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Importance of Eye Exams as a Secondary Preventative Measure for Diabetic Retinopathy: Winning the War on Blindness

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IMPORTANCE OF EYE EXAMS AS A SECONDARY PREVENTATIVE MEASURE FOR DIABETIC RETINOPATHY: WINNING THE WAR ON BLINDNESS

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Abstract

Despite current efforts by medical professionals to reduce the prevalence of diabetic retinopathy (DR), a microvascular complication of uncontrolled diabetes, this noncommunicable disease remains the leading cause of preventable vision loss worldwide (Cheloni et al., 2019). Research estimates 90% of DR cases could be prevented if detected early through routine eye exams, yet certain social determinants of health still remain a significant barrier for many individuals to receive this care. According to Wong & Sabanayagam (2020), only 25% of DM patients in developing countries receive routine care with adequate eye screenings. The goal of this community service project was to address these barriers in hopes of reducing the progression of DR into blindness. The researchers partnered with Medical Missions Outreach to publicize information on DR by creating an educational poster and implementing a new fundoscopic eye screening station at their pop-up clinics. The project was implemented on the trip to Trinidad and Tobago in August 2022 where knowledge regarding the importance of adhering to routine eye examinations and close management of diabetes was successfully portrayed and barriers to healthcare were temporarily eliminated. Discussion was made on the growing concern of DR, social determinants of health affecting developing countries, research methods for intervention, execution of the chosen educational model, and the sustainability of this community service project.

Chapter I: Introduction

Introduction

Diabetic retinopathy (DR), a complication of diabetes mellitus (DM), is a leading preventable cause of vision loss worldwide; however, an estimated 90% could be prevented through early detection and management via routine eye exams (Cheloni et al., 2019; Liu, 2017). According to Wong & Sabanayagam (2020), only 25% of individuals with DM in developing countries are getting eye exams. The following chapter addresses this issue by discussing DR, Medical Missions Outreach (MMO), current medical needs in developing countries in regards to eye health, and educational opportunities. Chapter one will also discuss the community outreach purpose and medical significance.

Background

It is widely accepted that developing countries have a disproportionately higher prevalence of DR—a secondary manifestation of DM—due to limited clinical, economic, and educational resources (Khandekar, 2012). Collaborative findings also note that timely eye screenings significantly reduce the percentage of DR cases from progressing to vision-threatening diabetic retinopathy (VTDR). Varying methods for reducing the burden of disease via eye screenings have been proposed by public health representatives; however, many are still not being implemented into the communities.

Diabetic Retinopathy

Diabetic retinopathy is a proliferative condition that manifests from poorly managed diabetes (Fraser & D'Amico, 2021). The condition begins when capillaries become damaged, die, and release factors for neovascularization. When this process occurs, the amount of fibrinogen in the plasma increases and leads to vascular ischemia, infarct, and

hemorrhages—visualized as soft exudates on a fundoscopic exam (Fraser & D'Amico, 2021). Over time, these vessels become distorted and increase the risk for secondary complications such as cataracts, retinal thickening, acute glaucoma, and vision-threatening diabetic retinopathy. Statistical analyses highlight patients with DR are at an increased risk for morbidity and mortality, specifically through cardiovascular complications of myocardial infarction, stroke, and cardiovascular disease (Fraser & D'Amico, 2021). Furthermore, patients diagnosed with late-stage proliferative DR have a two-fold greater risk of CVD complications and death (Fraser & D'Amico, 2021). Given these risks, it is important to routinely screen patients for early signs of DM-associated symptoms via an eye exam.

Vision Threatening Diabetic Retinopathy

The initial stage of DR may remain asymptomatic since the degree of proliferation remains minimal. However, once lesions begin to neovascularize, the area between the macula and retina begins to accumulate fluid and affect vision—it is at this stage that patients are at most risk for VTDR (Alemu Mersha, Woredekal, & Tesfaw, 2020). The process from non-proliferative DR to proliferative VTDR takes about 17 years and ultimately affects both eyes (Groeneveld, Tavenier, Blom, & Polak, 2019). Currently, 899,000 Americans have already developed VTDR, a number that is expected to increase as the number of cases of DR does, too (Centers for Disease Control and Prevention, 2020). Several risk factors such as a diagnosis of DM at a younger age, unmanaged blood sugar, and failure to get routine eye exam screenings increase the chance that VTDR will progress to permanent blindness; however, by adhering to an effective treatment plan for DM, and maintaining healthy glycemic and blood pressure levels, this process may be regressed (Groeneveld et al., 2019).

Diabetic Retinopathy and Diabetes Screening

Diabetic retinopathy, which can be visibly detected via an eye exam, often remains asymptomatic during early stages. This disease will remain asymptomatic until it progresses into proliferative stages which presents as decreased visual acuity, floaters, or sudden vision loss resembling a dropped curtain appearance (Fraser & D'Amico, 2021). Approximately 10-20% of patients diagnosed with late-stage DM had DR proliferating for four to seven years (Fraser & D'Amico, 2021). In addition to the emergence of proliferative DR, the risk for VTDR greatly increases (Fraser & D'Amico, 2021). Without screening for diabetes, there is a potential the disease will remain uncontrolled and lead to secondary effects of chronic hyperglycemia, DR, and potential vision threatening diabetic retinopathy (Fraser & D'Amico, 2021).

Eye Exam Screenings

Regular eye screenings can help prevent up to 90% of the world's preventable vision loss; however, only 50-60% of DM patients adhere to their advised screening recommendations (Kuo et al., 2020). Given the prevalence of DM is expected to increase 69% in developing countries by the year 2030, it is expected the rate of DR will also rise (Wong & Sabanyagam, 2020). If initiatives to increase the compliance toward routine eye exams in DM patients can be made more effective, the manifestations of DR could decline. (Kuo et al., 2020). Despite this, 30% of patients in the United States still fail to comply with annual eye exam recommendations, a percentage that is disproportionately higher in developing countries (Zou et al., 2017).

Global Initiatives

In 2013, the International Council of Ophthalmology (ICO) strategized a global Public Health initiative to reduce vision-threatening diabetic retinopathy. They did this by conducting a multi-country collaboration consisting of representatives from countries with varying monetary

resources, communication methods/preferences, clinical tools, and geographic barriers who could provide insight to their community's economic and social parameters (Wong et al., 2018). The purpose of this initiative was to create a global eye screening guideline outlining which patients should be screened based off a risk-assessment, timelines of when they should be screened to reduce financial burden of travel and health care fees, which clinical methods to use depending on location-specific economic availability, and which care providers should be involved in the team-approach care (Wong et al., 2018). By incorporating views of multiple countries, the goal was to close the gap in social determinants of health by removing barriers to care via more feasible screening schedules, cost-effective tools, increased communication through shared decision-making, and more applicable education material (Wong et al., 2018).

Patient Education

The ICO found that a team-based approach, consisting of the physician, ophthalmologist, and patient was the best method to convey health-sensitive patient education (Wong et al., 2018). Through this, the physician's conversation about the importance of a healthy diet, regular exercise, healthy blood pressure, and routine check-ups to manage their DM would be heard by both the patient and ophthalmologist. Similarly, when the patient visits an ophthalmologist for their eye exam, the ophthalmologist contributes microvascular fundoscopic findings to both the physician and patient in order to collectively discuss how well the current DM and DR treatment plan is working. With this team approach, they are also able to identify when treatment is no longer effective and when an additional therapist or rehabilitation specialist should be introduced to provide supplementary support (Wong et al., 2018).

Moinul et al. (2018) conducted a study using a different Telemedicine mode of communication to assess whether an off-site pre-retina screening followed by an educational

seminar on DR would increase the percentage of patients who returned for their follow-up visit and whether the seminar would increase their dedication to their recommended glucose-sensitive diet. For this, 101 high-risk patients diagnosed with DM were recruited and asked to participate in a tele-retina screening through which images of the patient's fundus and retina were obtained via optical tomography and sent for remote screening (Moinul et al., 2018). Patients then participated in a seminar that focused on DR education and information on how complications from DM can exacerbate their conditions. Follow-up examinations were scheduled in periods of six and twelve months in which both post-retinal examinations and HbA1c levels were measured to assess changes from the pre-test. Results found that of the 101 participants, 33 admitted that prior to the study, they had never received a general eye exam screening to check for DR (Moinul et al., 2018). In addition, post-seminar education results indicated a significant increase from 35.6% to 50.5% in annual screening compliance ($p = 0.03$) (Moinul et al., 2018). Given the ability to follow-up with patients, the healthcare providers were able to refer these individuals to an appropriate specialist—88% to an optometrist and the 11.9% who developed DR to an ophthalmologist for more specialized care (Moinul et al., 2018). While this Telemedicine method did not show significant improvement in lowering patients' HgA1C, it did indicate a 99% satisfaction score for the modality of the visit, specifically with the tele-retina component (Moinul et al., 2018). Since management of both DM and DR is important for reducing comorbid complications and potential VTDR, additional methods for improved DM education are still needed; however, the multi-modality approach has proven to be an effective method for certain populations and should be explored more.

Zou et al. (2017) also conducted a cross-sectional study in China to identify what factors into a patient's decision to return for their eye exam. For this, 720 participants already diagnosed

with DM were recruited. Of these, 519 were randomly chosen to participate in an additional patient education awareness interview. Results from the interviews revealed that 95% of participants understood that DM affects eye health and that eye exams are important; however, only 12% knew about DR and that this was why eye exams are encouraged (Zou et al., 2017). Furthermore, these participants did not know that early stages of DR do not present with symptoms and that they must be screened with an eye exam.

These findings strengthen the importance of improving the amount of educational resources available to patients and for improving the method in which it is discussed. Guidelines, education reforms, and multi-modal methods have been explored to enhance patient compliance to annual health screenings. However, the percentage of DM-related complications continue to rise.

Needs Assessment

In 2003, Bradley and Kelly Edmondson started going on annual mission trips. With each mission trip they took, the medical need for underserved populations globally became more apparent to them. What started out as an annual mission trip is now a non-profit organization Medical Missions Outreach (MMO) that dedicates itself to providing medical care and education through serving a local church. Medical Missions Outreach's goal is to evangelize through providing ethical, quality medical care around the globe (Medical, n.d.c).

During a short term mission trip, MMO sets up different types of clinics including medical, vision, physical therapy, surgical, and public health educational clinics. However, currently, none of the clinics focus on eye health as the vision clinic only focuses on visual acuity. The organization is in need of eye health screening tools and education. This will serve to

specifically benefit diabetic patients as they are at higher risk for developing asymptomatic eye complications that will eventually lead to blindness.

Problem Statement

Vascular health, central to DM, can be directly screened and most readily identified in only one location: the eye (Schneiderman, 1990). Through secondary preventive measures such as eye screening in DM patients, early detection of DR would emphasize the urgency for prompt management of diabetes. This early management could improve quality of life by minimizing manifestations of diabetes including VTDR and blindness (Wong & Sabanayagam, 2020). Lack of medical education and adequate access to healthcare, especially seen in developing countries, increases the prevalence of undetected DR in diabetic patients (Wong & Sabanayagam, 2020).

Purpose

In light of MMO's needs assessment, the aim of this community outreach project is multifactorial. First, to equip MMO volunteers with PanOptic ophthalmoscopes to perform adequate fundoscopic exams enabling the identification of DR in DM patients. Second, create an educational poster MMO can use to counsel diabetic patients regarding the importance of disease management in preventing the progression of DR to VTDR and blindness. Thirdly, to provide means of sustainability both within the community and the organization by providing resources and teachings that allow continuity of the project on future trips. The goal of this proactive approach is to address current healthcare barriers by minimizing the knowledge gap as it relates to the importance of receiving routine eye exams and managing DM, as well as to provide resources to increase sustainability in healthcare.

Significance of the Problem

A major health misconception patients have is when there are no symptoms involved, no action is required (Wong & Sabanayagam, 2020). In this case, there is little drive from patients to follow provider recommendations for navigating their diabetes, even when there are no complications at the time of diagnosis. Given that the prevalence of DM has increased four-fold in adults worldwide since 1980, education explaining potential negative ramifications associated with untreated DM and DR, whether symptomatic or asymptomatic, is imperative (Cheloni et al., 2019).

Healthcare providers who specialize in eye care report inadequate education on DM and DR, delayed eye screening, and inadequate tools and resources for patients to be the most frequent barriers to sufficient eye health (Wong & Sabanayagam, 2020). Providing tools to eye care teams, including medical technicians and patient care assistants serving with MMO, will increase screening for DR in patients living in developing countries (Wong & Sabanayagam, 2020). Early screening in these patients will allow for earlier disease management. In addition, easily accessible resources summarizing proper steps in the management of DM and DR that can be explained to patients by ophthalmologists or optometrists serving with MMO will help bridge the current knowledge gap surrounding DM and DR management in developing countries.

Limitations to the Study

Potential project barriers include: COVID traveling restrictions, cost of bringing educational materials overseas, and lack of volunteers and resources. If COVID traveling restrictions were to occur, then the team would focus on creating educational material for MMO to use on future trips. The project itself, however, would be implemented at a local underserved clinic in Minnesota. The second consideration of cost can be minimized to making the

educational materials available via a poster. Lastly, the barrier of the lack of volunteers, resources, and time can be met by the "see one, do one, teach one" approach. By training the volunteers and community members who help at the clinic, they can subsequently teach prospective, future volunteers about educational eye health topics and on how to perform ophthalmic eye screenings.

Definition of Terms

For clarity and understanding, terms pertinent to this study must be defined.

Developing countries: "A country having a standard of living or level of industrial production well below that possible with financial or technical aid; a country that is not yet highly industrialized" (Cambridge University Press, n.d., Definition 1).

Social Determinants of Health (SDOH): Aspects of the environment that impact health, life quality, and the ability to function. This includes where an individual works, learns, lives, worships, and was born (U.S. Department of Health and Human Services, n.d.).

Communicable diseases: "Illnesses caused by viruses or bacteria that people spread to one another through contact with contaminated surfaces, bodily fluids, blood products, insect bites, or through the air" (Edemekong & Huang, 2021, para. 2).

Noncommunicable disease: Behavioral, physiological, genetic, and environmental influences that contribute to the development of long term, chronic diseases which cannot be spread between persons ("Noncommunicable diseases," 2021, para. 1).

Prognosis: Refers to the probability of a particular outcome through the course of disease (Merriam-Webster, n.d.).

Primary prevention: Clinical tools used to prevent the likelihood of disease in healthy individuals. The goal of primary prevention is to intervene early before disease manifestation (Kisling & Das, 2021).

Secondary prevention: Stresses early intervention in patients with an active condition that has developed pathologically but is still asymptomatic. The goal of secondary prevention is to mitigate the progression of the established disease (Kisling & Das, 2021).

Tertiary prevention: Prevention directed towards diseased patients with intention to reduce disease severity and decrease accompanying symptoms through clinically guided treatment (Kisling & Das, 2021).

Diabetes Mellitus (DM): A metabolic disorder that impairs all organs of the body through sustained elevated blood glucose levels. This disorder is broken down into two categories: type I diabetes and type II diabetes ("Diabetes," 2021, para. 1).

Type I Diabetes Mellitus (T1DM): An autoimmune response against the pancreatic beta cells, inhibiting insulin production (Centers for Disease Control and Prevention, 2021a).

Type II Diabetes Mellitus (T2DM): A form of diabetes defined by increased circulating blood glucose levels due to inadequate insulin secretion from the pancreas as well as poor insulin response from the body's cells (Mayo Clinic Staff, 2021).

Diabetic retinopathy (DR): A complication of diabetes impacting blood vessels within the eye that can progress to impaired vision and blindness ("Diabetic Retinopathy," 2021, para. 1).

Proliferative diabetic retinopathy (PDR): Newly developed, unstable blood vessels in the retina and vitreous of the eye, creating difficulties with oxygen distribution. At this point, the disease is in a more severe state ("Diabetic retinopathy," n.d., para. 5).

Cardiovascular disease (CVD): A collection of diseases impacting the heart, namely peripheral artery disease, coronary artery disease, cerebrovascular disease, and aortic atherosclerosis (Lopez et al., 2021).

Conclusion

Medical Missions Outreach recognizes that DM and DR are international epidemics requiring new and improved screening and management (Medical, n.d.c). Secondary preventative measures, like eye screening, could identify DR caused by DM and promote the need for disease management (Wong & Sabanayagam, 2020). The next chapter includes a summary of current literature that discusses how SDOH impacts developing countries, the effect it has on DM and DR, and medical practices that can be used for prevention of DR complications. Specifically, chapter two focuses on DR and the need for preventive medicine through eye exams.

Chapter II: Literature Review

Introduction

Developing countries face a unique challenge in their healthcare system because they have high prevalence rates of both noncommunicable and communicable diseases (Centers for Disease Control and Prevention, 2021b). Fortunately, lowering the prevalence rates of noncommunicable diseases through early intervention and frequent screening are highly cost effective and can help alleviate some of the health burden in these countries (Orach, 2009). Identifying the specific SDOH impacting developing countries helps determine the most optimal channels for intervention and screening.

A type of examination that helps aid in the detection of chronic eye diseases is fundoscopic exams. Only by a fundoscopic exam are providers able to see the patient's blood vessels with the naked eye. Thus, vascular health can be an indicator of underlying noncommunicable diseases such as diabetes.

Prevalence of Disease

Developing Countries

Noncommunicable diseases underlie seven out of every ten premature deaths worldwide (Centers for Disease Control and Prevention, 2021b). Most concerning is the fact that 85% of these deaths occur in low-income, developing countries who have disproportionately higher incidences of both infectious and noncommunicable diseases (Centers for Disease Control and Prevention, 2021b). Public health initiatives aim to reduce risk factors and to prevent the development of comorbid conditions via recommendations for lifestyle modifications, screenings, and preventative care. However, given the rise in cardiovascular diseases, cancer, respiratory diseases, and DM—the leading preventable, comorbid diseases accounting for 80%

of the premature noncommunicable deaths—it is apparent current public health methods are not effective (Pan American Health Organization, n.d.).

Leading Causes of Death

Type II diabetes affects 9.3% of adults worldwide, a percentage that represents nearly 463 million people and warrants T2DM among the top ten leading causes of death (Hayward & Selvin, 2021; Lin et al., 2020). By the year 2040, the prevalence of T2DM is expected to increase by 69% and 20% in developing and developed countries, respectively (Wong & Sabanayagam, 2020). This rise is of notable concern given the vast impact DM poses on microvascular health, such as DR and diabetic cataracts. Diabetic retinopathy is a chronic, irreversible manifestation that will lead to blindness (Maseko, Van Staden, & Mhlongo, 2021). Without primary intervention via proactive health initiatives, DM can progress to comorbid cardiovascular disease, kidney disease, metabolic dysfunction, and death (Maseko, Van Staden, & Mhlongo, 2021).

Diabetes Mellitus

Diabetes Mellitus is classified into two types: type I diabetes and type II diabetes. Type I DM occurs when pancreatic beta cells are unable to produce insulin due to an autoimmune disruption or destruction (Inzucchi & Lupsa, 2021). Type II DM occurs as a result of chronic overproduction of insulin from the pancreas; over time, the excess insulin circulating in the blood causes receptors to desensitize and become insulin resistant (Inzucchi & Lupsa, 2021). In the early stages of the disease, many patients are asymptomatic aside from subtle presentations of weight changes, blurred vision, polyuria, and nocturia which can make diagnosis difficult, especially if one is not aware of their risk and is not detected during a routine health visit.

Risk Factors

Several factors increase the risk for developing T2DM such as family history, ethnicity, obesity, birth weight, lifestyle, and diet (Robertson, 2021). For example, 25% of the global cases of T2DM are found in Polynesia and the Pacific islands, impacting a disproportionate 14.3% of Pacific Islander's and 9.9% of Asians when compared with 8% of Whites (Robertson, 2021). While family history plays a large role in the probability of developing T2DM, lifestyle habits including smoking, exercise, diet, and sleep can also give rise to increased incidence rates. By adopting a diet rich in fruits, nuts, grains, and vegetables, increasing physical activity, and avoiding the use of tobacco and alcohol, the risk of developing T2DM can be significantly reduced (Robertson, 2021). Unfortunately, without adequate knowledge of these risks nor adequate access to health facilities to help screen for early symptoms, cases are still on the rise.

Preventative Medicine

Definition

Preventative medicine combines physical, psychological, social, and therapeutic aspects of health to provide exceptional care and eliminate disease. Successful prevention requires collaboration between the provider and patient (Katz, 2015). Within this form of medicine, there are primary, secondary, and tertiary preventative measures (Centers for Disease Control and Prevention, n.d.). Primary prevention is implemented when a disease is absent. Molding a patient's environment, diet, and personal decisions can reduce risk factors and aid in the reduction of disease occurrence. Secondary prevention involves screening to discover existing disease that has yet to show signs and symptoms. Tertiary prevention is when the disease has progressed with notable effects on the body. This stage of prevention works towards disease management to slow or halt the progression (Centers for Disease Control and Prevention, n.d.).

Clinical Screenings

General health screenings are one way in which secondary prevention can be implemented in a clinical setting (Centers for Disease Control and Prevention, n.d.). Historically, basic physical examinations and lab values have proven their importance in early diagnosis and treatment. Modern medicine continues to use these examination tools to enhance quality of life and avert untimely death by diagnosing and treating disease before irreversible effects develop (Bell, 2017). Initial actions include performing a history and physical exam, ordering necessary lab tests, and determining the patient's risk factors for the screened disease (Dans et al., 2011; Silvestre et al., 2011). The second step is to conduct further testing that can confirm if the disease is present or absent (Silvestre et al., 2011). This process is completed for a variety of disease screenings, such as breast cancer, prostate cancer, diabetes, hypertension, colorectal cancer, anxiety, and depression (Silvestre et al., 2011).

Although screening can provide numerous benefits to patients, there are potential pitfalls (Bell, 2017). The purpose of preventative screening is to foster improved patient health rather than uncover new, potentially unimportant, diagnoses. Screening can also produce false-positive results that require patients to undergo further testing and treatment, developing a sense of unmerited stress, anxiety, and financial burden (Bell, 2017). To eliminate the downfalls of screening, there is criteria that indicates which screenings are necessary and beneficial in different patient populations. The decision to screen a patient is based on five criteria:

> "The burden of illness must be high, the tests must be accurate, early treatment must be more effective than late treatment, diagnostic tests and early treatment must be safe, and the cost of screening strategy must be commensurate with the potential benefit." (Dans et al., 2011, p. 235)

Data is collected from randomized clinical trials and analyzed to determine which results are significant and which population benefits most from the screenings (Bell, 2017). Lack of evidence does not ultimately mean a patient will not receive the screening intervention, but rather that the provider and patient need to make a combined decision based on what is best for that specific patient (Bell, 2017). Overall, if screening is performed, there must be a beneficial treatment accessible for the diagnosed disease (Dans et al., 2011).

Eye Examinations

Routine eye exams are a beneficial form of screening that any provider can perform, not just ophthalmologists. These exams are most commonly performed through visual acuity, inspection of the eye, and fundoscopy (Salz, 2015; Schneiderman, 1990). The innermost features of the eye include the lens, retina, retinal vasculature, and optic nerve; looking through an ophthalmoscope allows inspection of these structures during a fundoscopic exam (Schneiderman, 1990). Given that the eye contains the only directly visible vasculature in the entire body, this specific exam can be useful in identifying pathology (Schneiderman, 1990). For instance, cotton wool spots develop in NPDR when retinal nerves become inflamed and lead to ischemia (Sivaprasad & Pearce, 2019). Retinal hemorrhages are another finding providers might see on examination which may be present in patients with DM, endocarditis, leukemia, and pernicious anemia. Visualization of these retinal hemorrhages can help providers diagnose a patient or track progression of the disease (Schneiderman, 1990). Providers may also see arteriovenous (AV) nicking. Arteriovenous nicking, while uncorrectable, can help diagnose the underlying disease state, such as hypertension or diabetes (Schneiderman, 1990).

There are also other imaging options providers can use to visualize the retina, retinal vasculature, and optic disc (Salz, 2015). One of these mechanisms is color fundus photography.

This form of imaging is useful for patient education as it captures exactly what the provider is seeing and allows the patient to visualize their disease (Salz, 2015). Color fundus photography is also beneficial in disease progression as it can capture how the vasculature appears at each visit with references from the last (Salz, 2015). A second option is fluorescein angiography (FA). Patients receive IV sodium fluorescein that allows better visualization of microaneurysms, ischemia, and neovascularization compared to a fundoscopic exam (Salz, 2015).

Eye Health Program Implementation and Sustainability

Public health education seeks to minimize health risk and complications by providing a community with the educational resources necessary to inform, educate, and empower the patient to implement lifestyle modifications (Welp, Woodbury, McCoy, Teutsch, & National Academies of Sciences, Engineering, and Medicine, 2016). This same ideology can be applied when preventing blindness and further eye complications in diabetic patients. According to Welp et al., the first step in public health education promotion is to analyze the current knowledge of the community (2016). For example, in a telephone survey conducted by the National Eye Institute and Lions Club International Foundation, the data revealed that most people did not realize that diabetic retinopathy could be asymptomatic without warning signs (National Eye Institute & Lions Club International Foundation, 2008).

Afterwards, an assessment of the relevant risk factors for eye complications needs to be identified. The National Eye Health Education Program states,

> "Although diabetic eye disease often has no early warning signs, it can be detected early through a comprehensive dilated eye exam. Research has shown that early diagnosis and timely treatment can prevent vision loss in more than 90 percent of people with diabetes, yet approximately half of all people with diabetic

> retinopathy are diagnosed at a stage when it is too late for treatment to be effective" (2011).

Thus, by knowing that diabetes is a risk factor in diabetic retinopathy and blindness, providers and public health professionals know where to target the educational resources (Wong & Sabanayagam, 2020).

The optimal way to include educational resources and public awareness among a community is by working alongside the respective public health department (Welp et al., 2016). Then, the federal agency would incorporate smaller-scale educational programs wherever it is necessary such as school, community centers, and public areas. Ultimately, in order to make educational programs as sustainable as possible, the patients would have "access to community-based vision screening services and follow-up care" (Welp et al., 2016). However, that is not where the work of the organization ends as it should also support environments that encourage optimal eye health (Welp et al., 2016).

Diabetic Eye Screening

As a secondary screening method, eye exams are used in patients with DM to reduce the chance of blindness (Lingam, 2018). According to Liu, DR is one of the main causes of blindness in adults worldwide (2017). By performing routine eye exams and providing adequate treatment, 90% of DR can be eliminated (Liu, 2017). When doing a fundoscopic examination, providers can diagnose DR by the presence of microaneurysms, pre-retinal and vitreous hemorrhages, hard exudates, and/or cotton wool spots. To determine how severe a patient's DR is, a grading system is used that assesses the optic disc, macula, lesions, and surrounding fields (Sivaprasad & PGrearce, 2019). The American Diabetes Association produces recommendations on how frequently medical providers should screen diabetic patients to catch and monitor this

disease. According to this organization, T1DM patients are recommended to get an eye exam within 5 years of their diagnosis. Type II DM patients are recommended to get an eye exam in the same visit in which they are diagnosed (Sivaprasad & PGrearce, 2019). If DR is not noted for either group, annual exams are recommended; however, once DR develops, providers may want to check the eye more frequently to assess if the disease is progressing based on the grading scale (Liu, 2017). Even with these guidelines, 50% of American diabetic patients are not receiving eye exams, a reason why blindness continues to be problematic within this patient population (Liu, 2017).

Screening rates in the United States, especially in underserved and rural areas, continue to be subpar despite guidelines from The American Diabetes Association and numerous eye exam options, including fundoscopy, color fundus photography, and fluorescein angiography (Liu, 2017). Primary care providers are limited in their time to see patients, normally given only 15-20 minutes. During this time, the provider is expected to address numerous concerns and screen for a variety of other diseases. Discerning which exams to perform is often challenging, resulting in eye exams being sacrificed as they are not a high priority to most (Salz, 2015).

However, new technology is being used to diagnose and monitor DR more efficiently by automatically detecting microaneurysms and lesions. As of now, EyePACS and IDx-DR are the only two softwares that detect DR lesions and microaneurysms, with IDx-DR being the only software approved by the US Food and Drugs Administration (Sivaprasad & Pearce, 2019). Primary care clinics in Scotland are currently using the IDx-DR automated intelligence system with great success. EyePACS is still in the research stage with future clinical trials planned and a need for image resolution improvement. Once both softwares are approved and widespread, this

technological advancement will ideally increase the rate of screening within diabetic patients and reduce the time strain on providers (Sivaprasad & Pearce, 2019).

Barriers to Healthcare in Developing Countries

The field of public health was created to help maximize the quality and quantity of healthcare while minimizing healthcare disparities. In order to identify healthcare disparities that impact developing countries, non-medical factors that are impacting health outcomes also need to be identified. These factors are defined as social determinants of health (World, n.d.). The five major SDOH are as follows: economic stability, education access and quality, health care access and quality, neighborhood and built environment, and social and community context (Office, n.d.).

Economic Stability

Some populations in developing countries are undergoing an epidemiological transition from communicable to noncommunicable diseases, (Misra et al., 2019). However, countries in South Asia, the Middle East, and Sub-Saharan Africa have the financial burden of both types of diseases at the same time (Misra et al., 2019). Since treatment options for noncommunicable diseases are usually more expensive than communicable diseases, preventive care for noncommunicable diseases is more cost-effective than communicable diseases (Orach, 2009). For example, the cost of a lifetime supply of insulin for T2DM is greater than preventing T2DM with exercise and healthy eating habits (Orach, 2009). Given the high costs associated with insulin injections, developing countries often struggle to afford the necessary treatment for type II diabetes. Unfortunately, uncontrolled T2DM brings further health complications which results in more expensive medication and treatment options (Misra et al., 2019). A larger percentage of the limited resources are distributed to noncommunicable diseases even though communicable

diseases may be the higher burden of disease in the country simply due to overall financial concerns for the country (Orach, 2009).

To make matters more difficult, some health services in developing countries require out-of-pocket expenses that often hinders if a person is able to afford their medical visit--an action that could result in a worse prognosis. Out-of-pocket expenses, especially for managing chronic diseases, fuel the poverty cycle: patients are paying for healthcare or indebting themselves and thus are unable to climb up in economic status (Orach, 2009). Even the health insurance coverage in developing countries fails to lower the economic barrier because the insurance is costly as well (Orach, 2009). A cross sectional study by Merepa et al. focused on identifying the most prevalent barriers in eye care for a community in the Upper East region of Ghana (2017). The methods included interviewing the randomly selected Ghanaians participants. The data suggested that high cost of service and health insurance inversely affected whether they sought out eye care. This study emphasized the significance of the role that economic stability plays in the access to healthcare (Merepa, 2017).

Educational Access and Quality

The lack of knowledge and awareness about eye health is another SDOH that has negatively impacted health outcomes (Orach, 2009). In a qualitative study conducted in Iran, the researchers "investigate(d) barriers to patient engagement in the delivery of safe hospital care" (Chegini et al., 2019, p. 1). The study focused on conducting individual semi-structured interviews among an Iranian population knowledgeable in healthcare. The data demonstrated that higher levels of health literacy correlated with patient engagement, compliance, and empowerment. According to Chegini et al. (2019), some patients were not given adequate health education at the time of discharge. However, proper eye care education can help combat this

social determinant. In the study conducted by Merepa et al. (2017) in Ghana, patients believed their deteriorating eye health was irreparable. This study further highlights the importance of public education and community awareness about eye care services available and what exactly the treatment targets (Merepa, 2017).

Healthcare Access and Quality

In all countries, lack of healthcare access is an injustice. Orach et al. (2009) collected data on human rights, sexual health, and reproductive health in Uganda. The researchers became aware that low income communities in Uganda did not receive health care because the government unjustly allocated their medical resources to the richer communities (Orach, 2009).

On the other hand, some communities have access to health care, but it is of poor quality. Research conducted by Wong & Sabanayagam concentrated on the benefits of shifting DR prevention from a tertiary to a secondary or primary level of prevention (2020). One of the reasons why primary prevention was not very well developed was because of the lack of systematic screening programs. Lack of equipment, medication, and trained professionals were also barriers in preventing DR and resulting in a lower quality of eye care (Wong & Sabanayagam, 2020).

An increase in the number of hospital staff also improves the quality of healthcare (Misra, 2019). This principle is demonstrated in the research conducted by Chegini et al. in Iran (2019). The Iranian participants that were knowledgeable in the community healthcare system shared there was a lack of medical staff in the hospital. The nurse shortage in Iran meant nurses were rushed with each patient and thus unable to fully explain and educate the patient on his or her health concerns. According to the study, an additional strategy that led to better healthcare delivery was the positive attitude of hospital staff. During the interviews, some participants

shared that kind attitudes from nurses and strong relationships with providers allows the patient to feel safe to ask questions about his or her health concerns (Chegini et al., 2019).

Environmental and Social Dynamics

The neighborhood and built environment of a community places a role in a patient's access to care. An example of an environmental determinant that creates a barrier in receiving healthcare is the lack of affordable transportation in the community (Merepa et al., 2017). The study conducted by Merepa et al. (2017) in Ghana interviewed participants about their experiences receiving eye care to help determine the prevalent barriers in the community. Among one of the financial barriers in getting access to care was the cost of transportation (Merepa et al., 2017).

The dynamics of the community and individuals social status may also influence the quality of healthcare. For example, financial resources distributed to public service are not always allocated fairly. As previously mentioned, in the research conducted by Orach (2009) most of the public service money was given to the wealthy instead of the poor. Other SDOH that are influenced by the social environment are whether the motivation of the patient is acceptable in hierarchical and paternalist cultures and whether the parent encourages this motivation to change (Chegini et al., 2019). According to the participants who were interviewed in the Iranian study concerning barriers to healthcare, these societal constructs impacted the quality of health care that was received (Chegini et al., 2019).

Current literature suggests that early eye screenings positively affect eye health. Therefore, identifying the social barriers to receiving eye exams helps improve overall health. In the case of DR, screening and early intervention may improve eyesight and motivate patients to control their diabetes (Wong & Sabanayagam, 2020).

Retinopathy

Overview of Diabetic Retinopathy

In the year 2045, approximately 629 million individuals worldwide are predicted to have diabetes (Cheloni et al., 2019). Given the relationship between DR and DM, it is estimated that the prevalence of DR is also increasing (Sivaprasad & Pearce, 2019). As for today, data from 35 different studies indicated that DR was identified in 6,920 of 20,000 DM patients (Yau et al., 2012). Within the same population, an estimated 1,400 had PDR and 1,360 had diabetic macular edema (Yau et al., 2012). Both DME and PDR put patients at risk of losing their sight (Lechner et al., 2017). In fact, DR is the "leading cause of vision loss in working-age adults" (Cheloni et al., 2019, p. 1). In 2015, 2.6 million people had diminished sight because of diabetic retinopathy. While some studies predict sight-threatening stages of DR to decrease in higher income countries because of perfected therapies, increased screening for DM, and greater DM awareness, low-income countries where DM prevalence is still rising do not share that same trend. Inefficient planning, lack of health resources for the eye, and decreased access to healthcare all contribute to this major incongruence (Cheloni et al., 2019; Wong & Sabanayagam, 2020).

Diabetic Retinopathy Fundoscopic Findings and Staging

Diabetic retinopathy is categorized into two stages: non-proliferative (NPDR) and proliferative. Within the NPDR stage of development, microaneurysms, hemorrhages, cotton wool spots, and hard exudates can be visualized in a fundoscopic exam and are typically asymptomatic (Wang & Lo, 2018). Initial stages of DM can foster increased blood glucose levels and result in retinal vascular basement membrane thickening. This in turn can impair intercellular communication within the retinal endothelium and may contribute to a decrease in visual function (Lechner et al., 2017).

Microaneurysms and hemorrhages are the two earliest signs of NPDR and present as microscopic lesions on the fundus and represent, “the ballooning of capillaries where the vessel wall is compromised from loss of supporting pericytes and/or glial attachment” (Lechner et al., 2017, p. 8). Hemorrhages are the result of ruptured microaneurysms and are crucial for aiding in the diagnosis and monitoring of DR development. Hard exudates are ‘waxy’ lipoprotein deposits with precise borders typically positioned on the outer levels of the retina; these deposits arise from capillaries with increased permeability. Retinal capillary closure may cause inflammation of nerve fiber axons or even ischemia/infarction of the nerve itself leading to the development of cotton wool spots. These distinct fundoscopic findings are indicative of poor perfusion and aid in early diagnosis of non-proliferative diabetic retinopathy (Sivaprasad & Pearce, 2019).

The progression of NPDR can further develop into PDR in response to local hypoperfusion on the surface of the retina causing neovascularization (Kollias & Ulbig, 2010). Sometimes these new, irregular blood vessels can bleed into the vitreous and produce vision loss in patients due to their weak infrastructure and high likelihood for vitreous hemorrhage.

Another possible outcome resulting from NPDR is diabetic macular edema. When fluid accumulates in the sub- and intra- retinal spaces due to the breakdown of the blood-retinal barrier, inflammation of the macula occurs as well as associated vision alterations (Wang & Lo, 2018). Both PDR and DME have great potential to cause sight-threatening diabetic retinopathy (Sivaprasad & Pearce, 2019).

While it is not easy to determine how close DR is to causing a loss of vision, the “4-2-1” rule of the Early Treatment Diabetic Retinopathy Study (ETDRS) grading system can give non-specific severity classification of diabetic retinopathy. The “4-2-1” rule includes hemorrhages and microaneurysms in four quadrants, venous bleeding in at least two quadrants,

and intraretinal microvascular abnormalities in at least one quadrant. While this tool is excellent in classifying DR non-specifically, with increasing severity of cases the accuracy reciprocally diminishes (Sivaprasad & Pearce, 2019).

Diabetic Retinopathy Risk Factors and Prevention

Increased blood sugar levels, hypertension, and an increased duration of diabetes are risk factors for developing diabetic retinopathy. Individuals who have diabetes, either T1DM or T2DM, for 20 years have a 2.6 times greater risk on average of developing DR and roughly a 7 times greater risk for developing VTDR than those who have only had diabetes for 10 years (Wong & Sabanayagam, 2020). In addition, only 18% of diabetic patients with well controlled DM and HbA1c's less than 7.0% showed signs of diabetic retinopathy. However, nearly 51.2% of diabetic patients with uncontrolled DM with HbA1c's greater than 9.0% showed signs of diabetic retinopathy. Lastly, patients with a blood pressure of less than 140/90 show signs of DR in 30.8% of cases whereas patients with a blood pressure greater than a 140/90 show signs of DR in 39.6% of cases (Yau et al., 2012).

Primary, secondary, and tertiary modes of prevention can be applied to diabetic retinopathy. Primary prevention includes education on the disease as well as vision loss, increased exercise, and positive nutritional modifications. Secondary prevention to DR can also include pharmacological intervention in diabetes patients and early screening to monitor the development of diabetic retinopathy (Wong & Sabanayagam, 2020). Secondary prevention is geared toward improvements of blood glucose levels, as well as hypertension, in DM patients and routine DR screening for disease progression monitoring (Wong & Sabanayagam, 2020). Tertiary prevention includes direct treatment and surgical intervention to correct the disease. These measures, such as laser photocoagulation treatment, ocular surgery, and anti-vascular

endothelial growth factor therapy (VEGF) medication, tend to be favored among eye professionals including ophthalmologists particularly those in high income countries (Wong & Sabanayagam, 2020).

Diabetic Retinopathy Current Treatment

Anti-VEGF, laser photocoagulation, and surgery are the modern treatment options for diabetic retinopathy. Of those treatment options, anti-VEGF medications like pegaptanib, ranibizumab, and aflibercept are the current mainstay treatment (Wang & Lo, 2018). Improved visual acuity is desired, but not usually attained with laser therapy. Laser therapy is useful in inhibiting further neovascularization, reducing the risk of vitreous hemorrhage and preserving current vision level. Therefore, early diagnosis with early screening is imperative for improved outcomes of visual acuity management. Intravitreal glucocorticoids are also used for stabilization and less for visual improvements and also necessitate preventative measures for improved outcomes. Perhaps the best treatment for DR is prevention with adequate exercise and a healthy diet to decrease the risk for DM development of DR progression (Kollias & Ulbig, 2010).

Furthermore, DR awareness in low- and middle-income countries continues to be inadequate. The National Health and Nutrition Examination Survey in the USA stated, “73% of patients with DR were unaware of their disease status” (Wong & Sabanayagam, 2020, p. 13). In addition, the Singapore Epidemiology of Eye Disease Study showed 80% of patients were unaware of their disease and 73% of patients in the Andhra Pradesh Eye Disease Study in India did not know they had diabetic retinopathy. These numbers were consistent even in late stages of the disease with those needing treatment. An article by Wong & Sabanayagm (2020) supports this study, stating that over 33% of diabetic providers were not focused on eye health.

Screening measures for DR are also less than satisfactory. A 5-year survey demonstrated only 25% of those with type 2 diabetes were screened for DR in low-income countries. This lack of awareness and education surrounding the importance of prevention, screening, and quick intervention needs to be targeted for the reduction of this preventable disease. (Wong & Sabanayagam, 2020)

Conclusion

Given the rising prevalence of DM, most notably in developing countries, there is an increased concern for higher incidences of microvascular diseases, cardiovascular diseases, kidney disease, and death. Eye exam screenings can help identify chronic manifestations of DM, such as DR, in patients and aid in identifying disease progression. However, due to economic, social, educational, and clinical barriers, many individuals are not receiving their routine eye screening. Current data suggests that even despite efforts to improve the social determinants of health, many barriers remain. Additional preventative measures are now needed to address the widening health disparity by actively promoting the importance of seeking an eye exam during a clinic visit to safeguard optimal health via increased educational material, resources, and social support.

Chapter III: Methods

Introduction

An overwhelming lack of awareness for DR in diabetic patients is exacerbated in developing countries due to public health barriers (Orach, 2009). To address this knowledge gap, the researchers paired with MMO and implemented a poster that discussed the role DR has in diabetic patients as well as created an eye screening station for their August, 2022 trip to Trinidad and Tobago. The purpose of the poster was to educate diabetic patients on DR and the potential negative outcomes associated with this disease, including blindness. In doing so, the goal was to promote an increased adherence to diabetic regimens and halt the progression of the disease into further detrimental states. Moreover, the addition of an eye health screening station fostered a secondary approach to prevention of DR in diabetic patients rather than tertiary treatment. Chapter three will include the project's rationale, population, methods, ethical implementations, tools, and barriers.

Rationale for Project

The goal of MMO is evangelism by providing medical care around the globe (Medical, n.d.c). Medical Missions Outreach organizes teams of medical and non-medical volunteers to run a five-day clinic. They partner with local missionaries and churches in the countries they are serving to create an environment for patients to form lasting relationships with their community. Since 2003, MMO has provided medical services to underserved communities with the goal of leading people to the Great Physician, Jesus Christ (Medical, n.d.c).

The patient population MMO focuses on is underserved communities worldwide (Medical, n.d.c). The medical missions organization planned 19 trips in 2022 to the following countries: Merida, Mexico; El Progreso, Honduras; Atkinson, Dominica; Santo Domingo,

Dominican Republic; Lagro, Philippines; Blantyre, Malawi; Lima, Peru; Bishoftu, Ethiopia; Bingerville, Ivory Coast; Cunupia, Trinidad and Tobago; Port Elizabeth, South Africa; Hatgal, Mongolia; Ouagadougou, Burkina Faso; East Bank, Guyana; and Santa Cruz, Bolivia (Medical, n.d.a). In order to best serve these communities long-term, MMO has established permanent locations internationally. The Rearick Surgical Center opened in 2018 and permanent medical centers in Africa and Asia are currently in progress (Medical, n.d.b).

According to Hannah Bender, MMO's director of educational services, the organization saw approximately 17,000 patients in 2019 (personal communication, September 23, 2021). Different clinical teams, including medical, patient educators, optical, physical therapy, dental, and surgical, assisted in serving these patients. The clinics are being modified and improved to ensure that patients are receiving the highest quality of medical care (Medical, n.d.c).

Medical Missions Outreach sought a more comprehensive way to incorporate eye health into their clinics. Initially, the main focus of the optical clinic was to assess visual acuity and distribute glasses (Medical, n.d.b). However, expanding their medical clinic to include fundoscopic exams allowed MMO to evaluate DR in DM patients as secondary prevention. All DM patients, especially those positive with DR, were encouraged to adopt a healthy lifestyle to decrease blood glucose levels and slow the progression of blindness. Since DM patients are at a higher risk for vision loss, as a result of progressive DR, they benefit greatly from eye exams that track the severity and progression of their diabetes. This screening method aids in the prevention of DR from progressing into further complications, such as blindness. The researchers helped mend the gap in quality eye health by incorporating additional eye screenings and eye health education as part of MMO's optical clinics. By implementing this new station, immunocompromised patients, such as those with DM, are at a reduced risk of vision loss due to

secondary diseases.

Population

The target population for the eye screenings was adult, diabetic patients who visited MMO's pop-up clinic in Trinidad and Tobago between August 12, 2022 and August 20, 2022. The characteristics of the inclusion criteria of the population were diabetic patients 18 years or older who came to the clinic. By ensuring that the patients were 18 years or older is a delimitation that the researchers imposed to prevent possible legal challenges with working with minors. Additionally, pediatric diabetes was outside of the scope for this project.

Because the MMO clinic is free of charge, the clinic attracts patients who would otherwise not be able to receive health care due to financial barriers. The local diabetic education clinic, Caribbean Lifestyle Diabetes Centre, costs 300 Trinidad and Tobago dollars which is approximately 44 US dollars per visit (Wellness Connect, 2013). The community does not have other, less expensive diabetic centers for patients, and thus limits healthcare options. Low socioeconomic patients cannot afford this care and, therefore, seek out free care provided by MMO.

Project Plan and Implementation

To meet MMO's need for educational resources on eye health and to reduce costs associated with printing and shipping, the researchers created a reusable poster that MMO volunteers can bring on each medical mission trip to use as a visual aid when educating diabetic patients about diabetic retinopathy. In addition to the poster, a new eye screening station was utilized to assist in visualizing manifestations of DR in DM patients. The screening station was added to the progression of stations that were already implemented at MMO's clinic. Upon arrival to the clinic site, patients checked-in, had their vitals taken, and then were seen by a

general provider. After the provider session, diabetic patients detoured to the diabetic education portion of the clinic. Trained volunteers, under the supervision of a provider, performed fundoscopic exams with a PanOptic and 1% cyclopentolate dilating drops. These eye health screenings examined for eye abnormalities including diabetic retinopathy. Discussion and education on disease management modifications followed. A poster was placed in the exam room for the providers and volunteers to reference while educating patients on DR and overall wellness for DM patients. These two additions were implemented in August, 2022 on MMO's trip to Trinidad and Tobago.

An additional goal for this project was overall sustainability. This specific goal focused on ensuring sustainability of eye health screenings within the Tinidad and Tobago community, as well as globally on future MMO mission trips. The researchers trained, informed, and educated local community members on eye health education and screenings so they can provide their own community with continual diabetic care as needed. One of the project's researchers, Alondra Arredondo, informed MMO staff about the set up and delivery of the eye health screening station with the purpose of replicating these screenings on future trips.

Project Tools

Educational Poster and Diabetic Retinopathy Screening Station

The poster was made of laminated paper to allow for easy rolling and transportation. Dimensions measured 24 inches wide by 36 inches tall. The poster was also equipped with a stand for ease of display and for enhanced visualization. A combination of words, numbers, and graphics were used to help overcome potential language barriers. Information displayed on the poster included definitions of both DM and DR, risk factors for the development of DR if DM remains unmanaged, the percentage of diabetics who develop DR, symptoms and presentation of

DR, screening options, and an explanation of how DR can progress to blindness. Numbers were presented via percentages as well as on a graph to highlight current statistics and projected incidences of DR-related blindness. Photographs were used to illustrate what DR looks like on a fundoscopic exam.

The background was a light gray color with a central image of a fundoscopic view of the human retina in orange-red colors. The poster title was located on the upper middle portion of the poster and read, “Diabetic retinopathy” in bolded, uppercase, cardinal red letters. Supporting definitions and statistics were placed in a clockwise pattern surrounding the central retina image and each contained a corresponding icon or image. Words were colored black while icons and images varied in color between blue, purple, orange, green, yellow, and red. Each section also had a solid white border to enhance the separation between topics.

The additional DR screening station consisted of one long table, chairs for Arredondo and patient, a PanOptic ophthalmoscope, 1% cyclopentolate drops, and index cards. Index cards were white. Each card had a line for the patient’s name, three statements written in black ink with a corresponding check box, and a line at the bottom of the card for Arredondo to sign. Statements read, “Diabetic retinopathy screen complete,” “Diabetic retinopathy symptoms present” and “Diabetic retinopathy symptoms not present.”

Potential Barriers

Before implementation of the project, researchers developed a list of barriers they were anticipating to occur. The first potential barrier was inaccessibility to travel due to COVID-19 travel guidelines by the time of departure to Trinidad and Tobago. If traveling was restricted, the researchers would have created educational materials in video form for MMO explaining how to utilize and best implement fundoscopic exams. These educational resources would have provided

them with the tools necessary to still implement the project in future trips. In the event travel was restricted, the project would have been conducted at a local underserved clinic in Minnesota instead.

Another potential concern was that by adding another station to the optical clinic, patients would wait longer to be seen by the provider. This barrier could have been magnified by the possible lack of volunteers, lack of resources, and limited time. If these barriers would have come to fruition, the efficiency of the clinics would have been reduced and thus would have resulted in seeing fewer patients. Recruiting volunteers and training local community members helped minimize these barriers.

Furthermore, culture and language dialect was also an anticipated barrier. To address this, missionaries MMO partnered with instructed the volunteers on pertinent cultural and language differences in the country. Also, MMO volunteers consisted of foreign volunteers as well as local community members who were aware of the cultural context of the patients. If foreign volunteers faced a challenging cultural or linguistic barrier, they were able to freely communicate with a community member associated with Medical Missions Outreach.

Ethical Implications

An ethical implication of this community service project, and of short term mission trips in general, is not being able to provide continuity of care. Medical Missions Outreach tries to return to every country each year or biannually, depending on the location. However, due to the inability of short term mission trips to provide continuity of care, MMO partnered with a local church in the area so patients have a resource and community to return to if they need emotional support. Another way this implication was addressed was by emphasizing the importance of

preventing DR on diabetic patients and by emphasizing healthy habits to control diabetes and slow the disease state.

Additionally, MMO was not able to see everyone who needed care and medical services. The sole purpose of the organization is to evangelize through the tool of medicine. Even though not everyone in need of care was able to be seen due to the nature of a pop-up clinic, MMO ensured the community was aware of local community church members that care for them. As a Christian organization, they comforted their volunteers by reminding them that Christians themselves are not called to be saviors but to be the hands and feet of Jesus, their Savior (Medical Missions Outreach, n.d.d).

The last ethical implication is that MMO was not able to treat high risk patients. Because MMO generally focuses on primary care, there were some patients that MMO was not equipped to manage and treat. When this happened, MMO staff tried to connect these patients with other resources who may be able to address the patient's needs. When money is an issue, which did not occur during this trip, MMO historically has started a fundraiser or sponsorship for a specific patient so he or she may receive the care they need. Unfortunately, there were also situations where medical care could not alleviate the burden of the disease. In these situations, MMO volunteers and local church members sought to provide emotional support and prayer for these patients.

Conclusion

The aim of this project was to implement secondary preventative measures in Trinidad and Tobago for early detection and education of DR, to promote prompt management of DM, and to ultimately reduce the progression of DR to blindness. Through partnering with MMO, researchers were able to increase the depth of resources educating on DR that MMO utilizes on

medical trips. The incorporation of this screening station and poster at MMO clinics magnified dispersion of DR awareness to additional developing countries. Chapter IV will focus on the outcomes of implementing these interventions and the impact had on MMO and the Trinidad and Tobago community.

Chapter IV: Discussion

Introduction

This chapter is designed to address the outcomes of the DR community outreach project implemented during the 2022 Trinidad and Tobago MMO trip. This section will detail the DR education poster and the eye screening station located at the MMO pop-up clinic. In addition, this section will include further review of this project's limitations as well as how those limitations could be overcome. Lastly, suggestions for future implementation of this project and closing thoughts will be discussed.

Summary of Results

Problem Statement

Vascular health, central to DM, can be directly screened and most readily identified in only one location: the eye (Schneiderman, 1990). Through secondary preventive measures such as eye screenings in DM patients, early detection of DR would emphasize the urgency for prompt management of diabetes. This early management could improve quality of life by minimizing manifestations of diabetes including VTDR and blindness (Wong & Sabanayagam, 2020). Lack of medical education and adequate access to healthcare, especially seen in developing countries, increases the prevalence of undetected DR in diabetic patients (Wong & Sabanayagam, 2020).

Necessity of Project

The medical sustainability component of international short-term medical mission trips has come into question within the last decade (Sykes, 2014). A cost-effective means for providing sustainability is public health awareness and education for patients to become advocates of their own health (Moinul et al., 2018). Thus, the research members sought to work alongside MMO to expand their eye health services by incorporating public health education and

screening. As previously mentioned, keeping systemic glucose levels within the physiological target range for a DM patient can optimize protection for the vascular system and, therefore, minimize complications such as vision loss. Educating patients on the importance of controlling their systemic glucose levels and informing them of their current stage of DR, or lack of, through fundoscopic eye screenings can encourage patients to implement healthy lifestyle modifications to protect their vascular health and vision.

Project Implementation

The DR education and screening was implemented within the educational portion of the medical clinic. Patients would first receive public health education on diabetes. Topics of discussion included the pathophysiology of diabetes and lifestyle modifications to lower glucose levels and blood pressure, both discussed at a level that the patient would fully understand. Next, diabetic patients continued to the DR education and screening where a trained volunteer reiterated systemic effects of uncontrolled DM and informed them about DM-related vision complications via the DR educational poster. The volunteer then notified the patient that a fundoscopic eye screening could be performed to see early manifestations of diabetic retinopathy. Verbal consent was obtained from patients opting for an eye screening. One drop of 1% cyclopentolate was used to dilate the eyes. The eye examination was performed with a PanOptic ophthalmoscope, and the patient was immediately informed of the findings. The DR education poster served as a visual aid for patients to better understand what their physiologic findings indicated. Healthy lifestyle modifications and adhering to DM treatment plans were encouraged to prevent further vascular changes. The volunteer answered patient questions and concerns appropriately. Sunglasses and proper care instructions were given to the patients to protect their dilated eyes. Throughout the entirety of the DR education and screening, volunteers

brought awareness to the importance of controlling DM to minimize vision loss and systemic vascular damage.

Final Results/Product

The goal of this community outreach project was to provide eye screenings and education on DM and DR to an underserved population. This information served as a tool to help patients understand the urgency and importance of controlling their DM to preserve their vision and overall vascular health. These project goals were brought to life in the Caribbean island of Trinidad and Tobago.

Various Patient Responses

Fifty patients were screened during the course of the five day clinic and the DR education and physical exam findings were received with various responses. The first response was how the education and screening brought patients relief and hope. Some patients were deeply afraid of their diagnosis of diabetes. They feared a decreased quality of life and a premature death. In patients who battled disease provoking anxiety, the volunteer directed them to the DR poster where it stated “[u]ncontrolled diabetes is the leading cause of preventable blindness in adults" and that “[f]ollowing diabetic treatment plans, making healthy lifestyle changes, and having regular eye exams can lower your risk of blindness by 95%.” The volunteer emphasized the best way to maximize the patient’s quality of life is by controlling systemic glucose levels. Additionally, the patients that were fearful of DM were also fearful they had developed diabetic retinopathy. Most of these patients did not have exam findings suggestive of DR, which helped reassure them. However, encouragement was provided to emphasize the importance of implementing lifestyle modifications for continued prevention of DM complications. On the contrary, if a patient had physical exam findings of DR, the volunteer

enlightened patients on how controlling systemic glucose levels can still slow down the progression of DR and delay visual complications. Patients that were once terrified of their disease were able to leave with relief and hope knowing they can protect their vascular health can prevent or minimize medical complications such as vision loss.

Another response that was common in the DR clinic was confusion and frustration. Some patients knew they had DM for a while and were diligent about controlling their chronic illness. These patients initially responded with excitement to learn more about diabetic retinopathy. However, when the eye screenings were done, they had findings suggestive of diabetic retinopathy. These patients then became confused and frustrated that they developed DR even though they were actively managing their diabetes. The volunteer explained that DM may progress more severely in some patients and that having DM for a longer period of time increases the risk of developing diabetic retinopathy. The volunteer was respectful of the patients emotions and validated their frustration and confusion. Additionally, the volunteer explained that the hard work of managing their DM thus far had not been in vain as it likely slowed down the progression of DR and other DM complications. Knowing that further damage would have occurred if the patients had not been proactive towards their health was a point of encouragement and comfort.

The last main category of responses towards the DR clinic was astonishing. Some patients who came to the clinic were apathetic towards their health and unwilling to incorporate change. These patients had a history of uncontrolled diabetes. They were uninterested in the education portion of the clinic but were still willing to get their eyes checked. Most of these patients ended up having eye exam findings suggestive of diabetic retinopathy. When the volunteer would disclose this information, the patients developed new interest and curiosity in

DM and diabetic retinopathy. Because the patient was initially uninterested, the information on the DR poster was repeated to ensure they understood the material. The eye screening and education was exactly what some patients needed to become invested in their own health.

For all 50 patients seen, the volunteer was supportive, validated their reactions, and always ended the encounter with encouragement, regardless of how they responded to the screening and education. For patients to become advocates in maximizing their quality of life, the public health volunteer needed to bridge the knowledge gap between DM progression and prevention and the patients' understanding and feelings towards their chronic illness. By fostering an atmosphere of encouragement and validation, patients were empowered to also take control of their health.

Unexpected Results

There were two unexpected results the researchers had not anticipated with the addition of the DR screening station within MMO's pop-up clinic. The first unexpected result was the benefit of having an ophthalmoscope on a medical mission trip. The initial expectation was the ophthalmoscope would be used solely for discovering DR, but it became a useful tool for identification of other eye complications that patients had, such as retinal detachment. Without this instrument at the clinic, these additional patients would not have received as comprehensive of an exam. Another unexpected positive result of the DR clinic was that medical professionals on the trip were interested to learn more about DR and eye screenings. Nurses, nurse practitioners, medical doctors, and even non-medical professionals became intrigued at the impact of public health education within a community. Ultimately, the DR section of the medical clinic was more effective than expected and created a lasting impact on the Trinidad and Tobago community, MMO staff, and volunteers. Similar to the biblical story of Jesus feeding 5,000

people with 5 loaves of bread and 2 fish, educating a few community members about DM and DR will benefit more patients than just the ones who were seen at the popup clinic.

Findings Related to Literature Review

Prevalence of Disease

Developing countries are challenged with higher rates of noncommunicable diseases than developed countries (Centers for Disease Control and Prevention, 2021b). During MMO's five day trip to Trinidad and Tobago, this distinction was observed through the assessment of patients with type II diabetes. There were a total of 414 patients that were seen at the pop-up clinic, 50 of which had DM and were referred to the DR education and screening station. This meant that 12% of the patients were affected by diabetes. When compared to worldwide data, which estimates that 9.3% of patients are affected by DM, it is evident that the community of Trinidad and Tobago suffer more heavily from chronic illnesses (Hayward & Selvin, 2021; Lin et al., 2020).

Preventative Medicine

One of the project's goals included implementation of the DR eye screening as a means of secondary prevention. The purpose was to raise awareness of DR and encourage patients to control their systemic glucose levels to minimize the visual complications of diabetes. Positive findings on fundoscopic examination included cotton wool spots, retinal hemorrhaging, microaneurysms, and arteriovenous nicking, all of which were visualized during the five day clinic (Sivaprasad & Pearce, 2019). According to the literature review, a health screening should be implemented in such a way to improve the patient's health, not uncover unimportant or untreatable diseases, minimizing false positives, and decreasing the need for additional testing (Bell, 2017). These screening objectives were met in the DR portion of MMOs pop-up clinic.

Regardless if the patient had DR or not, there was still an opportunity to intervene and encourage patients to improve their future health by slowing down the progression of DR through proper management of their diabetes.

The literature review also addressed how the sustainability of a program can be maximized by providing proper education and working alongside the community's public health department (Welp et al., 2016). In the DR section of the clinic, patients were given information and insight on what they can do to improve their health now and in the future, without help from medical professionals. This was emphasized as the community of Trinidad and Tobago does not have easily accessible health care and the financial aspect is a factor that many patients are restricted by. Although the MMO volunteers were not able to work with the public health department directly, they were able to work alongside medical professionals within the community. Every patient that had a chronic illness or needed close follow-up care was directed to the local medical professionals who tried to find them a local point of medical contact. This implementation to the medical clinic ensured that the patients who needed continual care would be able to receive it.

Barriers to Healthcare in Developing Countries

The four main SODH observed during the implementation of this project were economic instability, limited access to healthcare, limited education, and the environmental determinant. In a chronic disease state, such as the diagnosis of DM, several appointments are recommended to control glucose levels and monitor the possible development of other health complications. Many patients stated they did not receive an annual diabetic eye exam and/or did not receive continual care for their DM due to financial constraints, inability to access health care, and/or were unaware of the importance of receiving this care. Some patients even said that the closest

medical contact they had would not see them unless it was for emergent services and thus routine care was not an option. Lack of transportation and far distances to the nearest healthcare facility in the rural areas was also a common barrier noticed while in Trinidad and Tobago. With MMO coming into this area, community members had five full days where they were able to receive the medical care they needed without worrying about any of the social determinants of health.

Retinopathy

The literature review above discussed the progression of NPDR to PDR, which is what was detected in DM patients during this medical mission trip (Lechner et al., 2017). Hemorrhaging, a sign of NPDR, with early disease progression of DM was the exam finding most commonly identified. In patients with a more progressive disease state, such as in the development of PDR, neovascularization was also seen. An additional trend that was noted during the five day clinic was that higher blood pressure and higher glucose readings correlated with patients having developed diabetic retinopathy. This observation aligned with the results of Yau et al.'s research included in the literature review above (2012). Overall, patients were not aware of DR nor its disease process. The explanation of the pathophysiology and the positive fundoscopic findings helped bring awareness to vision loss caused by diabetes.

Limitations

Prior to the implementation of this project, the researchers hypothesized that COVID, finances, and scarce volunteers would be the main limitations encountered. In August 2022, the only boundary surrounding travel to Trinidad and Tobago was restriction to individuals without updated COVID-19 vaccination. Arredondo was fully vaccinated, resulting in granted travel to the intended countries. In regards to project finances, the researchers decided to create a single, laminated poster as opposed to multiple pamphlet handouts. This decision reduced the potential

cost of transporting a large quantity of paper overseas and eradicated this limitation. Financial constraints from overall trip cost was a limiting factor as it reduced the number of volunteers available. Due to the multiple stations concurrently on the MMO trip and the scarce number of volunteers, it was difficult for each station to receive the amount of assistance needed. To overcome this barrier, nonmedical staff were recruited to assist at adjunct stations of the pop up clinic. This allowed Arredondo to focus specifically on fundoscopic examinations, rather than on helping in multiple areas, and gave the other stations more aid. This barrier was also addressed by training additional medical professionals on the trip how to perform proper eye exams.

Limitations that were encountered but not anticipated included the brightness of the eye exam area which interfered with exam quality as well as the short duration of the trip. Due to the time of day this clinic was held, and its outdoor location, the sun was a major factor in the ability to visualize the eye during exams given the light's constricting effect on the patients' pupils. This barrier was overcome by moving the exams into building custodial rooms to create a dimmer environment to perform the eye exams. Due to the short duration of this MMO trip, not every patient who presented needing an eye exam could be seen. Patients with minimal to no symptoms of DM were deferred in effort to assess higher acuity patients. The promotion of DM control regardless of eye symptoms, but especially those with manifesting signs of eye disease, may lessen the impact this limitation has on future trips.

Further Projects

The creation and implementation of a new DR station at MMO's eye health clinic in Trinidad and Tobago successfully provided DR eye health screening and education to 50 local DM patients. This pilot trip provided valuable insight to how effective researchers' current methods were of educating patients on signs and symptoms of DR via an educational poster and

educator, screening for DR with a PanOptic fundoscopic exam, and detecting early signs of diabetic retinopathy . Researchers' original goal was to use the eye exam screenings as a tool for raising awareness about DR by discussing findings on ophthalmic exams with patients and how adherence to treatment plans is critical in preventing blindness. In effort to maximize effectiveness, efficiency, and sustainability of this project, researchers reviewed how daily interactions with patients and volunteers went during the Trinidad and Tobago trip and have developed new modifications and extensions of methods to optimize project value and sustainability.

The first modification to this project entails separating who leads the education portion and who performs the eye exam screenings. This modification was trialed by Arredondo during day two of the pilot trip after noticing too much time was being spent at the station; the number of patients being seen was limited. Arredondo taught the remaining MMO volunteers the same DR information being taught to the diabetic population so they could help discuss the educational poster with patients prior to being screened. By increasing the number of people sharing information on DR, more patients were able to be seen. Reducing the amount of duties allotted to each person also allowed for more detail, focused attention which greatly optimized care. Given this success, researchers now propose that to maximize the amount of patients educated and screened on future trips, all MMO volunteers should be taught the same DR education information that patients receive so they can begin the conversation about DR prior to being screened. Increasing the amount of people who have knowledge of the disease-state, signs, and symptoms of both DM and DR would increase the number of patients attended to and would also promote the spread of information via word-of-mouth — a goal of researchers' for instilling a sustainability component. Having MMO volunteers assist with the education portion of the

clinic would also allow the trained medical professional more time to screen the patients comprehensively and efficiently.

In addition, researchers propose an extension of the educational poster to include contrasting descriptions between non-DM and DM provoked changes in vision; specifically, how to discern between natural changes in visual acuity and DM-provoked changes in vision. During this trip, several patients were noted to have fatty lipid deposits, signs of hemorrhaging, and even a case of retinal detachment. While none of these patients fit within the screening category for DR, they still required additional attention that could not be ignored. Therefore, the last extension of this project proposes that an additional station be created for patients whose fundoscopic exam presents with signs of eye conditions that warrant further evaluation, but who's criteria do not match with the signs of diabetic retinopathy. Index cards would be modified to include an additional section for the eye examiner to detail what was seen with the PanOptic prior to sending them to the next station.

Conclusion

The purpose of this community outreach project was to spread awareness surrounding eye health with emphasis on DR in diabetic patients. Furthermore, researchers planned to educate individuals with identified DR on the importance of DM regimen adherence for better overall health and enhanced visual outcomes. Researchers' partnering organization, MMO, expressed interest in expanding their current DM education and screening to achieve a more comprehensive patient visit. These needs were met through both the delivery of DR education as well as an added screening station to identify the targeted population. Both aspects of this project were in unison of and supported by a thorough literature review. The resources discussed above were implemented by Alondra Arredondo and adjunct medical staff on the MMO trip to Trinidad

and Tobago. This community outreach project was designed to be replicated and fulfilled on future MMO trips.

This community outreach project was developed with the intent of benefitting MMO and the communities they serve. This was achieved as MMO was able to provide more patients with quality eye care while also spreading the word about Jesus to a community in need. The patients benefited as they were able to receive health care without restrictions from their SDOH, were educated on their chronic illness and methods to maintain their DM regimen, and were given encouragement that they can still have a healthy life despite their diabetes. Moreover, the unintended benefit of the project was that the researchers benefitted as well. By creating a detailed literature review, the researchers were able to enhance their knowledge of T2DM and diabetic retinopathy. This added knowledge will continue to benefit future patients that the researchers encounter and contribute to lowering the rates of blindness due to this chronic illness. The project also demonstrated the importance of providing health care to the underserved and allowed the researchers insight to this demographic setting. With experience and knowledge, the researchers were able to complete the project with an increased passion to provide quality healthcare to those in need.

Appendices:

On behalf of Medical Mission Outreach I, Hannah Bender, give permission to Bethel University Physician Assistant students, Alondra Arredondo, Oliver DeMeyer, Rachel Pfenning-Wendt, and Samuel Wolfe, to conduct their Master's Community Service Project with this organization with permissions being granted for patients to be educated and screened on eye health.

Signature 

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