye care services at UMC Kissy Hospital than Connaught Hospital. Our results also found that patients presenting to UMC Kissy Hospital have a higher prevalence of a past ocular history. These results suggest that patients go to UMC Kissy for chronic eye condition follow up and are

presenting to the other health facilities for acute care. Secondly, patients are likely going to UMC Kissy Hospital for subspecialty care. At Connaught Hospital, we observed that visual acuity was better overall compared to the visual acuity of the patients presenting to the other two health facilities.

We observed a high burden of vision impairment in the poorer seeing eye of the general eye care population. Glaucoma diagnosis followed by uveitis were the top two diagnoses in the general eye care population. Conversely, the Ebola survivors had more uveitis diagnosis followed by glaucoma. These results are as we would expect given that the general eye care population was older than that of the Ebola survivors population. These findings are consistent with other studies conducted in Sierra Leone on Ebola survivors highlighting uveitis as one of the most common ocular complications among Ebola survivors[67]. An ongoing case control study on Ebola survivors in Liberia also highlighted uveitis as one of the most common health issues faced by Ebola survivors[96]. Pseudophakia cases were more often diagnosed among the general eye care population as compared to Ebola survivors. This condition occurs after cataract surgery and it is common among older individuals. Given that the general population was older than the Ebola survivors, this increase in pseudophakia is consistent with an aging population. This findings of pseudophakia among the general population also indicates that patients that visit the three eye care facilities have access to cataract surgery services.

We were able to demonstrate that telemedicine is feasible and is a useful technique to identify pathological ophthalmic disease processes of the anterior segment. Portable cameras can be used to capture anterior segment images by a trained healthcare provider to detect diseases of the eye. This technique is a promising model for improving access to high quality eye care for many Sierra Leoneans who cannot afford to access tertiary facilities in urban areas. Telemedicine techniques

has proven to be an effective way to detect eye diseases as demonstrated in a recent study evaluating corneal diseases in patients[97]. Using the Telemedicine system, photographs can be used to generate an anterior image grading scheme of the eye, that can then promote prompt referral to an eye specialist when necessary. Eyes of patients were graded based on the quality of the image, artifact, and ophthalmic diagnosis. We did find, however, that grading an image with a diffuse light will miss corneal pathology in some cases. The quality of each of the anterior images were graded as excellent, good, satisfactory, poor and ungradable. Our work suggests that diagnoses can be made using the anterior image grading scheme of the eye by an ophthalmologist or trained ophthalmic staff. Cataract emerges to be the highest diagnosis from the grading of the anterior segment of the patients eye, followed by pterygium, posterior synechiae, uveitis, arcus senilis, conjunctivitis, and uveal prolapse. While clinical examination is imperative to define aspects of disease that cannot be observed by photography, the telemedicine approach has been successfully used in low resource countries to identify patients requiring referral and treatment [98]. To our knowledge, our study was the first use of a new technology for ocular examination in Sierra Leone. We demonstrated the feasibility and established clinically meaningful diagnoses using a telemedicine approach.

5.2 Limitations

There were several limitations to this study. There was selection bias in recruiting Ebola survivors to the study as they were part of a larger screening program in two of the health facilities. Patients showed up for the screening because they had an ocular problem, so this skews the data to detect high prevalence of disease, whereas in reality, the prevalence of eye disease may be lower. Given we are looking at 3 tertiary health facilities, the results of the ocular diagnoses are not necessarily generalizable to the entire population of Sierra Leone. To better understand the ocular disease

affecting the citizens of Sierra Leone, it would be important to include peripheral health facilities in future analyses. There was no feedback mechanism established for the telemedicine approach during the study period. As such, it was evident that there was a learning curve for the healthcare professional when using a new camera device in a new healthcare setting. As the study progressed, the images improved and became easier to capture.

5.3 Public Health Implications

Untreated uveitis and glaucoma can lead to irreversible vision loss if not detected early and treated appropriately. The high burden of visual impairment in Sierra Leone is a critical public health issue that not only affects ordinary life as a disability, but it may also be associated with depression and may increase susceptibility to injuries or accidents. Visual impairment impacts negatively on productivity and national progress, increases economic and social costs, and burdens the health care system. A positive outcome from this study was the high prevalence of pseudophakia, which indicates access to cataract surgery for patients presenting at the tertiary eye care facilities. However, beyond cataract surgery, there was a failure to treat conditions behind the lens, such as uveitis and glaucoma, which may be due to lack of tools to diagnose these diseases, health staff not properly trained, and the ineffective downstream therapeutic supply chain within these health facilities. The application of telemedicine can not only be used to diagnose uveitis and glaucoma, which addresses a critical need in Sierra Leone, but it can also be leveraged to reduce the expense of eye care services and improve access to eye care services especially for population in rural regions. Ultimately, telemedicine can work to promote early detection of eye disease, expedite the appropriate treatment of patients with eye disease, and prevent vision loss and blindness among the most disadvantaged rural populations.

5.4 Recommendations

From the findings of this study, we provide the following recommendations for the Ministry of Health and Sanitation.

- We recommend that the government should embark on health education messages at the community level to promote the importance of early detection for eye disease and the economic impact of blindness.
- To negate the limited trained eye care professionals, the government of Sierra Leone should train more middle level health staff (CHO, SRN and SECHN) on eye diseases to complement the insufficient supply of ophthalmologists in the country.
- The government should utilize the telemedicine technique to be able to recognize eye disease earlier by training health staff on how to take anterior photographic image, grading and interpretation of anterior eye images. With proper feedback mechanisms in place, these health staff could be posted at health facilities where there are no ophthalmologists to address eye diseases.
- We recommend that the MOH improve the quality of existing healthcare facilities to address the long distance traveled for patients to access eye healthcare in tertiary hospitals.
- We recommend that the government should integrate eye health services into other health services in the peripheral health units and other district hospitals.

Appendix

INTAKE FORM

Name of Clinic…… Location……

Personal Information

1) Name of Patient…….
2) Sex……
3) Age……
4) Permanent Address……
5) What is the distance from your address to the clinic? ……..
6) Name of Next of King……...
7) Phone #.....

Clinical Complaints

8) What are your complaints? ……
9) Duration of symptoms……
10) Do you know the cause of your eye problem? Yes / No
11) Are you an Ebola survivor? Yes / No
12) If yes, when did you discharged? ……
13) Have you been on medications? Yes / No
14) If yes, do you know the names of medications? Yes / No
15) Name of medications……
16) Is this your first visit to the clinic for this complaint? Yes /No
17) If yes, when last you visited a clinic for eye problem? ……
18) Do you know your previous diagnose? Yes /No
19) If yes, name your previous diagnose…….
20) Have you ever applied herbal medication on the Eye? ……
21) If yes, when last did you applied it?.....
22) Did anyone in your family have eye problem? .....
23) If yes, how many family members? .....
24) Were they diagnosed in the clinic of eye problem?.....

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