PLANNING FOR SUSTAINABILITY, SPREAD & SCALE OF AN AI MEDIATED EYE HEALTH SCREENING INITIATIVE:
FINAL REPORT

Centre for Digital Health Evaluation, &
The Office of Spread & Scale,
Women's College Hospital Institute for Health System Solutions and Virtual Care

PREPARED FOR:

Ontario Health

Acronyms

AI: Artificial Intelligence

AMD: Age-related Macular Degeneration

CDHE: Centre for Digital Health Evaluation

CHC: Community Health Centre

CRaNHR: Centre for Rural and Northern Health Research

DAC: Diabetes Action Canada

DME: Diabetic Macular Edema

DR: Diabetic Retinopathy

DVCS: Digital and Virtual Care Secretariat

IDHC: Indigenous Diabetes Health Circle

KHSC: Kingston Health Science Centre

LHIN: Local Health Integration Network

NHS: National Health Service

OAO: Ontario Association of Optometrists

OCT: Optical Coherence Tomography

OH: Ontario Health

OHIP: Ontario Health Insurance Plan

OSS: Office of Spread and Scale

OTN: Ontario Telemedicine Network

PAN: Patient Advisors Network

PPE: Patient Partner Evaluators

REB: Research Ethics Board

SPOR: Strategies for Patient-Oriented Research

TDCC: Toronto Diabetes Care Connect

TOP: Tele-ophthalmology Program

VLRC: Vision Loss Rehabilitation Canada

WCH: Women's College Hospital

WIHV: Women's College Hospital Institute for Health System Solutions and Virtual Care

Operational Definitions

Sustainability, Spread & Scale

The terms “sustainability”, “spread”, and “scale” are often defined differently, with spread and scale often used interchangeably.[1] For this report, “Sustainability” refers to continuing the current VLRC AI Mediated Eye Health Screening Initiative. “Spread” refers to the stepwise expansion of the program where new screening partners are added regularly. “Scale” or “Scale-up” refers to the provincial expansion of DR screening, including the role of the VLRC program at the provincial level and the connection to similar programs across Ontario.

Core Components & Adaptable Forms

Definitions of core components and adaptable forms are interrelated. Core Components are the key aspects of a program that need to be in place for the program to work. In this report, sub-components provide further detail on aspects within the Core Components, leading to possible adaptations. Adaptable forms are aspects of the program that can change, ideally based on the needs and recommendations of all involved.

Liaising Organizations

Liaising Organizations provide a crucial link between the community and VLRC to ensure that the specific needs of the community are met throughout the screening pathway. The Liaising Organization identifies and connects with other relevant organizations/partners in the community which may become involved in screening and appears key to establishing a relationship and facilitating a long-term strategy for embedding screening within the community. To ensure long-term success within the community, the Liaising Organization could make important decisions regarding which screening model (an “adaptable form”) should be used. Currently, the Indigenous Diabetes Health Circle (IDHC) is a main Liaising Organization working in partnership with VLRC.

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Background

Vision loss can profoundly affect the quality of life of those who experience it and often impacts health beyond the eyes and visual system. Early screening and detection of eye impairments are essential for the initiation of treatment and prevention of further vision loss.[2] Early screening is particularly crucial for high-risk groups such as individuals living with diabetes who are at risk for diabetic retinopathy (DR). Despite this risk, many people are not screened regularly for DR. Vision Loss Rehabilitation Canada (VLRC) has implemented an Artificial Intelligence (AI) Mediated Eye Health Screening Initiative targeting under-screened groups to reduce the incidence of vision loss, particularly focused on DR. This program received funding through the Digital and Virtual Care Secretariat (DVCS) because of its potential to improve access to care.

The purpose of this work is to make recommendations on the potential for sustainability, spread, and scale of the VLRC AI Mediated Eye Health Screening Initiative specifically focused on DR.

Objectives

- **Integration:** To take a population health perspective to explore the feasibility of integrating this program into the healthcare system by scaling/spreading this model throughout Ontario. Considerations for spread and scale of multi-condition eye-related AI screening will also be explored.

- **Reach:** Examine current patient recruitment methods to determine the most efficient/effective methods of patient recruitment to support sustainable and scalable DR screening that supports patient needs and encourages sustainable patient outcomes.

- **Cost:** Describe the resource implications compared to current screening models and, if sufficient data is available, include recommendations on how it could be paid for after DVCS funding.

Methodology

The work included (1) a rapid literature review and environmental scan of similar screening programs; (2) review and interpretation of program data provided by VLRC; (3) discussions with key project teams & expert partners; (4) discussions with health system leaders. Results were integrated using implementation science methodology to address the three objectives.

Findings

The VLRC AI Mediated Eye Health Screening Program has the potential to address an unmet need for DR screening in rural and remote parts of Ontario and is making progress with Indigenous Communities through partnership with the Indigenous Diabetes Health Circle (IDHC). This is one of several screening programs in the province, but it has distinct features which support sustainability and spread, including the ability for anyone to be trained to conduct the screening, the use of portable, handheld cameras, and the use of AI technology so only positive screens need to be reviewed by an ophthalmologist.

The VLRC program is still developing. Strategies are underway to increase the number of individuals living with diabetes screened by the program, and there is reported to be capacity among the VLRC team and ophthalmologists reviewing the images to screen more individuals at the current costing level. Data regarding date of last eye exam of individuals who screened at risk of DR shows that the program is achieving their aim to screen those who are not regularly screened, as 39–58% of individuals screened at risk through the program had not been screened in over 5 years, and 67–77% had not been screened in 3-5 years.

Efforts for provincial scale-up of DR screening should consider how this program complements other DR screening programs and learn from population-level screening programs such as the NHS program in the UK. Development of provincial level systems, such as a diabetes registry accessible to multiple partners, including VLRC, could support an integrated approach to DR screening across the province.

Key Recommendations

Key recommendations for sustainability, local spread, and provincial scale-up of this VLRC program include:

1. **Continue to support the VLRC program to provide DR screening for those who are less likely to access the healthcare system**. The VLRC program can be complementary to and not a replacement for, existing DR screening programs. The VLRC program fills a niche need to support individuals who have not been screened recently and could be complementary to other screening programs. Maintaining the adaptable nature of this program will be key to meeting this need.

2. **Continue to support the VLRC program to work closely with the IDHC to provide an Indigenous-led DR screening program.** An Indigenous-led strategy must be considered within the provincial strategy.

3. **Learn from and link with existing DR screening programs.** Many well-studied programs have been operating for several years in Ontario, and although they operate at a small scale, they have overcome some barriers to screening for underserved populations. As the VLRC program has only been running for a year in specific settings, much can be learned from other programs that will be relevant for provincial scale-up of DR screening.

4. **Encourage sustainable collaboration with Liaising Organizations.** As the VLRC program and the provincial-level strategy progress, sustainable collaboration with Liaising Organizations that understand the needs of their community is required for a customizable approach to overcome barriers in access to screening. Health Equity Impact Assessments can be used to support development of community-led screening strategies.

5. **Support development of a diabetes registry to support provincial screening.** A sustained provincial diabetes registry, such as the one currently piloted in an existing research program, that is accessible to organizations including VLRC would facilitate targeted screening of high-risk individuals on a larger scale.

6. **Confirm that the AI technology is appropriate.** Although the Kingston Health Science Centre (KHSC) evaluation is underway, there are concerns among health system leaders as to whether the technology is appropriate for all populations in Ontario. Safeguards and quality checks need to be included to ensure the sensitivity and specificity of the tool is adequate for the specific populations being screened.

7. **Develop a more sustainable strategy for reviewing positive screening results.** Each DR screening program across Ontario currently relies on their own small number of ophthalmologists to review results, which is a risk to program sustainability, and limits the potential for spread, and provincial scale-up. To overcome this, a provincial pool of ophthalmologists could be convened to review results, or the role for optometrists could be further explored. Individual programs have rarely engaged optometrists, but a province-wide approach that takes advantage of new funding agreements may be more effective.

8. **Consider a system of treatment prioritization.** As the VLRC program is designed for those who do not regularly access eye care, a process for prioritized treatment for patients who are screened positive could be considered. For example, specific time slots could be held for treatment appointments to ensure the individuals screened through this program receive timely treatment and are supported to receive that treatment (transportation, referral support etc.).

9. **Screening should be paired with prioritization when there are excessive wait times for treatment.** An increase in screening rates could lead to increases in wait times for treatment, but if cases are prioritized, then people can be treated within an interval appropriate to their risk of progression of DR.

10. **Support a holistic approach to screening.** As the AI technology advances, the VLRC program could focus on screening for different eye conditions among multiple subsets of the population. However, collaboration with other diabetes-related organizations and screening program appears to be more aligned with a person-centered and holistic approach to support individuals living with diabetes.

1. BACKGROUND

1.1 Context

More than 8 million Canadians are living with eye disease from age-related macular degeneration (AMD), cataract, diabetic retinopathy (DR), or glaucoma.[3] These diseases may result in vision loss, which can profoundly affect the quality of life of those who experience it and often impacts health beyond the eyes and visual system. Vision loss may result in an increased risk of falls and injury, decreased mobility, and increased mental health problems such as anxiety and depression, as well as reduced social functioning, such as loss of independence, employment, and educational attainment.[4] Early screening and detection of eye impairments are essential for the initiation of treatment and prevention of further vision loss.[2]

Early screening is particularly crucial for high-risk groups such as individuals living with diabetes who are at risk for DR. Approximately 30% of Ontarians are living with diabetes or prediabetes, and the prevalence of DR in Canada is approximately 25%.[5] DR is the leading cause of acquired blindness in Canadians under the age of 50.[6] Despite this risk, access to screening programs for DR may be limited in many areas across Ontario, particularly in remote, rural, and/or Indigenous Communities where there is a greater incidence of diabetes in the population, but fewer health resources.[7,8] To address this challenge, Vision Loss Rehabilitation Canada (VLRC) has implemented an Artificial Intelligence (AI) Mediated Eye Health Screening Initiative to improve population health outcomes and reduce the incidence of vision loss, mainly focused on DR.

The screening technology uses a hand-held, portable fundus camera that can be used in remote and in-home settings, making screening more accessible and equitable. Images can be captured without internet access; however, internet access is required for a short time to upload images and receive the screening result. This screening initiative is designed to be integrated into already-established programs and services to allow more opportunities for screening of those with less connection to the healthcare system. The approach to screening also encourages community-driven opportunities, such as integration of screening into community events, or one-off screening days. Another unique aspect of this program is that anyone can be trained to conduct screening. When screening is not conducted by a healthcare provider, VLRC provides on-demand access to experts who can answer patient questions. The screening takes only 15 minutes, and, with a good internet connection, results are available almost immediately, making it quick and easy for both patients and those conducting the screening. This screening program shows promise.

This VLRC program has received funding through the Digital and Virtual Care Secretariat (DVCS) as part of the Tests of Change funding envelope. The program has been highlighted by the Ontario Ministry of Health and Ontario Health (OH) as an innovative program with the potential to improve patient health outcomes and access to care. This program is supported by the Kingston Health Sciences Centre (KHSC), and VLRC works closely with the Indigenous Diabetes Health Circle (IDHC) in the Indigenous-led strategy. The program currently operates in Northern and Eastern Ontario communities and is regularly adding new partners.

1.2 Purpose and Objectives

The purpose of this work was to make recommendations on the potential for sustainability, spread, and scale of the VLRC AI Mediated Eye Health Screening Initiative specifically focused on DR. Screening of other conditions including AMD and Drusen was piloted by VLRC in this model and this potential is given consideration as part of *Integration: Health System Integration – Multi-Condition Screening*.

The three main objectives include:

- ***Integration:*** To take a population health perspective to explore the feasibility of integrating this program into the healthcare system by scaling/spreading this model throughout Ontario. Considerations for spread and scale of multi-condition eye-related AI screening will also be explored.

- ***Reach:*** Examine current patient recruitment methods to determine the most efficient/effective methods of patient recruitment to support sustainable and scalable DR screening that supports patient needs and encourages sustainable patient outcomes.

- ***Cost:*** Describe the resource implications compared to current screening models and, if sufficient data is available, include recommendations on how it could be paid for after DVCS funding.

2. METHODOLOGY

To address the objectives described above, the Centre for Digital Health Evaluation (CDHE) and the Office of Spread and Scale (OSS), both part of Women's College Hospital, collaborated to conduct the following activities:

- Rapid literature review & environmental scan
- Review and interpretation of data provided by VLRC and their partners
- Discussions with key project teams and partners
- Discussions with health system leaders

All information collected was integrated to address the three objectives. Implementation science methodology, including theories and frameworks regarding sustainability, spread, and scale, was used to support analysis and provided a foundation on which to build this report.

2.1 Rapid Literature Review and Environmental Scan

A brief literature review was conducted to identify learnings from similar published DR screening programs. The review mainly focused on barriers and facilitators to DR screening for underserved populations, and cost considerations for these programs. The environmental scan focused on identifying similar programs in Ontario, and potential opportunities for health system integration, and opportunities for potential short-term funding.

2.2 Data Analysis

Data provided by VLRC and their partners are listed in **Table 1.** Data was reviewed and integrated with the other information collected and is presented in the results.

Table 1: *Summary of data received by VLRC and their partners for use in this work.*

Data Received
regions served (separated by OH regions + provider type)
% positivity per screening type (Indigenous, health centres, community paramedicine)
# and list of recruitment facilities (foot clinics etc.)
# people trained to deliver screening and their role
# people screened (monthly between Feb 2022–Jan 2023)
Demographics on patients screened positive (age, sex, and time since last screening)
Staffing costs (core team)
Implementation costs
Camera location details
Travel distance between screening locations and ophthalmologists (snapshot from Nov 2022)
Travel distance between screening locations and optometrists (snapshot from Nov 2022)

2.3 Discussions with Project Teams and Partners with Key Expertise

Multiple discussions were held with VLRC, IDHC, the Centre for Rural and Northern Health Research (CRaNHR; WIHV's rural and northern health expert consultants), and representatives from the Patient Advisory Network (PAN; WIHV's patient engagement partner). Ongoing discussions with VLRC focused on understanding the program elements, the data provided, the multiple barriers and facilitators to operating the program, sustainability, spread, and scale. In February/March 2023, VLRC asked questions of all but two of their partners regarding barriers and facilitators to participating in the program, and a brief summary was provided to the WIHV team. Some conversations were held with IDHC; however, it was determined that an Indigenous-led strategy would be required to truly understand the IDHC success and that much more involvement from Indigenous Communities would be required to properly integrate the Indigenous perspective into the provincial strategy. CRaNHR provided ongoing input, with particular focus on rural and remote considerations, and strategies for interpreting cost-related information. PAN provided ongoing input to key questions, continually encouraging the consideration for patients and treatment options within this systems-focused work.

2.4 Discussions with Health System Leaders

Multiple discussions were conducted with health system leaders who described learning from other DR screening programs. Health system-focused discussions were with an endocrinologist with expertise in quality and innovation; a researcher with expertise in DR screening in Ontario, including with First Nations & Métis women; an expert in screening programs for underserved populations across Ontario; an expert in implementation science and spread/scale across a health system; an ophthalmologist who developed a DR screening program in Quebec; a retina specialist who developed a DR screening program in Ontario; a clinician researcher with expertise in diabetes research programs; an epidemiologist with expertise in interprofessional primary health care and vulnerable populations; an expert in Health Technology Assessment, evaluation, and health services research; and an expert on health research methodology and Health Technology Assessments. Key points from these conversations are integrated throughout and supported by information provided through the literature review and environmental scan.

2.5 Applying Implementation Science Methodology

All data and discussions were reviewed from an implementation science lens, applying frameworks including the Program Sustainability Assessment Tool,[9] and the Going to Full Scale Framework.[10] This information was then integrated and used to develop a series of figures mapping the aims and core components of the program for a deeper understanding of the elements. For the final report, key considerations were aligned with the three main objectives.

2.6 Assumptions

As the focus of this report is on sustainability, spread, and scale (not overall effectiveness) some assumptions were made to support our work. Assumptions included:

- A separate narrative evaluation focused on program effectiveness is being conducted by VLRC. For this report, we assume the program is effective in some areas, including rural and remote areas, and with some Indigenous Communities.
- We assume (and recommend) further work will be undertaken with a specific focus on Indigenous Communities and will be conducted in collaboration with the IDHC.
- As we are not focused on the specific technology used, we assume that the AI technology is effective. We also assume that this AI technology is valid for Indigenous People living in Canada, which is considered in the evaluation underway by KHSC. However, we still

acknowledge the concerns posed in the literature and through our discussions, recognizing that the sensitivity and specificity of this technology will impact all aspects of this program, including patients' and providers' trust in the results.

- We assume that further work will be done to understand the specific modes of screening delivery (i.e., community-led screening, VLRC direct screening) that could be matched to meet the needs of specific communities, including the strategies being piloted in 2023.

2.7 Scope of Work Considerations

Within the short time frame of this project, considerations regarding our scope of work include:

- This is not an evaluation of the program itself. Information was not collected regarding the effectiveness of the program as this is covered elsewhere.
- There is a strong need for an Indigenous-led strategy to be developed as a key part of planning for provincial scale-up. However, advising on this strategy is outside our scope.
- The IDHC plays a key role in the program. Further work will be required to fully understand their role, learnings, and relationship with VLRC—this additional work is outside our scope.
- Information was not collected regarding the experience of those involved in the program (clinicians, staff, patients etc.).
- Although three patient partners are members of the WIHV team, they do not have personal experience with the VLRC program.
- Discussions held by VLRC with their screening partners were provided as a summary from VLRC, not directly collected by the WIHV team. These responses were only from partners who were part of the program, not from those who declined to participate.
- The focus was on screening for underserved populations only, including, but not limited to, rural, remote and Indigenous Communities.
- Focus was mainly on screening for DR with some considerations of use of AI technology and cameras that screen for multiple conditions.
- An economic evaluation was not feasible and cost-benefit information was not comprehensive.
- Developing and testing new, strong, and practical knowledge resources was not feasible. An existing tool for planning for sustainability has been adapted for use by this program.
- REB approval was not required as no primary data were collected by WIHV.

3. RESULTS

To understand the potential for sustainability, spread, and scale of a VLRC program that is focused on underserved populations, the literature review sought evidence regarding barriers and facilitators to delivery of, and access to, DR screening. Acknowledging these individual and system-level barriers, the environmental scan focused on programs and organizations in Ontario that conduct work in this field. Details of the VLRC program were examined to identify and understand core elements within the program aim, and the "core components" of the program. Results were integrated to address the three objectives focused on Integration, Reach and Cost. Barriers and facilitators to sustainability, spread and scale were then summarized, along with a tool to support future sustainability planning. Results were summarized into 10 recommendations.

3.1 Facilitators to Diabetic Retinopathy Screening

Effective strategies for increasing DR screening uptake have been identified in the literature and include both a patient- and physician-centered approach.

Patient education on the consequences of DR, the difference between DR screening and routine eye exams, and reminders to attend screening are essential to improving uptake.[11-14] Other patient-centered approaches include increasing a sense of comfort and support by screening within the community, encouraging the involvement of social supports, and providing screening in the patient's language of choice and in a culturally appropriate manner.[11,15] Physician-centered approaches include clinician education on screening guidelines, integrating eye screening with other healthcare services, audit and feedback on screening rates, financial incentives, and use of electronic registers and prompts.[11,13,16-18]

Teleophthalmology may play an important role in increasing DR screening rates, especially in rural and remote areas. Some studies indicate that teleophthalmology has been well-received in First Nations Communities in Canada due to its ability to increase accessibility to services within the community and decrease travel time and costs for patients.[19,20] Teleophthalmology is also positively viewed by patients in urban settings where screening can be provided at their regular primary care sites, thus leading to more continuity of care.[21] While healthcare providers recognize the importance of teleophthalmology in increasing convenience to patients in need of screening, buy-in among providers – particularly in urban settings – remains low in part due to a perceived increase in work burden and lack of streamlined processes.[21,22]

3.2 Barriers to Diabetic Retinopathy Screening

Unfortunately, there are many barriers to DR screening in urban, rural, and remote communities, with further barriers encountered when encouraging DR screening in cultural minority groups.[15,23-26] Barriers included interconnected challenges at the individual and system level while considering delivery of, and access to, screening. For example, the lack of awareness that screening was needed, combined with fear of the potential harm associated with screening, are associated with changes needed at the system level to raise awareness and at the care delivery level to acknowledge the need to address this fear once individuals have understood the need for screening. [15] A comprehensive study is underway by Dr. Valeria Rac, Associate Professor at the University of Toronto, and her team, which takes an intersectionality approach to provide a more comprehensive look at barriers and facilitators to DR screening across Canada.[27]

Lack of Awareness and Fear of Harm

In a patient survey assessing the Toronto Tele-Retinal Screening program, researchers found that 72% of 330 patients reported a lack of awareness about DR as the main reason for not getting screened.[25] This lack of awareness has also been reported as a significant barrier to screening among immigrants to Canada, with evidence from multiple cultural and linguistic minority groups.[15] Interviews with individuals who identified with these groups revealed that in addition to lack of awareness of DR and its consequences, misconceptions about potential harms caused by the screening itself was another barrier to screening.[15] Lack of understanding of DR screening and fears of a negative result have also been reported as significant barriers to attending screening clinics for patients in settings outside of Canada.[11,13,14]

Limited knowledge of diabetes and eye care has also been reported among Indigenous Populations.[23,24] Indigenous women living with or at risk of diabetes in Saskatoon, Canada, were surveyed on their DR awareness and eyecare behaviour. Survey questions included measurements of knowledge of DR (e.g. “Diabetes can damage the eyes and vision”), attitude towards eye screening (e.g. “I do not need regular yearly tests if I control my blood sugar”) and practice (“I go for regular [yearly] diabetic eye checkups”). Researchers found that younger women (18–25 years of age) and women at risk of diabetes had significantly lower knowledge scores compared to older women (46–71 years of age) and women living with diabetes. Results also showed that women living with diabetes had significantly lower positive attitude scores compared to women at risk of diabetes. The study notes that attitude towards eye screening was

lower than knowledge of DR and its consequences, indicating the knowledge alone is not enough to impact attitudes towards eye care for this group of Indigenous women. The authors attribute this to various determinants of health which impact the health behaviour of Indigenous Peoples, such as self-determination, social exclusion, and colonialism. In a separate study surveying Indigenous Peoples living with diabetes in Alberta, Canada, researchers found 35% of 743 participants rated their overall understanding of diabetes as fair or poor, and 47% reported not attending a formal diabetes education program.[23] These learnings further highlight the need for an Indigenous-led approach to provincial DR screening.

Perceived Cost and the Role of OHIP Coverage

Patients surveyed in the Toronto Tele-Retinal Screening program reported cost (23.7%) of DR screening as a barrier to seeking services even though most respondents (92.6%) had provincial health insurance coverage.[25] The authors hypothesize that patients may have misunderstood OHIP's coverage of diabetic eye screening services, given that the majority of patients were between 20–65 years of age.[25] Routine eye examinations for people aged 20–64 was delisted from the provincial health insurance plan in 2004, however they continue to be covered for people with diabetes, regardless of age.[28] Research has shown that this delisting has had the unintended consequence of reducing DR screening among people aged 40–64, but not people 65 and older.[29] This difference may be due to a misunderstanding of OHIP-covered services by both patients and providers, leading to a decrease in optometry referrals and self-referrals, and potentially inappropriate billing for services misclassified by optometrists as "routine".[29] Decreased utilization of eye-care services after de-listing has also been found among Ontarians with low socioeconomic status and low education, regardless of diabetes status.[30] The researchers hypothesize this may be due to poor health knowledge/health seeking behaviour, limited time away from work for medical examinations, and a shift of eyecare cost from the government to the individual. Taken together, these studies highlight the inequity of eye-care utilization in the province and the need to address this barrier alongside raising awareness of the need for DR screening.

On Tuesday March 21, 2023, a new four-year funding agreement between the Ontario Association of Optometrists (OAO) and the Government of Ontario was announced.[31] As of September 1, 2023, there will be increased access to OHIP-covered optometry care for people with chronic diseases, including complications due to diabetes. Currently, an individual must have a documented history of diabetes to be eligible to receive an insured eye exam. With the new

agreement, optometrists can clinically assess and verify whether a patient has diabetes in order to receive an insured eye exam. This change is designed to empower optometrists to clinically assess their patients to help ensure care is available to those that need it most. All other provinces in Canada that cover these services already provide this access.[31] This agreement also changed access to the regular eye exam for seniors aged 65 and over.[31] Seniors with eligible medical conditions affecting their eyes, including diabetes, will continue to receive one exam every 12 months, while seniors without an eligible medical condition can receive one exam every 18 months. This change may cause further confusion regarding access to eye screening. [31]

Access to Screening

Although the VLRC program mainly focuses on rural and remote areas, research has shown that the majority of Ontarians living with diabetes who have not received eye screening reside in urban areas of Southern Ontario, with the highest density of unscreened patients located in Toronto.[25,26] Urban areas of Ontario have the highest density of ophthalmologists and optometrists[32] and the Toronto Central Local Health Integration Network (LHIN) has the highest density of Community Health Centres (CHC). These data highlight a need for better utilization of these services as well as the need for more involvement from family physicians and nonmedical technicians to increase screening uptake.[26] Rates of unscreened individuals with diabetes was found to be higher in low-income areas and higher among people with immigrant status, indicating a disparity in access to care for these individuals.[26] The high need for screening in rural and remote areas, combined with the lack of screening in urban areas, further emphasizes the need for a more comprehensive provincial approach that builds on the work conducted in rural, remote, *and* urban areas.

Interconnected Barriers

Most barriers to DR screening are interconnected, and further challenges are encountered when screening services are not accessible due to language barriers, associated costs, lack of social supports, and lack of support from healthcare providers.[15] These barriers may be particularly acute for new immigrants.[15] Attendance at screening clinics and adherence with follow up assessments and treatment may be further complicated by barriers to accessibility such as travel distance and the associated cost.[25] This may be especially true for individuals living in rural and remote communities where the availability and accessibility of eye care may be limited.

3.3 Service Delivery & Research

Several DR screening programs were identified in Ontario along with organizations connected to the work, and ongoing research. Although based in the UK, the National Health Service (NHS) DR screening program was regularly mentioned as a model for health system integration and was also included in the environmental scan.

Ontario Telemedicine Network (OTN)

OTN partners with OH and Diabetes Action Canada (DAC) to deliver accessible virtual care to patients across Ontario.[33,34] Since 2009, OTN has run a teleophthalmology program (TOP) which operates at 11 sites across Ontario. The goal of this program is to make eye screening services more accessible to underserved and vulnerable groups and regions, including rural and remote areas where eye care is not otherwise accessible, and urban areas where services are tailored to the needs of underserved groups. To receive eye screening, patients must have a referral from their physician and must travel to one of the 11 sites. A health care provider takes a digital image of the patient's eye, which is then securely uploaded to the Teleophthalmology service. An Ontario ophthalmologist reviews the case and responds to the referring health care provider. The referring health care provider coordinates any necessary follow-up care. From 2009 to 2018, TOP served approximately 10,000 patients.[35]

The VLRC program has the potential to be complementary to the OTN service as the VLRC program is designed to support individuals who do not access OTN or other similar services. The VLRC program overcomes a few of the barriers to OTN as it: does not rely on physician referrals; uses handheld cameras to allow screening to go to the person when needed; requires that only positive screens need to be reviewed which decreases burden; and is developing community connections that support screening within non-healthcare related initiatives and thus further increasing access to screening. The community-driven approach of the VLRC program can be complementary to the OTN model that serves individuals who can and do access the OTN service.

Toronto Tele-Retinal Screening Program

The Toronto Tele-Retinal Screening Program – funded by the Toronto Central Local LHIN and OTN – was launched in 2013 with the goal of optimizing DR and diabetic macular edema (DME) screening in primary care settings by identifying people living with diabetes who are in need of

eye screening, providing timely access to care, engaging community health professionals, and providing treatment support.[25] The program operates in seven communities across Toronto that were selected based on low-income status, high density of individuals with diabetes who have not received eye screening, ratio of eye-care specialists, and availability of screening facilities and staff.[25] Participation in the program requires a referral from a health professional. OHIP coverage is not necessary to participate in the program. From 2013 to 2019, the program performed 1374 screenings on 973 unique patients.[36]

As the VLRC program has not been tested in Toronto, further exploration of the connection with this program is encouraged in developing a provincial DR screening strategy.

Toronto Diabetes Care Connect (TDCC)

TDCC provides free DR screening to individuals 18+ who are living with diabetes, have not had a screening within the past year, and have a doctor or nurse practitioner referral.[37] The screening process is similar to that provided by OTN. Digital images are taken of the retina and sent electronically to an eye specialist who reviews the case and sends a report to the referring care provider. Screening through TDCC was formerly offered through several different sites across the GTA. However, due to the COVID-19 pandemic, screening was only being offered at one location in the downtown core, making it less accessible to individuals living outside this area. TDCC offers transportation support depending on eligibility, which may negate some, but not all, of the travel issues presented by offering screening at one location only. The program also emphasizes that OHIP is not required to receive screening and patients may receive care and services in their language of choice. This program may make screening easier for recent immigrants who have limited English and who may not be covered under the provincial health insurance plan.

Further exploration of the connection with this program is encouraged in developing a provincial DR screening strategy.

SPOR & Diabetes Action Canada

The Canadian Institutes of Health Research (CIHR) Strategy for Patient-Oriented Research (SPOR) and DAC have partnered to create a DR research program with the goal of establishing a framework for timely retinopathy screening for all Canadians living with diabetes.[38] The program currently reports on six core research goals, one of which includes an OTN/DAC proposal to scale

up DR screening in Ontario.[39] The research also includes: a cost-effectiveness analysis of a pilot DR project in Toronto[40]; a study identifying the barriers to and enablers of attendance at eye screening clinics for patients from cultural/linguistic minority groups (as mentioned above)[15]; an initiative to scale up TOP by assessing patient and provider perceptions of the screening program[21]; as well as a study of interventions with the greatest potential to increase screening rates.[41] A project developing AI algorithms to read retinal fundus photo images and optical coherence tomography (OCT) images for diagnosis of DR and other eye disease is also being explored[42], along with the expansion of tele-retinal screening to additional urban and rural sites in British Columbia.

The SPOR/DAC research program also supports Project OPEN – a population-based strategy for identifying patients living with diabetes who are in need of DR screening through the use of administrative health data.[38] Through this program, patients in Ontario, Alberta, British Columbia, Newfoundland and Labrador who have not received screening in more than a year are identified using health data and invited to be screening at participating CHCs.[43] The goal of this program is to support primary healthcare DR screening and eliminate DR as the leading cause of acquired blindness in working-aged adults in Canada.[27]

It seems opportune to include the extensive work (noted above) in the strategy to scale-up DR screening across the province, while acknowledging that there have been challenges in the scale-up of these programs. Each program serves a small portion of the population and has learned from their experience, but none have scaled-up across the province. A coordinated effort to achieve provincial screening is needed, likely using the VLRC program model to screen those with the least access to the healthcare system. It is also important to learn from programs outside of Canada which have been able to scale, such as the NHS DR screening program.

NHS Diabetic Retinopathy Screening Program

The NHS Diabetic Eye Screening (DES) program is different than what has been trialed in Canada. However, it is worth examining due to its success in reducing rates of DR. Started in 2003, the program achieved high population uptake by 2008, and by 2009, DR was no longer the leading cause of certifiable blindness among working age adults in England and Wales.[44,45] In 2017–2018, 2.23 million eligible patients (82.7%) received screening through the program, which resulted in 8,782 urgent referrals and 54,893 routine referrals to ophthalmology departments.[44,46]

For the NHS program, General Practitioners are obligated to provide data to the DES program on all patients living with diabetes.[47] This information is entered into a master list that is used for screening, grading, recall, and audit of the program. Patients in the list are mailed a leaflet that explains DR and the importance of screening, and then are invited to book a screening once a year. The screening method uses two 45-degree field mydriatic digital photographs per eye, and screening and grading is performed by trained technicians or optometrists (i.e., not mediated by AI technology). Screening images are uploaded to the master database containing the list of all diabetic patients. As of 2017, there were approximately 1500 graders taking part in the program. Quality assurance is a key part to ensuring the ongoing success of the program, with screeners and graders undergoing extensive initial training as well as ongoing professional development and monthly Quality Assurance Test sets.[47] External Quality Assurance audits of the program are also performed four times a year to ensure that standards are being met. A similar type of quality assurance program will be required for a DR screening program in Ontario.

Key elements of this population-based screening program include a master list or registry of patients, direct recruitment of patients on a large scale, a large central pool of graders, and extensive quality control. The elements are quite different than the VLRC program. For instance, the VLRC program relies on individual organizations to identify who needs to be screened, rather than a master list/registry. Although mediated with the AI technology, the VLRC program relies on a small number of ophthalmologists rather than a central pool of graders, and there is no direct recruitment of patients on a large scale. Quality Assurance measures are still being established.

In the future, the NHS program plans to integrate AI technology, aiming to reduce the workload of graders by eliminating negative screens from the grading queue.[44] While the Ontario program scales, learning from and collaboration with the NHS program is encouraged, particularly while the NHS considers adding AI technology and Ontario considers a population-based screening program.

3.4 Understanding the Program

Results from all information collection sources were integrated to explore the three main objectives of Integration, Reach, and Cost. To begin, a deeper understanding of the program aims, core components, and adaptable forms were needed. The core aim of the program is: *To improve access to eye screening for individuals in underserved populations living with diabetes.*

3.4.1 Key Aspect of the Aim

Within this aim, key aspects (listed in **Figure 1)**, begin with the need to increase awareness of DR and its long term-impact, and thus the importance of this screening. This awareness raising can be achieved through education, awareness-raising sessions, and other strategies. Next is the increased access to screening, particularly for those who have not been screened in several years and have less connection to the healthcare system. Ensuring that the screening delivered is culturally appropriate was another key aspect of the overall aim, recognizing the need to overcome various barriers and meet the needs of their patients. The immediate access to results, enabled by use of the AI technology, was also key. The AI technology also decreased the burden on ophthalmologists by only requiring them to review positive screens. As noted in other screening programs, the individual conducting the review does not necessarily need to be an ophthalmologist, and other options such as involvement of an optometrist could be considered when planning for sustainability and scalability. Involvement of optometrists could be facilitated by the March 2023 OAO and Government of Canada agreement.[31] Direct access to care for individuals who screen positive is included to represent all aspects of the treatment process. There are many components within treatment grouped here to address this specific aim. Without each of these key aspects, the program would not achieve its aim. Details regarding how each key aspect of the aim connects to scalability (**Appendix A**) and sustainability (**Appendix B**) are provided separately, and integrated throughout the sections on Integration, Reach and Cost.

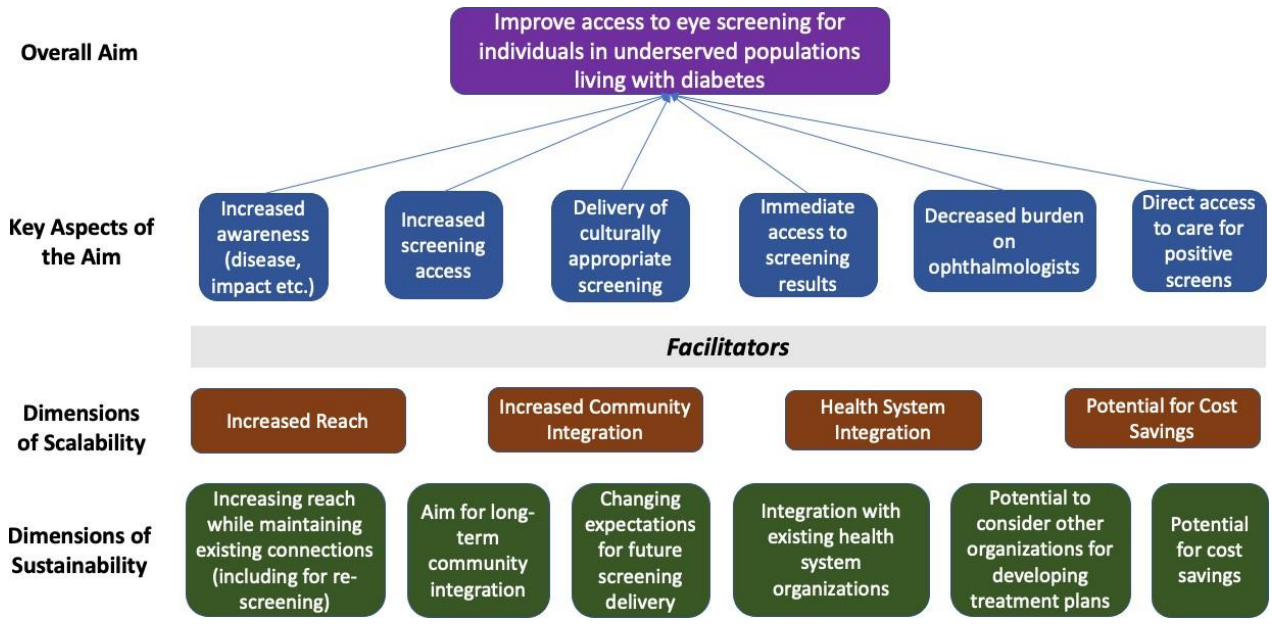


Figure 1: *Summary of overall aims, key aspects of the aim, and implications for sustainability and scalability.*
For full scalability and sustainability considerations see ***Appendix A*** *and* ***Appendix B*** *respectively.*

3.4.2 Core Components and Adaptable Forms

Overall, results indicate the need for a balance of standardization with adaptability, particularly to ensure screening strategies can be customized based on community priorities, resources, and needs. Core components — key aspects of a program (explained in "Definitions") — are needed to ensure the program will work, with sub-components providing detail on aspects within the core components that may lead to possible adaptations. **Figure 2** summarizes the core components found in this program, with more detail provided in **Appendix C**. Core components include: *awareness, education and prevention; AI technology and cameras; a coordinating and treatment organization (VLRC); a Liaising Organization* (explained in "Definitions")*; a screening delivery process; treatment pathways for positive screens;* and *a referral pathway to support continual screening.*

Adaptable forms (explained in "Definitions") are aspects of the program that can change within the core components, ideally based on the needs and recommendations of all involved. For example, one core component is the need for a screening delivery process, and the adaptable forms articulate how that screening delivery can happen. For example, this could be through an Indigenous Partner Organization, a diabetes foot clinic, or a home visit from Community

Paramedicine. Within each of these strategies, screening could be delivered through individual patient follow-up, a one-off screening day, or integrated into an existing screening program. Knowing that a screening process is required is key overall, but allowing communities to adapt the method of delivering that screening allows for the individual needs of that community to be met. As visualized in **Appendix C**, there are pros and cons with each adaptable form, and further evaluation of each form is needed before a decision can be made on effectiveness. For example, when someone in the community is trained to provide screening, this supports integration into the community (beneficial). However, if the camera will only be available for a short time (potential challenge) and staff turnover is high (challenge), the training may not be beneficial and having an external VLRC screener visit may be more appropriate, which suggest another screening model.

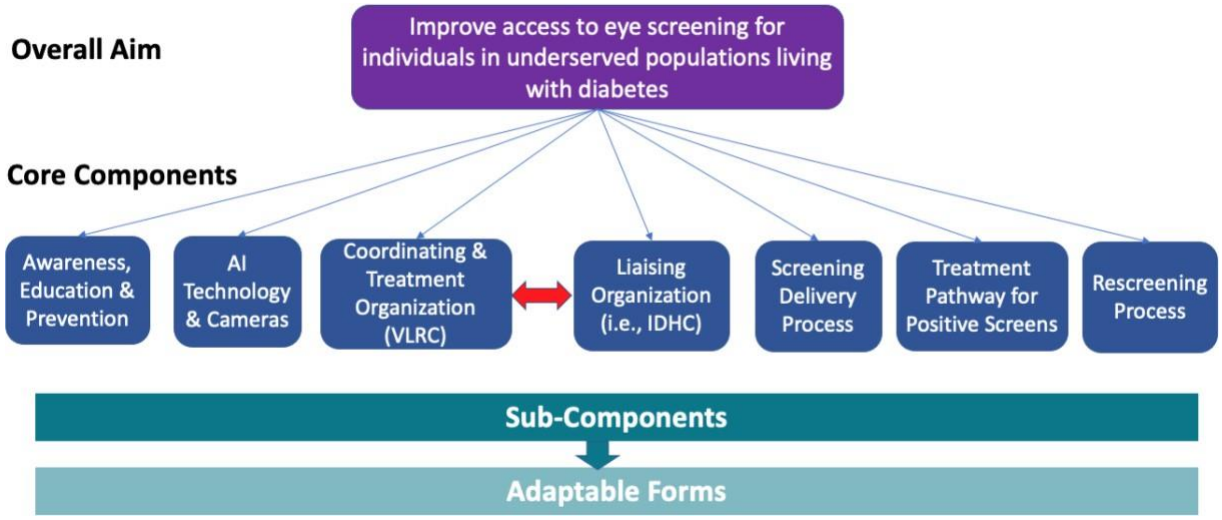


Figure 2: *Summary of the core components necessary for the program to function. See* ***Appendix C*** *for the detailed version.*

Example of a Liaising Organization: Indigenous Diabetes Health Circle (IDHC)

As defined above, a Liaising Organization provides the connection between VLRC and the community being served. The current organization that holds this role and leads the screening process for Indigenous Communities is IDHC. IDHC provides culturally appropriate diabetes education, prevention, and management services to Indigenous Communities in Ontario. IDHC serves First Nation, Métis, and Inuit Communities both on and off-reserve, with the aim of facilitating community capacity-building, building upon traditional strengths, and supporting community-driven programming.[48] IDHC has partnered with VLRC to increase access to DR screening in Indigenous Communities through the AI-mediated eye screening initiative. As of their

2021–2022 annual report, IDHC and VLRC have provided eye-screening training to 20 Indigenous frontline workers and continues ongoing training to ensure the program reaches Indigenous Individuals living in urban, rural, and remote settings.[49]

3.4.3 Partner-Reported Barriers to Participation

On behalf of WIHV, VLRC asked current partners regarding which challenges they faced while participating in the program, and reasons for wanting to continue. The most frequently mentioned challenge was lack of capacity and challenges with staffing and resourcing. Many partners reported staff already had too many other commitments, and even when there was strong organizational support, there could still be strong resistance from frontline staff. Some sites reported sending a staff member on training, and then the staff member moved to another organization or took a leave of absence, which meant that screening stopped. Another common challenge was lack of time to complete the screening. Although only 15 minutes is required, this time adds up quickly, particularly when screening is part of a diabetes education program where many other topics need to be covered. Although changing priorities based on time of year were anticipated for flu season, some sites reported needing to change priorities for other seasonal changes, such as hunting season. Challenges in using the camera were also reported, including difficulty holding the handheld camera still. Keeping the camera still was a particular challenge when screening older individuals who may have difficulty sitting still, have dry eyes, or blink frequently. This difficulty further emphasizes that a chinrest should be included in all screening kits (as mentioned in costing), and that the handheld camera may not be suitable for some screening settings, particularly those that screen a lot of older adults.

Within the camera sharing model, a reported challenge was when a region with a small population only needed to screen a few individuals, and it was difficult to arrange for the return of the camera, particularly when the camera was shared with a region with a larger population. As the program expands, a deliberate, less opportunistic, approach to camera sharing is planned by VLRC to ensure that smaller communities still have access to the camera when needed. The final challenge mentioned, which VLRC is already planning to address, is the need for more detailed patient handouts. Sites also reported requesting more training on general eye health and anatomy to help answer basic questions for their patients. If patients have immediate questions the screener can call VLRC and have someone answer those questions, however screeners felt that more general training would be useful to support patients, as the current training only focuses on the screening procedure. From the non-clinical sites, requests were made to learn more about

what happened after a positive screen was identified. For various reasons, individual patient-level data is not shared with non-clinical sites, however annual, aggregate reports may be one approach to provide the requested feedback without needing to share patient-level data.

3.4.4 Partner-Reported Facilitators to Continued Participation

Screening partners reported that the program is very well received by patients, who appreciate seeing the photos and knowing the results immediately. Patients were willing to be screened and there was enthusiasm for the program from staff and patients. The program was even referred to as the "talk of the town". Beyond patient impact, organizations appreciated that being involved helped them to stand out, including while reporting to their board of directors and when mentioned throughout their community. It was even mentioned to encourage further funding, such as continuation of community paramedicine funding. The program was seen as innovative and easy to use once staff overcame the initially steep learning curve. Confidence to use the equipment increased over time, although, as mentioned above, use of additional equipment such as chin rest was needed. All involved also appreciated the direct access to the ophthalmologist and the decreased wait times. Some partners reported typical wait times of 2 years to see an ophthalmologist, while patients in this program were prioritized with much shorter wait times (details to be provided in the other evaluation). The ethical dilemma posed here regarding patient prioritization is addressed later in the report. In general, direct involvement of the ophthalmologist was reported to give the program a "stamp of approval".

3.5 Need for Accountability

To sustain DR screening delivered through this program, strategies to ensure accountability are needed. Currently, VLRC can work with an organization, provide training, send the camera, and follow-up. However, VLRC cannot hold an organization accountable to their screening commitment. In some organizations, particularly Health Centres, eye screening information is reported to OH, however basic eye screening, not including DR screening, is often seen as sufficient, thus potentially decreasing motivation and commitment to DR screening.

One suggestion to increase accountability was through further integration of the VLRC program with organizations that have existing accountability mechanisms, particularly Diabetes Education Centres. It was mentioned that at these Centres, patients are asked for the date of their last eye screening. However, if the patient indicated it has been more than 1–2 years, this information did

not necessarily lead to DR screening. Referring patients in need of DR screening from these Centres to the VLRC program could potentially provide better patient care (i.e., patients receive the required screening), allow the Centre to report on DR screening rates, and improve accountability.

Another suggestion came from a health system leader who highlighted the potential to learn from a regional cancer screening program where there is an agreement between the organizations that screening will be conducted. Within this agreement, there is a quarterly meeting to talk about the data, challenges etc., and collected data are reported regularly. Funding is provided to enable participation in this process. The combination of funding, regular meetings, and the need to report data were all used to increase accountability.

This need for accountability is particularly important when planning for sustained spread and scale-up. Time and effort are needed to implement this screening, yet if set-up is completed and screening is not done, then this may lead to wasted effort that could be better spent elsewhere. It seems reasonable to assert that accountability measures, including integration with existing programs that already have the accountability mechanisms, will support ongoing and sustained screening. Accountability measures need to be considered in the provincial DR screening plan.

3.6 Integration

To take a population health perspective to explore the feasibility of integrating this program into the healthcare system by scaling/spreading this model throughout Ontario. Considerations for spread and scale of multi-condition eye-related AI screening will also be explored.

In exploring Integration, the VLRC program was found to be complementary to and not a replacement for, existing DR screening programs. The VLRC program fills a niche need to support individuals who have not been screened recently and could be complementary to other screening programs.

The question of integration has been separated into three components including: integration of the VLRC program into the *communities* participating in the VLRC program; integration with the *health system* including integration with the ongoing research on DR screening programs; and health system integration considering *multi-condition screening*. These components are interconnected and have only been separated in this report to facilitate understanding.

3.6.1 Community Integration

Integration within the community is a clear priority for the VLRC program, which allows the screening criteria and methods to change based on community needs and staff capacity. While the overall program includes screening for all individuals over the age of 18 living with diabetes, some partners choose to screen those who have not been screened in over a year, while others focus on those with high HbA1C and need more regular screening. In sites where staff capacity is a significant barrier, the criteria has been more stringent, such as only screening those who have not been screened in two or more years.

The method of delivery and who conducts the screening is also adapted based on community need and provider capacity. For example, some communities/organizations have opted to conduct the DR screening themselves and have supported a staff member (not necessarily a healthcare provider) to participate in the online training by VLRC. These sites are sent the "screening kit" which includes the portable fundus camera, a laptop with the AI technology, chin rest (not currently available to all sites but deemed essential for sustained screening), and other relevant material required for screening (see Cost section for details). At the end of the specified screening period, the screening kit is transferred to another participating community/organization. Other communities/organizations which do not have the capacity to perform screening themselves have requested "VLRC screeners" to visit the community to conduct one-off "screening days". Being able to provide multiple options for screening delivery is an asset to this program and may be complementary to population-level screening conducted through organizations such as CHCs. Aligning the timeline of the VLRC Eye Van, a fully equipped, mobile eye clinic, with community screening may also support increased availability and accessibility of treatment for patients who need minor treatments, such that the screening is conducted a few months before arrival of the Eye Van. This alignment may increase capacity and impact of the Eye Van service and could align with any of the screening models. Options for screening models include:

- ***Permanent Screening Kit:*** The screening kit is permanently in one region with one organization (e.g. Community Paramedicine). Individuals connected to the organization are trained to conduct screening themselves. This permanent model would typically only be relevant for larger areas with high proportions of individuals living with diabetes. This is not a common approach in the current program due to the limited number of cameras and focus on smaller communities.

- ***Screening Kit Sharing:*** Currently the standard approach for the VLRC program. Individuals are trained and the screening kit is in the area for a set period of time. All screening would need to be done during this time. This model has been running for one year, so coordination of rescreening is planned but has not been tested.

- ***VLRC Screeners:*** When capacity is not available in the community/organization, VLRC is testing a program where VLRC screeners visit the area and conduct individual screening days. This takes the training and capacity burden off the community, but still requires identification of patients and coordination of the screening event, while also increases the demands on the VLRC team. This model is currently being tested based on demand from potential screening organizations and contingent on VLRC capacity.

- ***Indigenous Communities*****:** IDHC has developed their own strategy for community screening which includes an "eye health worker" who does the training, facilitates community connections, and screens. Further details on this model are provided through the VLRC narrative evaluation.

Within each screening model, each community/organization can tailor how they use the camera to meet the needs of their community (screening days etc.). In maintaining this adaptable approach, the ability to determine if one screening model is "more effective" than another may not be relevant. Rather, it may be more appropriate to ensure that the different models become as effective as possible within that community. As each of these models is applied, it will be important to identify the core components of each strategy and to develop eligibility criteria for use of each model and the costs involved. For example, in regions with a high prevalence of individuals living with diabetes, even if the community/organization does not have the capacity to conduct screening themselves, having VLRC screeners deliver an occasional screening day is unlikely to be an effective way to support ongoing screening and rescreening. In this case, the permanent or shared camera model would be recommended, however this will also be based on camera availability, which is reliant on available funding.

Working closely with the Liaising Organization will be an important part of the decision-making process to pick a screening model that ensures the needs of the individuals being screened, and the community/organization delivering the program, are met. Within the decision making process, use of community champions was mentioned as a strong indicator of ongoing success in many

of the health system stakeholder discussions, however, in the literature, reliance on one champion has been shown to have mixed effects and is not necessarily sustainable.[50] This evidence further emphasizes the need for strong connections with Liaising Organizations to support community integration that includes, but does not rely on individual champions.

3.6.2 Health System Integration

In the current form, it does not seem appropriate for the VLRC screening program to replace other DR screening programs like TDCC. However, it can provide a complementary service to screen individuals with little connection to the healthcare system and who have not been screened in the past few years. The program's focus on community driven approaches (screening days, home visits, community events, etc.) that don't rely on a visit to a healthcare institution through use of the handheld camera can be complementary to other initiatives. For example, there may be opportunities for this program to complement existing screening efforts, such as by having a CHC screening program identify individuals who have lost touch with the Centre and require further outreach, which can then be provided through the VLRC program with the handheld cameras. However, several barriers currently prevent an integrated approach. For example, comprehensive identification of individuals in need of screening poses a significant challenge to already overworked healthcare workers. Work is underway to develop a diabetes registry that would support identification of individuals in need of screening.[43] However, as VLRC does not have access to that list, this further siloes screening efforts. The potential integration of services is visualized in **Figure 3.**

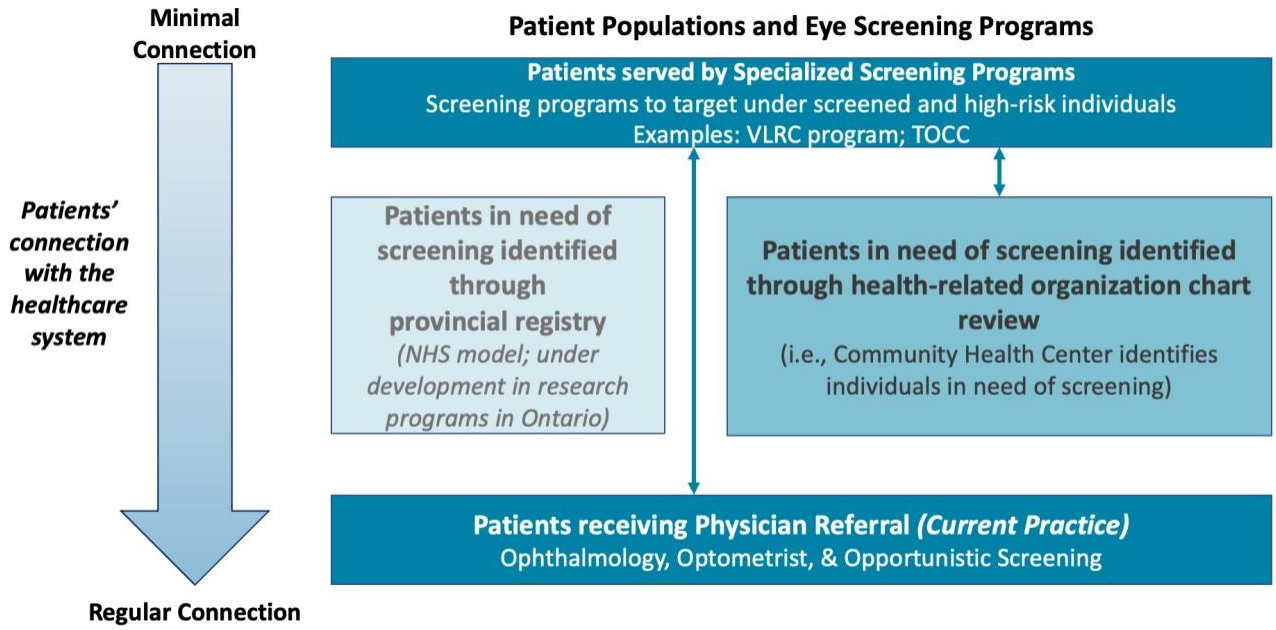


Figure 3 *Summary of patient populations with eye screening programs to support integration.*

Patient (or client) populations and screening programs are placed within the spectrum of the patients' connection to the healthcare system. Physician Referral represents the current screening strategy. Middle boxes represent emerging strategies for identifying individuals in need of screening. The lighter box (centre-left) is not currently available in Ontario. The Specialized Screening Programs are those, such as the VLRC program, that can meet the needs of individuals with minimal access to the healthcare system. Small arrows show that specialized programs can connect with other patient identification methods to help individuals across the connection spectrum receive the necessary screening.

Alongside an accessible diabetes registry, other strategies that would support integration and provincial scale-up could be to develop a coordinated group who reviews the screening images. Currently, each DR screening program across the province appears to have their own method for reviewing the images. The VLRC programs relies on an ophthalmologist in Kingston, while others rely on other individual ophthalmologists. A singular and coordinated group reviewing the images from across the province would support sustainability of all these screening programs and decrease reliance on individuals. There are also many questions, particularly when the first level of screening is conducted through an AI program, regarding who should review the images and develop a treatment plan. With approximately 450 ophthalmologists across the province,[51,52] and 2758 optometrists registered with the College of Optometrists of Ontario,[53] it may not be an effective use of resources for ophthalmologists alone to conduct this screening. Health system leaders also mentioned that ophthalmologists may also not see prevention, including screening, as part of their professional role. When asked about optometrist involvement, system leaders

indicated multiple barriers to engaging optometrists, including their lack of ability to bill OHIP for screening, the need for standardized training, and inconsistency in whether or not the optometrist bills patients for screening. When the VLRC program launched, optometrists were engaged in a "work to rule" campaign and their engagement was not feasible.[54] The siloed approach to engaging ophthalmologists and the current lack of engagement of optometrists does not appear to be effective: a provincial-level strategy may be needed. For a provincial level strategy, a group of ophthalmologists could be involved, or another idea suggested was for an optometrist to be hired as the main contact to review positive screens, thus limiting the need for engagement of engaging individual optometrists or ophthalmologists. With the new OAO and Government of Ontario agreement,[31] the role of optometrists may be more feasible and scalable, as optometrists will no longer require documented history of diabetes. This change may increase the ability of optometrists to conduct DR screening, potentially making the VLRC program more efficient (i.e., not always needing to go through an ophthalmologist to review results and make a treatment plan) and potentially more cost effective with increased OHIP access.

In considering provincial scale-up of DR screening, strong connections must be formed with other programs, including research programs that have already tested other screening models, particularly within urban areas, and programs with stronger connections to the health system. For example, Project OPEN (described above) takes an intersectionality approach to develop a scalability plan for DR screening across the province, including a comprehensive understanding of barriers to screening, a policy study, and an economic evaluation.[43]

Although many barriers have been identified in the literature and through consultation, less is known about strategies to overcome these barriers, particularly when screening is not connected to a healthcare service provider such as a CHC. Some solutions are being piloted in urban areas, such as screening in shelters for underhoused individuals where a handheld camera is more appropriate. The VLRC program, with their use of handheld cameras, may align better with these more specialized approaches and be complementary to other DR screening programs.

3.6.3 Health System Integration – Multi-Condition Screening

To support integration and decrease siloing, the VLRC program will need to decide if their future focus is on eye health more generally or on diabetes specifically. The cameras and AI technology have growing potential to screen for multiple eye health conditions, with the EyeArt program (the AI program used by VLRC) recently receiving European approval for glaucoma and AMD

screening.[55] However, following ethical screening practices to ensure that screening is only conducted if relevant criteria (age range, risk level etc.) are met and treatment pathways are available, means that careful consideration of the care pathways for each condition is needed. Although further elaborated in the VLRC narrative evaluation, preliminary results indicate that screening for AMD may not have been particularly effective for this program. Screening for all patients over the age of 50, would lead to a very large pool of people being screened and vastly expands the scope of this screening program, potentially limiting the capacity to screen those with less connection to the healthcare system.

Careful consideration of screening and treatment pathways for each added condition is needed. The use of AI technology in screening for only a single condition was raised by health system leaders as another challenge as it restricts the ability to detect other conditions which could be identified by human screening. A balance must be met as the use of AI technology can be beneficial as a first level of screening, while still ensuring appropriate specificity and sensitivity so no patient at risk is missed. While only sending positive screens for review by an ophthalmologist increases the effective use of this scarce human resource, it limits the opportunity to identify other conditions, which may become an unintended side effect of the screening program. Although the camera has potential to screen for other conditions, the images taken/AI review are currently used for DR only, thus limiting the detection of other conditions which might be noticed by a person reviewing the images.

Health system discussions indicated DR screening programs have typically focused more on diabetes than overall eye health. Some of this decision appears to be based on sources of funding, with more funding available for diabetes than eye health. Integration with other diabetes programs would also provide more comprehensive support for individuals living with diabetes and has been identified in the literature as a facilitator to attending screening.[16] Connecting this program to other diabetes-related screening programs including, but not necessarily limited to eye health, kidney function, and foot care, would provide a more holistic and patient-centered approach to diabetes screening practices. To achieve this comprehensive approach, partnerships need to be supported, such as connections with Diabetes Education Centre and programs that already provide comprehensive diabetes care, but do not currently provide DR screening.

3.7 Reach

Examine current patient recruitment methods to determine the most efficient/effective methods of patient recruitment to support sustainable and scalable DR screening that supports patient needs and encourages sustainable patient outcomes.

Data regarding date of last eye exam of individuals who screened at risk of DR shows that the program is achieving their aim to screen those who are not regularly screened. To explore Reach, areas of focus included: public awareness of DR; organizations/approaches where screening was conducted; who was trained to deliver the screening within each community/organization; who was screened (patient demographics), including the process for individuals without OHIP coverage, and screening rates to date. Accountability to the screening process is also needed for sustained reach and connects to each of these categories, as does recognition of the need to manage thresholds where patients screened can receive timely treatment. With the approach VLRC is taking, time and capacity are needed within each of these areas to ensure partnerships set up with communities/organizations are strong, sustainable, and partners feel ongoing support to continue screening.

3.7.1 Lack of Public Awareness

An ongoing lack of awareness among the public about the connection between diabetes and eye health was noted in health system leader discussions and in the literature. Results from the literature review found that a lack of awareness about DR and its consequences, misunderstanding of the difference between DR screening and regular eye exams, fears of harms caused by screening, and misconceptions about the cost of screening were significant barriers to regular screening.[11,13-15,25] In all discussions with health system leaders, the same message was reiterated that the first step is raising awareness among individuals living with diabetes about the risks associated with DR, the need for regular screening, and free access to this screening. Awareness is listed as the first step within aspects of the program aims (**Figure 1**) and core components (**Figure 2**) when planning for sustainability, spread, and scale. A DR screening program needs to include a component of education and awareness raising. Working with a Liaising Organization may help to identify appropriate strategies to set this foundation for future screening.

3.7.2 Screening Organizations & Approaches

Screening was conducted through Community Paramedicine, Health Centres including Family Health Teams, and in Indigenous Communities. Currently, there is no one approach that appears more effective than another, and there are pros and cons to each. A Health Equity Impact Assessment[56] conducted in partnership with Liaising Organizations, is recommended when working with new communities and populations.

Community Paramedicine appears to be an effective strategy for DR screening. With strong connections to VLRC, screening has become embedded within their routine care delivery. Community Paramedicine has access to lists of patients living with diabetes and are already well positioned and trained to conduct screening at people's homes and other off-site settings. However, the Community Paramedicine program is expensive to run, and relying on highly qualified individuals to conduct this screening when it can be done by non-healthcare professionals may make this approach difficult to sustain.

Health Centres is a general term used by VLRC which includes hospitals, Family Health Teams, and other settings that provide clinical care and have their own list of patients who need DR screening. As a sole DR screening strategy, this model does not appear to be the most effective use of resources for these settings, except in specific circumstances. Health Centres would likely benefit from a combination of approaches, where patients who regularly connect to the Centre can be screened through a standardized, and likely non-portable, screening process, such as referral to a nearby location that does screening, or in-house DR screening by a trained staff member. Where the VLRC program could add value is in screening those who have not been screened within the last two or more years and do not have regular contact with the Centre. A targeted approach to these individuals, combined with the ability to screen in the patient's own home and close follow-up by VLRC throughout the referral and treatment process, may add value to the Health Centres and meet patient needs. This targeted and intensive approach is unlikely to be needed for all patients.

For the Health Centres using the VLRC program, there are typically extenuating circumstance that increase the value of the program, such as when there is no other option for DR screening in that region. This lack of access is more common in rural and remote areas, or in marginalized urban neighbourhoods, and can occur when there is no local optometrist or ophthalmologist, or

they are not taking new patients. These Health Centres reported seeing the VLRC program as a way to meet the DR screening needs of their patients when no other option was available.

Indigenous Communities: The IDHC has developed multiple strategies for connecting with Indigenous Communities and is finding unique ways to deliver screening. For example, in February 2023, IDHC attended, presented, and completed screens at a frontline Worker Circle research day (Aki Gimiiniigonna Mshkoziwin) at Kingston Indigenous Languages Nest. This event led to further connections and a new session was held in March where the IDHC brought the program to the sweet water ceremony with Wasauksing First Nation and the Indigenous Interprofessional Primary Care Team (an existing partner), with an educational and screening booth available to screen participants. Further evaluation, led by an Indigenous partner is needed to thoroughly understand this approach and how it can be sustained, spread, and scaled across the province.

Additional approaches to screening delivery have also been considered, particularly the potential to work with pharmacists to support local spread and provincial scale-up. Pharmacists were seen as a key touchpoint in the community and typically a trusted source. Pharmacist involvement was proposed in a few forms including having a member of the pharmacy team conduct the screening (as other screening programs are already conducted through the pharmacy), or in identifying those who would be screened (not delivering screening themselves). Unfortunately, multiple barriers were mentioned. For instance, VLRC did extensive work to set up partnerships with large pharmacy chains, but a lack of payment for screens halted further development of this screening model. A provincial strategy for the involvement of pharmacies in DR screening could be considered with other programs to ensure a coordinated effort.

As the program continues to spread, VLRC and Liaising Organizations can work together to identify appropriate organizations/approaches to conduct screening based on learnings from other settings, and relevant to individual communities. To ensure the focus on screening of those with less access to the healthcare system is maintained, conducting Health Equity Impact Assessments is recommended before spreading to any new community. This Assessment can support development of a screening strategy that maintains health equity as a priority, while also potentially supporting the relationship development between organizations.

3.7.3 Training of Screeners

A strong component of the VLRC program that supports sustainability and scalability is that training can be done online and does not require the person conducting the screening to be a healthcare professional. So far, 13 different roles have been used to conduct the screening (**Table 2).** This approach opens many possibilities for ways to screen and provides more options for organizations to develop their screening strategies. This approach does require extra measures to ensure sufficient patient education, as non-healthcare screeners are unable to provide recommendations for treatment/care and may not be qualified to answer patient questions. To address this, all at-risk patients who are screened receive a follow-up from VLRC within 3 business days, and an on-demand service is available if patients have immediate questions. As mentioned above, some screeners do not necessarily find this sufficient, and have requested more general training to help answers basic questions from patients. There is also some concern about image quality and whether the non-healthcare professionals take more ungradable images. Data is not available for this report to answer this question. Extra tools, such as chin rests have been incorporated into the screening kit to overcome this issue, albeit with increased cost, but use of chin rests was deemed essential for future use of handheld cameras.

High staff turnover was mentioned by many partners and by health system leaders as another barrier to screening delivery. It is a risk to sustained screening when an organization commits to screening and has high turnover in trained staff, potentially decreasing the organization's ability to screen. High staff turnover needs to be considered within the context of a highly stretched healthcare system with multiple competing priorities and low capacity.

Table 2: *List of roles of individuals who have been trained as DR screeners using the handheld camera.*

1. Community Health Representative (non-clinical individual focused on health promotion, typically in Indigenous Communities)	8.Wellness, nutrition and life-long care workers
2.Community Health Nurse	9.Registered Nurse
3.Health Manager	10.Registered Practical Nurse
4.Diabetic Navigator	11.Diabetes Health Worker
5.Wellness Program Staff	12.Administrator
6.Diabetes Educator	13.Community Paramedics
7.Program Coordinator	

3.7.4 Patient Demographics

Demographic information for patients screened positive (at risk) is provided in **Table 3**. Screening in the North Region and by Community Paramedicine mostly served those over 65 years of age (58% and 75% of patients respectively). As expected, screening was lowest in those aged 18–30. In the East, 55% of patients were 31–64 years of age, and Health Centers were equally split by 31–64 and 65+ years. More females were screened at risk across all regions and setting types. In particular, 72% of patients screened at risk in the East were female.

Table 3: *Age and gender for all patients screened positive (at risk for DR) between February 2022 – January 2023.*

	18–30 years of age	31–64 years of age	65+ years of age	Female	Male
North	4.7%	37.2%	58.1%	56.1%	43.9%
East	18.2%	54.5%	27.3%	71.4%	28.6%
Indigenous Partners	20.7%	41.4%	37.9%	63.2%	36.8%
Paramedicine	0%	24.8%	75.2%	62.5%	37.5%
Health Centres	0%	52.4%	47.6%	61.1%	38.9%

Date of last eye exam among patients at risk for DR is provided in **Table 4**, where as many as 58% of individuals had not been screened in over 5 years (including never screened and if they did not remember being screened). With a range of 39–58% of individuals not being screened in 5+ years, and a range of 67–77% not screened in 3+ years, this program is reaching those who are not seeking regular screening.

Table 4: *Years since last eye exam for patients screened positive (at risk for DR) between February 2022 – January 2023.*

	Under 1 year	1–2 years	3–5 years	Over 5 years*
North	18.6%	6.98%	16.28%	58.14%
East	7.69%	23.08%	30.77%	38.46%
Indigenous	6.98%	20.93%	27.91%	44.18%
Paramedicine	15.38%	7.69%	19.23%	57.7%
Health Centres	8.7%	21.74%	30.43%	39.13%

* Over 5 years includes individuals who responded “never” and “don’t remember” when asked about the last time they had an eye exam.

As the VLRC program does not require physician referral, this can increase Reach (and Community Integration) as there are more options for screening individuals without relying on the referral. The lack of referral can also pose challenges to health system integration, continuity of care, and regular follow-up when the patient does not have access to a primary care provider. Further challenges are found for individuals without OHIP coverage.[15,26] In the VLRC program, individuals without OHIP can be screened, and the ophthalmologist has currently agreed to review those screens and develop a treatment plan (without billing OHIP), but access to treatment is a problem. These challenges have been identified in other DR screening programs, including those delivered in urban areas through CHCs where rates of patients without OHIP were mentioned verbally during health system leader discussions to be 20–25%, and in some areas, as high as 50%. Shared learning between these screening programs may help identify ways to support those without OHIP to receive required treatment. The focus on supporting non-OHIP covered individuals further demonstrates the need for the capacity to develop trusting relationships to work with communities to ensure that screening can lead to treatment for all those living with diabetes, as the capacity needed for this is more than for supporting an OHIP-covered individual.

3.7.5 Screening Rates to Date

Aggregate screening rates were provided by VLRC for between February 2022-January 2023, and grouped as Indigenous Partners (**Figure 4**), Health Centres (**Figure 5**), or Community Paramedicine (**Figure 6**). Across all three, highest rates were found in March 2022, shortly after initiation of the program. Screening rates were typically lower over the summer, except for Community Paramedicine which did not report screening in December 2022 and January 2023. Screening in Indigenous Communities was highest in March and May 2022, followed by January 2023, when a one-off screening day led to high screening rates. The success of this one-off event further strengthens the case for community-driven adaptable options for screening methods.

There are limitations with this data. Data is only reported in aggregate and VLRC indicated that data in some regions may be driven by some individuals conducting the majority of screening, rather than equal distribution of screening across sites. Community Paramedicine used a different screening tool (OphtAI), which does not report on “ungradable images” thus limiting comparison between settings. It is also not reported whether “ungradable” is due to user error, patient movement, or other factors, meaning that we cannot determine why certain regions/screeners have more “ungradable” responses than others. Some patients were unable to be screened due to a contraindication (cataracts), light sensitivity, or require dilation (out of project scope).

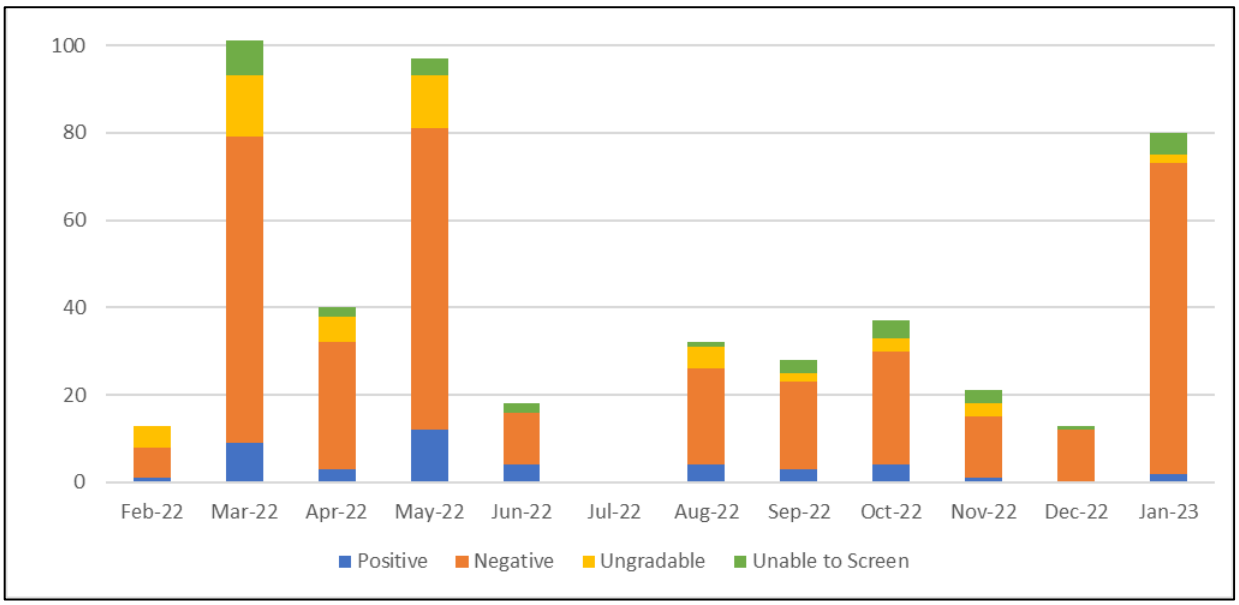


Figure 4: *Number of individuals screened for DR by Indigenous Partners between February 2022 – January 2023, and the screening results.*

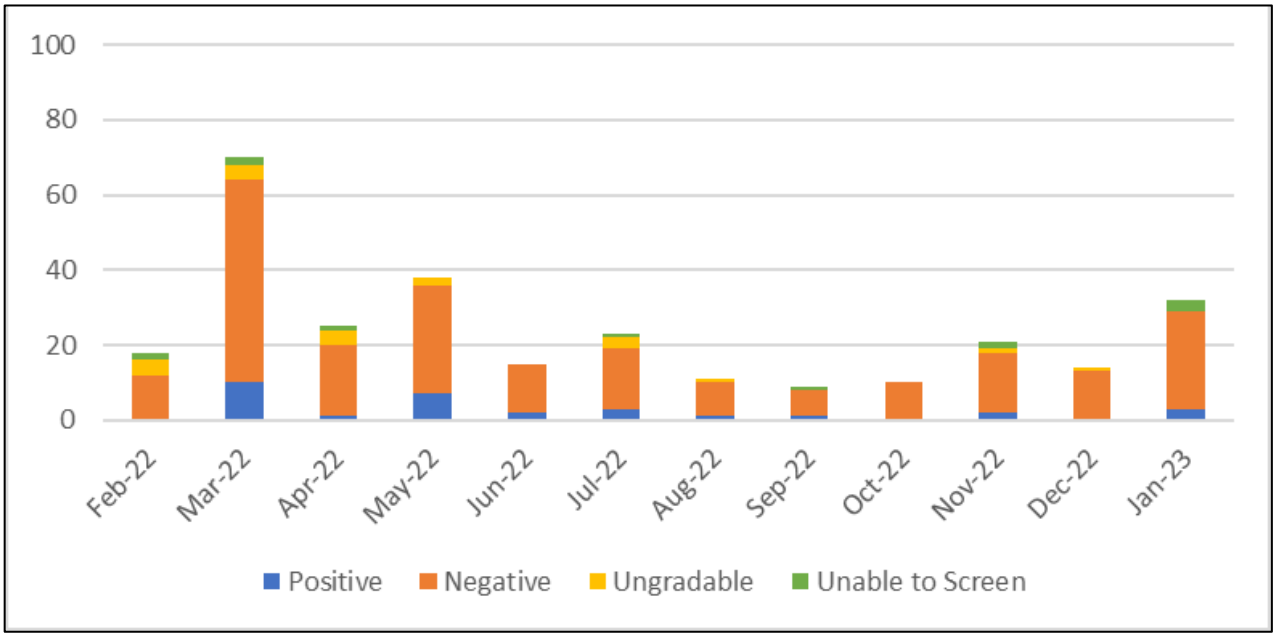


Figure 5: *Number of individuals screened for DR by Health Centres between February 2022 – January 2023, and the screening results.*

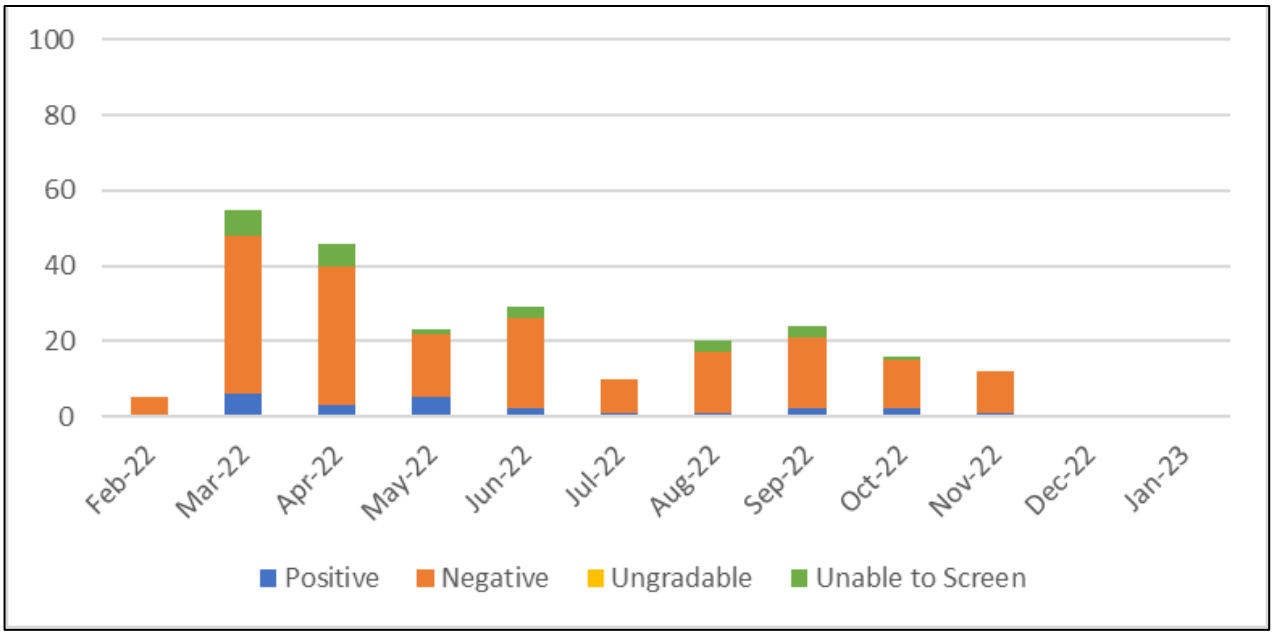


Figure 6: *Number of individuals screened for DR by Community Paramedicine between February 2022 – January 2023, and the screening results.*
A different tool is used here, which does not measure "Ungradable."

3.7.6 Meeting Thresholds

In planning for spread and provincial scale-up of DR screening programs, thresholds need to be considered to ensure that individuals screened at risk can receive timely treatment. Screening should be paired with prioritization when there are excessive wait times for treatment. An increase in screening rates could lead to increases in wait times for treatment, but if cases are prioritized, then people can be treated within an interval appropriate to their risk of progression of DR.

In discussion with a health system leader, a similar program was mentioned that focused on patients who have not been screened for 2 or more years. Patients identified through this process are treated as "priority patients" and seen sooner by having pre-scheduled slots left open, thereby allowing patients to be seen in a much shorter time period. Preliminary discussions indicate that screening and treating the volume of at-risk patients within individual catchment areas has not been an issue, however this will need to be closely watched as the program scales across the province. The ethical considerations of this prioritization should also be considered.

3.8 Cost

Describe the resource implications compared to current screening models and, if sufficient data is available, include recommendations on how it could be paid for after OH's DVCS funding.

The VLRC program is still developing. Strategies are underway to increase the number of individuals living with diabetes screened by the program, and there is reported to be capacity among the VLRC team and ophthalmologists reviewing the images to screen more individuals at the current costing level. Costing-related information focuses on learnings from the literature, the cost to the patient, current program resourcing (data provided by VLRC), and suggestions for future funding opportunities.

3.8.1 Learning from Other Programs

DR screening using teleophthalmology has been found to be more cost-effective than traditional ophthalmology screening in remote First Nations communities as well as urban and rural under-screened communities in Canada.[19,20,40,57] An economic analysis of the Toronto Tele-retinal Screening Program found that tele-retina screening resulted in more correctly diagnosed DR cases compared to traditional screening and had a lower cost per case correctly diagnosed ($82.21 vs $314.14 for traditional screening).[40] The cost-effectiveness of a teleophthalmology program in Manitoba was also found to be high, with average cost savings of $1007 per teleophthalmology exam.[57] In an isolated First Nations community in Northern Ontario, researchers modelled the cost-effectiveness of DR screening with a portable retina camera vs screening by a travelling retina specialist.[20] Results found the camera program to be more effective and less costly, with more years of vision projected to be saved over a 10-year period (67 vs 56) and a lower per-person cost ($403 vs $842). Although a different approach is used in the NHS program, the estimated cost of this program is approximately $85.6 million US or $40 US dollars per person screened.[47]

3.8.2 Patient Costs

The VLRC program strongly maintains that patients should not pay for DR screening. As mentioned above, there is confusion among the population regarding this cost,[25,29] which leads back to the need for education and awareness raising. Remaining true to this no-cost mandate has also led to challenges regarding health system integration and reach, particularly involvement of optometrists and pharmacists. To maintain reach, it is highly recommended that there continues to be no cost to patients for screening.

Particularly for rural and remote areas, travel costs, time off work, etc. for the patient and, if applicable, for the accompanying person, must be considered in developing a scalable DR screening program. The program has potential to save patient costs by coming to patients themselves (their homes, communities, events etc.), however there are still costs to consider for those who require treatment. Within the VLRC program, data provided by VLRC indicated the average distance between the community conducting the screening and the nearest optometrist was 17 km (or a 15-minute drive), standard deviation of 28 km (20 minutes), median 3 km (6 minutes), with a maximum of 96 km (68 minutes). These values increase considerably for the distance between the community and the nearest ophthalmologist, with the average of 149 km (107 minutes), standard deviation of 158 km (106 minutes), median 66.5 km (46 minutes) and a maximum of 479 km (317 minutes). **Appendix D** provides a map of the locations. Recognizing long travel times and associated costs further emphasizes the need for a strong screening pathway and the careful consideration of sensitivity and specificity of the AI technology. To decrease travel costs, the mobile "Eye Van" provides some treatment options, thus decreasing travel requirements for some, not all, conditions.[58] An additional consideration is time away from work for the patient or accompanying person, which is not detailed here as data were not available.

3.8.3 Current Program Resourcing

Costing data are separated into VLRC core costs, costs to run the program in the East and North, and a separate model for IDHC costing which places more focus on community integration. All data provided by VLRC and their partners are provided in **Appendix E**.

The VLRC cost to run the current program for 1 year was estimated at $700,000/year. This includes initial set-up of the program, and will expand as further human resources, technology, and base costs increase. This amount is based on values provided by VLRC and partners, including but not limited to, one time purchase of a fundus camera ($12,000 / camera), software license cost per individual screened (4 images per screen), laptops, eye cups, chin rests, carrying case, shipping costs, and communication resources for the patient. Although the chin rest was not included in original budgets, the ability of this device to support higher quality images, particularly when screening older adults, means it is recommended to be included in all screening kits. The overall equipment cost is less than other programs, but there are some issues in the quality of images while using a handheld camera. The program is underutilized so far, as VLRC noted they had capacity to screen more patients than were currently being screened.

In the East, program cost was estimated at $250,000/year, with additional in-kind contributions (project management etc.) of $230,000/year. This region had access to 6 cameras which were shared between 9 partners (4 of these partners joined between Jan–March 2023). A total of 308 patients were screened between March 2022–January 2023, with 35 patients having ungradable images and 22 patients unable to be screened due to a contraindication (cataracts), light sensitivity, or because they required dilation (out of program scope). Twenty-eight patients screened positive, for a positivity rate of 9.1% (excluding unable to screen and ungradable). This rate is likely lower than typical as 55 of the 308 patients (18%) were screened at a health conference where diabetes was more well managed than average. Thirty people with various roles (described above) have been trained to deliver screening in this region. Cameras were shared regularly between partners as most partner communities were only a 30-minute drive apart.

In the North, the program cost was estimated at $260,000/year, with additional in-kind contributions (project management, etc.) of $260,000 in the first year, and $480,000 in the second. Screening data were separated into North East and North West, but are combined here to align with reported costings. The North region had access to 10 cameras shared among 17 partners, however not all partners conducted screening while they had the camera (i.e., some had the camera for 3-months but did not conduct any screening before it was moved to a new site). Thirty-seven people were trained to screen. A total of 559 individuals were screened between February 2022–January 2023, with 37 ungradable and 47 unable to screen. Sixty-eight patients screened positive, for a positivity rate of 12.2% (excluding unable to screen and ungradable).

The IDHC program was estimated at $630,000/year. The IDHC model focuses more on community integration and community-led screening. Costs include, but are not limited to, Program Managers, Eye Health Workers who do community coordination, screening etc., team member travel, eye health kits, cameras, admin costs, and honorarium per community partner. The cost also includes program events where screening is taken to the community and funds are needed for space, honoraria, food etc.

In total, the cost to run this program was estimated at $1.84 million, with $710K in-kind, per year. However, this does not include ophthalmologist costings as this was not provided. A total of 867 individuals were screened between February 2022–January 2023, with a positivity rate of 11% (excluding unable to screen and ungradable). It must be noted that this is still early in the set-up for this program, and new partners are regularly added. The screening values and positivity rate

for the first year of the program do not necessarily represent the overall or projected rates. It should also be acknowledged that those screened are typically individuals with less access to the healthcare system and thus take longer to identify, support, and screen so results cannot be compared directly to other screening models.

Ophthalmology costs are not included in this estimate. When asked, these costs were more focused on the cost for an administrator who spends 20 minutes per at risk patient. Ophthalmologist's main costs were covered through OHIP, and timing was loosely estimated at 5 minutes/patient if the image required no alterations, and 10–12minutes per patient if any enhancement was needed to the image to make their assessment. Ophthalmologists also mentioned that they have the capacity to screen more people than the current rate, but acknowledged there was a threshold to consider as the program expanded.

As the VLRC program reduces the need to have an ophthalmologist review every image, and with the new March 2023 agreement, optometrists no longer need a documented history of diabetes,[31] potentially reducing OHIP billing claims for these services. To inform sustainable funding for the current program, and to support spread and scale, it may be possible for future research to develop a formula, or funding model, based on estimated savings (cost avoidances) to the OHIP program. Currently, costs and savings (i.e., avoided costs) connect to different funding envelopes, which represents a challenge for program sustainability. Further exploration into different funding options is recommended.

3.8.4 Future Funding

Future funding opportunities are considered from the short- and long-term perspectives. In the health system leader discussions, it was clear that short term research and pilot funding is not sufficient to support a province-wide DR screening program. Extensive research has already been conducted, and more is underway regarding what is required for a provincial program and how to take an intersectionality approach that emphasizes health equity. Further pilots will gain more information but cannot meet the provincial need without a more coordinated and provincial-level strategy, with provincial funding.

This VLRC program has a role to play in the provincial strategy, particularly in partnership with IDHC to include an Indigenous strategy within the provincial strategy. Developing a provincial strategy takes time, and the program needs current and ongoing funding to sustain current

screening and spread to new partners. Research, evaluation, and pilot funding can be considered as part of the "bridge" to a provincial program, however, is unlikely to be sustained on its own.

Some potential short-term funding suggested includes diabetes focused funding (Diabetes Action Canada etc.), or through the Ministry of Health "Northern Program" funding which currently funds the Eye Van. A newer opportunity is through funding from Orbis, which provides *"a wide range of activities that all work together to provide a comprehensive approach to eye care".*[59] Orbis is already providing some funding to specific DR related projects in Ontario.

3.9 Planning for Sustainability, Spread & Scale

Based on the results provided, a sample of potential barriers and facilitators are provided for sustainability (**Table 5**) and scalability (

Table 6) of the program. Factors impacting sustainability are based on the Program Sustainability Assessment Tool.[9]

Table 5: *Potential for barriers and facilitators to program sustainability. Factors adapted from the Program Sustainability Assessment Tool.*[9]

Factor	Potential Facilitators	Potential Barriers
Partnerships	Taking the time to establish strong relationships with Liaising Organization(s) can support sustainable community connections. Partnerships can also include other diabetes-related programs, outreach programs, and other partners who have an interest in diabetes, or eye health, care.	Strong partnerships take time and capacity to establish and maintain.
Funding Stability	Funding from multiple sources can support sustainability	Maintaining ongoing funding can be a challenge for continuing the program.
Organizational Capacity	Existing process in place for treatment pathways	As the program continues, and scales, organizational capacity needs will increase proportionately. Need to consider the time for partnership development and maintenance, not just patient care. Organizational capacity also needs to extend to the treatment options, so patients receive timely treatment.

Program Evaluation	Current evaluation(s) can inform future plans.	There is need for a mechanism of ongoing monitoring and quality checks to make sure the program is still working as intended, and there is opportunity to modify the program as needed (if the program is not achieving its goals, etc.)
Program Adaptation	Identifying the core components and knowing what can be adapted will help meet the needs of the community and screening partners.	Adapting the program too much can be confusing for those involved and mean more work for the support organization.
Communication	Strong, ongoing communication between different organizations involved.	Clear communication with patients, as well as current and future partners takes time, and messaging may need to differ based on the audience.
Environmental Support	Working with Liaising Organizations can bring in other partners and grow support for the screening.	The healthcare system is already siloed, and without connections to other organizations, this siloing continues.
Strategic Planning	Having a clear plan on the way the current program works and plans for next steps provides some structure to support a sustainable program, identifying challenges early.	Strategic planning can get delayed if one barrier seems to dominate.

Table 6: *A sample of potential barriers and facilitators to program scalability.*

Potential Facilitators	Strong relationship with Liaising Organization(s)
	Ability to adapt to meet the needs of the community
	Does not require individuals to have a family doctor
	Camera can go where needed
	Online training (no travel)
	Screener does not need to be a healthcare professional
	Immediate access to results
	Direct access to referral pathway
	Potential for multiple, community-selected avenues for screening which all connect to the same referral pathway
	Screening organizations may be more likely to see the value when it's part of meeting the needs of their community
	Only positive screens need to be assessed (currently by ophthalmologist but potential for other professionals to fill this role, likely optometrists)
	The new agreement with optometrists may facilitate DR screening and decrease reliance on ophthalmologists.
	Existing care pathway is already in place for positive screens
	Conducting Health Equity Impact Assessments when working with a new community (recommendation only, not currently conducted)
	Potential for economies of scale by partnering with other organizations

Potential Barriers	Lack of awareness of disease and negative impact
	Time and capacity to develop and maintain strong relationship with Liaising Organization(s) and screening partners
	Time and capacity to work with organizations to do the screening
	Lack of *funding* for screening organizations to do the screening
	Lack of *capacity* for screening organizations to do the screening
	Lack of payment (or billing codes) available to cover additional staffing/time to conduct screening
	Lack of ophthalmology capacity (recommendation to explore other professions, likely optometrists)
	Lack of system capacity to treat those who screen positive (at risk)
	Political constraints when involving optometrists
	Request for patient payment when pharmacy involved
	Increased capacity needs when screening more people (at all points in the care pathway)
	Lack of trust in the AI technology.
	Ability for the AI to accurately screen all patients.
	Technology challenges, including lower resolution images, many unreadable images, and challenges in taking pictures with the handheld camera (unstable).

4. RESOURCES

4.1 Sustainability Planning Tools

The Program Sustainability Assessment Tool is an evidence-based tool designed to support teams to plan for their intervention to continue long-term. Although the tool can be completed online and quantitative scores provided, we have adapted the tool specifically for use by VLRC. Two ways to use this adapted tool are provided, including a fillable Word version (**Appendix F)**, with space for additional considerations of strengths, challenges, actions, person/people responsible, and timeline. The Excel version (**Appendix G)** encourages use of the tool over time. Although the option to include scoring is included, quantitative scores are not always useful in planning for sustainability. **Appendix F** and **Appendix G** (separate files) includes the adapted Tool.

These tools have not been piloted with VLRC and changes are encouraged to ensure that the tool meets the specific needs of VLRC.

5. DISCUSSION

5.1 Key Findings

The VLRC AI mediated eye health screening program has the potential to address an unmet need for DR screening in rural and remote parts of Ontario and is making progress with Indigenous Communities through partnership with the IDHC. There are several existing elements that support sustainability and spread of this program as it focuses on supporting individual living with diabetes with less access to the healthcare system in Ontario.

Strategies are underway to increase the number of individuals living with diabetes screened by the program, and there is reported to be capacity among the VLRC team and ophthalmologists reviewing the images to screen more individuals at the current costing level. Data regarding date of last eye exam of individuals who screened at risk of DR shows that the program is achieving their aim to screen those who are not regularly screened.

When planning for provincial scale-up, integration with existing DR screening programs is needed. Development of provincial level systems, such as a diabetes registry accessible to multiple partners including VLRC, could support an integrated approach to DR screening across the province.

5.2 Ethical Dilemmas

This report does not cover all ethical dilemmas regarding DR screening. However, two examples are presented to demonstrate questions to consider in planning for scale-up of this program and DR screening more generally.

With the VLRC program, patients who are screened receive direct access to results and a treatment plan is typically developed within 2 weeks, with VLRC providing individualized support to overcome patient barriers to treatment (referral reminders, travel etc.). Patients in this program are reported to be seen by an ophthalmologist sooner than those who are not referred through the program, raising questions regarding “jumping the queue”. As patients in this program are generally higher-risk and less likely to have an eye exam as demonstrated through the demographic data on years since last eye exam, in some case this can be justified but raises ethical questions regarding this process.

Another ethical dilemma was raised regarding if AI mediated screening is, for example, “not as good as care-as-usual”. Given that many underserviced areas are, by definition, under-screened, is it ethical to use AI screening rather than no screening at all? It *might* be adequate to start with screening that is not as good as other types of screening rather than no screening at all, but it is not acceptable to be satisfied with poorer screening, if that is what other evaluations of the technology find. Questions regarding use of this technology are further explored in the KHSC evaluation.

5.3 Recommendations

Key recommendations for sustainability, local spread, and provincial scale-up of this VLRC program include:

1. **Continue to support the VLRC program to provide DR screening for those who are less likely to access the healthcare system**. The VLRC program can be complementary to and not a replacement for, existing DR screening programs. The VLRC program fills a niche need to support individuals who have not been screened recently and could be complementary to other screening programs. Maintaining the adaptable nature of this program will be key to meeting this need.

2. **Continue to support the VLRC program to work closely with the IDHC to provide an Indigenous-led DR screening program.** An Indigenous-led strategy must be considered within the provincial strategy.

3. **Learn from and link with existing DR screening programs.** Many well-studied programs have been operating for several years in Ontario, and although they operate at a small scale, they have overcome some barriers to screening for underserved populations. As the VLRC program has only been running for a year in specific settings, much can be learned from other programs that will be relevant for provincial scale-up of DR screening.

4. **Encourage sustainable collaboration with Liaising Organizations.** As the VLRC program and the provincial-level strategy progress, sustainable collaboration with Liaising Organizations that understand the needs of their community is required for a customizable approach to overcome barriers in access to screening. Health Equity Impact Assessments can be used to support development of community-led screening strategies.

5. **Support development of a diabetes registry to support provincial screening.** A sustained provincial diabetes registry, such as the one currently piloted in an existing research program, that is accessible to organizations including VLRC would facilitate targeted screening of high-risk individuals on a larger scale.

6. **Confirm that the AI technology is appropriate.** Although the Kingston Health Science Centre (KHSC) evaluation is underway, there are concerns among health system leaders as to whether the technology is appropriate for all populations in Ontario. Safeguards and quality checks need to be included to ensure the sensitivity and specificity of the tool is adequate for the specific populations being screened.

7. **Develop a more sustainable strategy for reviewing positive screening results.** Each DR screening program across Ontario currently relies on their own small number of ophthalmologists to review results, which is a risk to program sustainability, and limits the potential for spread, and provincial scale-up. To overcome this, a provincial pool of ophthalmologists could be convened to review results, or the role for optometrists could be further explored. Individual programs have rarely engaged optometrists, but a province-wide approach that takes advantage of new funding agreements may be more effective.

8. **Consider a system of treatment prioritization.** As the VLRC program is designed for those who do not regularly access eye care, a process for prioritized treatment for patients who are screened positive could be considered. For example, specific time slots could be held for treatment appointments to ensure the individuals screened through this program receive timely treatment and are supported to receive that treatment (transportation, referral support etc.).

9. **Screening should be paired with prioritization when there are excessive wait times for treatment.** An increase in screening rates could lead to increases in wait times for treatment, but if cases are prioritized, then people can be treated within an interval appropriate to their risk of progression of DR.

10. **Support a holistic approach to screening.** As the AI technology advances, the VLRC program could focus on screening for different eye conditions among multiple subsets of the population. However, collaboration with other diabetes-related organizations and screening program appears to be more aligned with a person-centered and holistic approach to support individuals living with diabetes.

6. CONCLUSION

The VLRC AI Mediated Eye Health Screening Program has potential to be a sustainable way to address an unmet need for DR screening in rural and remote parts of Ontario. The VLRC program is still developing and spread of the program to new sites and regions is feasible. Data regarding date of last eye exam shows that the program is achieving an aim to screen those who are not regularly screened. Strategies are underway to increase the number of individuals living with diabetes screened by the program, and there is reported to be capacity among the VLRC team and ophthalmologists reviewing the images to screen more individuals at the current costing level. Further work is needed to establish and evaluate the core screening model options (camera rotation, VLRC screener, etc.), while keeping the flexible aspects (screening days, etc.) of the program that allow it to meet needs of the community and stay within the available capacity of the screening partner.

This program may be complementary to, not a replacement for, other DR screening programs across Ontario as it has potential to fill a niche need to screen and support individuals with less access to the healthcare system. Learning from and collaborating with other DR screening programs and research, including the NHS population-based program, is needed to develop a provincial level DR screening program. An Indigenous-led strategy must be considered within the continued spread of the program and in the provincial scale-up. Treatment capacity must also be considered throughout spread and scale-up, ensuring there is capacity in the system to treat all patients who are screened at risk for DR.

7. REFERENCES

1. Moore JE, Mascarenhas A, Bain J, Straus SE. Developing a comprehensive definition of sustainability. *Implementation Science.* 2017;12(1):110.
2. Altomare F, Kherani A, Lovshin J. "Retinopathy", Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes.* 2018;42:S210–S216.
3. The Cost of Vision Loss: Canadian Counsil of the Blind. Deloitte Access Economics. https://www.fightingblindness.ca/wp-content/uploads/2021/12/Deloitte-Cost-of-vision-loss-and-blindness-in-Canada-report-May-2021.pdf. Published 2021. Accessed 9 February 2023.
4. *Making Eye Health a Population Health Imperative: Vision for Tomorrow - 3. The Impact of Vision Loss.* National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on Population Health and Public Health Practice; Committee on Public Health Approaches to Reduce Vision Impairment and Promote Eye Health; Washington (DC): National Academies Press (US); 2016.
5. Diabetes in Ontario. Diabetes Canada. https://www.diabetes.ca/advocacy---policies/advocacy-reports/national-and-provincial-backgrounders/diabetes-in-ontario. Published 2023. Accessed 23 February, 2023.
6. Ogurtsova K, Fernandes JDR, Huang Y, et al. IDF Diabetes Atlas: Global estimates for the prevalence of diabetes for 2015 and 2040. *Diabetes Research and Clinical Practice.* 2017;I28:40-50.
7. Report 4: Access to Health Services for Remote First Nations Communities. Ottawa, ON: Minister of Public Works and Government Services. Office of the Auditor General of Canada. https://www.oag-bvg.gc.ca/internet/English/parl_oag_201504_04_e_40350.html. Published 2015. Accessed 11 October, 2022.
8. Rural and Northern Health Care Framework/Plan: Stage 1 report. Ministry of Health and Longterm Care. https://www.health.gov.on.ca/en/public/programs/ruralnorthern/report.aspx. Published 2011. Accessed 11 October, 2022.
9. Luke DA, Calhoun A, Robichaux CB, Elliott MB, Moreland-Russell S. The Program Sustainability Assessment Tool: A New Instrument for Public Health Programs. *Preventing Chronic Disease.* 2014;11:E12.
10. Barker PM, Reid A, Schall MW. A framework for scaling up health interventions: lessons from large-scale improvement initiatives in Africa. *Implement Sci.* 2016;11:12.
11. Graham-Rowe E, Lorencatto F, Lawrenson JG, et al. Barriers to and enablers of diabetic retinopathy screening attendance: a systematic review of published and grey literature. *Diabet Med.* 2018;35(10):1308-1319.
12. Lawrenson JG, Graham-Rowe E, Lorencatto F, et al. What works to increase attendance for diabetic retinopathy screening? An evidence synthesis and economic analysis. *Health Technol Assess.* 2018;22(29):1-160.
13. Riordan F, Racine E, Phillip ET, et al. Development of an intervention to facilitate implementation and uptake of diabetic retinopathy screening. *Implement Sci.* 2020;15(1):34.
14. Egunsola O, Dowsett LE, Diaz R, Brent MH, Rac V, Clement FM. Diabetic Retinopathy Screening: A Systematic Review of Qualitative Literature. *Canadian Journal of Diabetes.* 2021;45(8):725-733.e712.

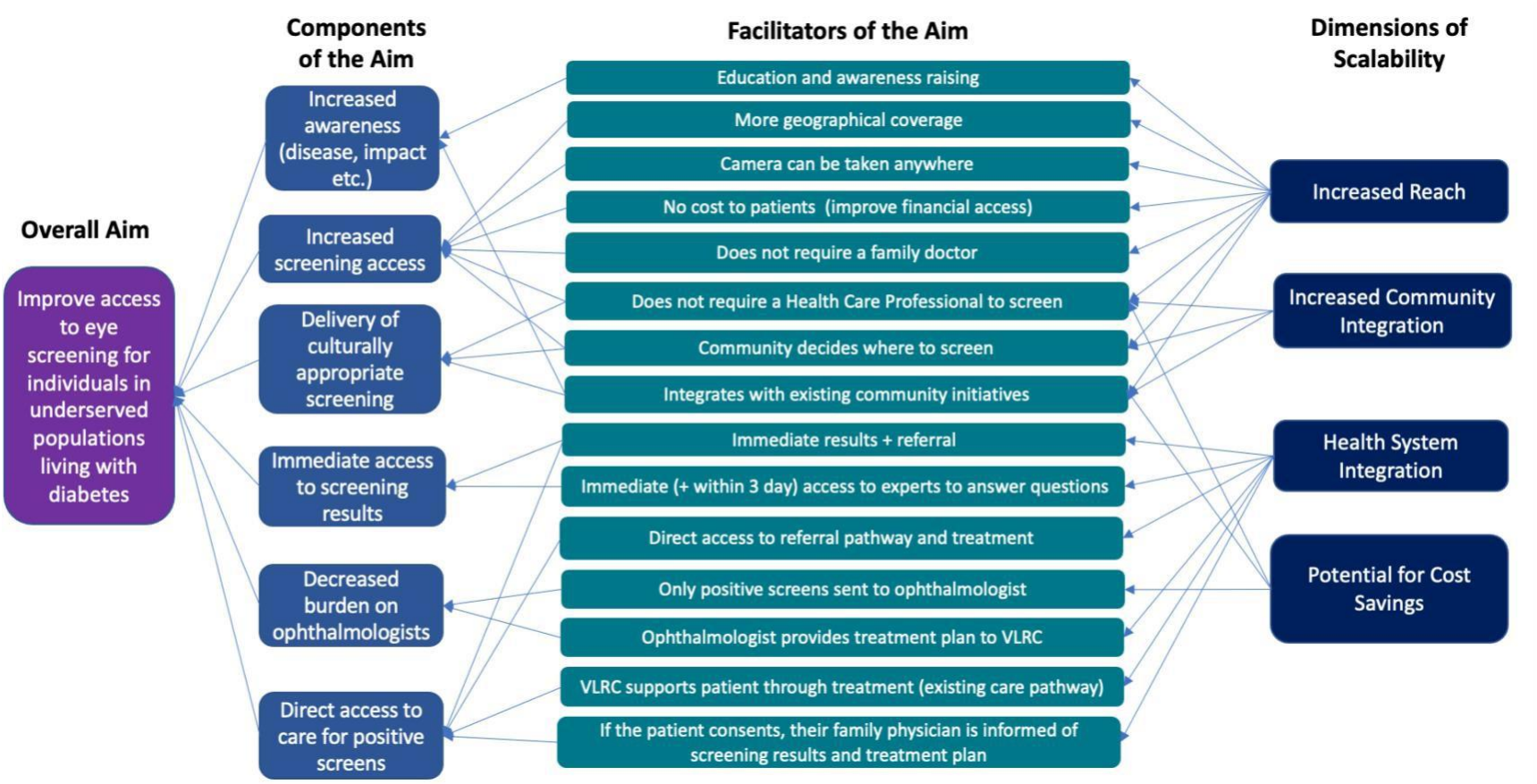
15. van Allen Z, Dogba MJ, Brent MH, et al. Barriers to and enablers of attendance at diabetic retinopathy screening experienced by immigrants to Canada from multiple cultural and linguistic minority groups. *Diabet Med.* 2021;38(4):e14429.
16. Prothero L, Lorencatto F, Cartwright M, et al. Perceived barriers and enablers to the provision of diabetic retinopathy screening for young adults: a cross-sectional survey of healthcare professionals working in the UK National Diabetic Eye Screening Programme. *BMJ Open Diabetes Res Care.* 2021;9(2).
17. Liu Y, Torres Diaz A, Benkert R. Scaling Up Teleophthalmology for Diabetic Eye Screening: Opportunities for Widespread Implementation in the USA. *Curr Diab Rep.* 2019;19(9):74.
18. Avidor D, Loewenstein A, Waisbourd M, Nutman A. Cost-effectiveness of diabetic retinopathy screening programs using telemedicine: a systematic review. *Cost Effectiveness and Resource Allocation.* 2020;18(1):16.
19. Kim J, Driver DD. Teleophthalmology for first nations clients at risk of diabetic retinopathy: a mixed methods evaluation. *JMIR medical informatics.* 2015;3(1):e10-e10.
20. Maberley D, Walker H, Koushik A, Cruess A. Screening for diabetic retinopathy in James Bay, Ontario: a cost-effectiveness analysis. *Cmaj.* 2003;168(2):160-164.
21. Nguyen M, Stamenova V, Onabajo N, et al. Perceptions of a Teleophthalmology Screening Program for Diabetic Retinopathy in Adults With Type 1 and Type 2 Diabetes in Urban Primary Care Settings. *Canadian journal of diabetes.* 2022;46(7):649-654.
22. Ramchandran RS, Yousefi-Nooraie R, Dadgostar P, Yilmaz S, Basant J, Dozier AM. Implementation of Teleophthalmology to Improve Diabetic Retinopathy Surveillance: Qualitative Interview Study of Clinical Staff Informed by Implementation Science Frameworks. *JMIR Diabetes.* 2022;7(1):e32162.
23. Oster RT, Virani S, Strong D, Shade S, Toth EL. Diabetes care and health status of First Nations individuals with type 2 diabetes in Alberta. *Can Fam Physician.* 2009;55(4):386-393.
24. Umaefulam V, Premkumar K. Diabetic retinopathy awareness and eye care behaviour of indigenous women in Saskatoon, Canada. *Int J Circumpolar Health.* 2021;80(1):1878749.
25. Felfeli T, Alon R, Merritt R, Brent MH. Toronto tele-retinal screening program for detection of diabetic retinopathy and macular edema. *Canadian journal of ophthalmology.* 2019;54(2):203-211.
26. Ballios BG, Park T, Chaudhary V, et al. Identifying gaps in patient access to diabetic screening eye examinations in Ontario: a provincially representative cross-sectional study. *Canadian journal of ophthalmology.* 2021;56(4):223-230.
27. Brent MH, Maberley D, Manca DP, Rac V, Sissmore D. Preventing Vision Loss from Diabetic Retinopathy: Guiding Primary Care Diabetic Retinopathy Screening in Canada Through the Use of Provincial Healthcare Administrative Data. In: Canadian Institutes of Health Research 2021.
28. OHIP coverage for eye services. Ministry of Health and Long-Term Care. https://www.health.gov.on.ca/en/public/publications/ohip/docs/eyecare_fs_en.pdf. Published 2015. Accessed 5 January, 2023.
29. Kiran T, Kopp A, Moineddin R, et al. Unintended consequences of delisting routine eye exams on retinopathy screening for people with diabetes in Ontario, Canada. *Cmaj.* 2013;185(3):E167-173.
30. Jin Y-P, Buys YM, Hatch W, Trope GE. De-insurance in Ontario has reduced use of eye care services by the socially disadvantaged. *Canadian Journal of Ophthalmology.* 2012;47(3):203-210.
31. Ontario Government and Ontario Association of Optometrists Reach Historic Agreement [press release]. Ontario Ministry of Health, March 24 2023.

32. Micieli JA. Geographic distribution of ophthalmologists in Ontario: a 10-year review. *Canadian Journal of Ophthalmology.* 2014;49(3):283-286.
33. Ontario Telemedicine Network. www.otn.ca. Accessed January 12, 2023.
34. Teleophthalmology: Telemedicine-enabled retinal screening. Ontario Telemedicine Network. https://otn.ca/wp-content/uploads/2019/05/Retinal-Screening-business-case-for-LHIN-CEOs-June-2017-002-1.pdf. Published 2017. Accessed 16 January, 2023.
35. Lank CN. Teleophthalmology in Action. Retina Labs Teleophthalmology Solutions. https://otn.ca/wp-content/uploads/2019/05/Teleophthalmology-in-Action_101618_HR-002.pdf. Published 2018. Accessed 13 January, 2023.
36. Cao J, Felfeli T, Merritt R, Brent MH. Sociodemographics Associated With Risk of Diabetic Retinopathy Detected by Tele-Ophthalmology: 5-Year Results of the Toronto Tele-Retinal Screening Program. *Canadian journal of diabetes.* 2022;46(1):26-31.
37. Diabetes Eye Screening Program - Teleophthalmology. Toronto Diabetes Care Connect. http://www.eyescreening.ca/. Published 2023. Accessed 9 February, 2023.
38. Diabetes Action Canada Annual Report 2019 - 2020. Diabetes Action Canada. https://diabetesaction.ca/wp-content/uploads/2021/02/SPOR_Networks_Annual_Report_2019-20_Diabetes-Action-Canada_FINAL_Red2.pdf. Published 2020. Accessed 17 January, 2023.
39. Scaling Up Diabetic Retinal Screening in Ontario: A Pan-Ontario Plan to Close the Screening Gap. Diabetes Action Canada, Ontario Telemedicine Network. https://otn.ca/wp-content/uploads/2019/05/Retinal-Screening-FULL-proposal-v3.pdf. Published 2017. Accessed 16 January, 2023.
40. Stanimirovic A, Francis T, Shahid N, et al. Tele-retina screening of diabetic retinopathy among at-risk populations: an economic analysis. *Canadian journal of ophthalmology.* 2020;55(1):8-13.
41. Stamenova V, Nguyen M, Onabajo N, et al. Mailed Letter Versus Phone Call to Increase Diabetic-Related Retinopathy Screening Engagement by Patients in a Team-Based Primary Care Practice: Prospective, Single-Masked, Randomized Trial. *J Med Internet Res.* 2023;25:e37867.
42. Expanding Diabetic Retinopathy Screening in Canada using Artificial Intelligence: A new collaboration supported by Diabetes Action Canada, the University of Montreal and The Montreal Polytechnique. https://repository.diabetesaction.ca/expanding-diabetic-retinopathy-screening-in-canada-using-artificial-intelligence-a-new-collaboration-supported-by-diabetes-action-canada-the-university-of-montreal-and-the-montreal-polytechnique/. Accessed 19 January, 2023.
43. Project OPEN: Improving access and diagnosis for diabetic retinopathy [press release]. Fighting Blindness Canada2021.
44. Scanlon PH. The contribution of the English NHS Diabetic Eye Screening Programme to reductions in diabetes-related blindness, comparisons within Europe, and future challenges. *Acta Diabetol.* 2021;58(4):521-530.
45. Liew G, Michaelides M, Bunce C. A comparison of the causes of blindness certifications in England and Wales in working age adults (16-64 years), 1999-2000 with 2009-2010. *BMJ Open.* 2014;4(2):e004015.
46. NHS Screening Programmes in England: 1 April 2017 to 31 March 2018. In: Public Health England; 2019.
47. Scanlon PH. The English National Screening Programme for diabetic retinopathy 2003-2016. *Acta Diabetol.* 2017;54(6):515-525.
48. About our Organization. Indigenous Diabetes Health Circle. https://idhc.life/about-our-organization/. Accessed 9 February, 2023.

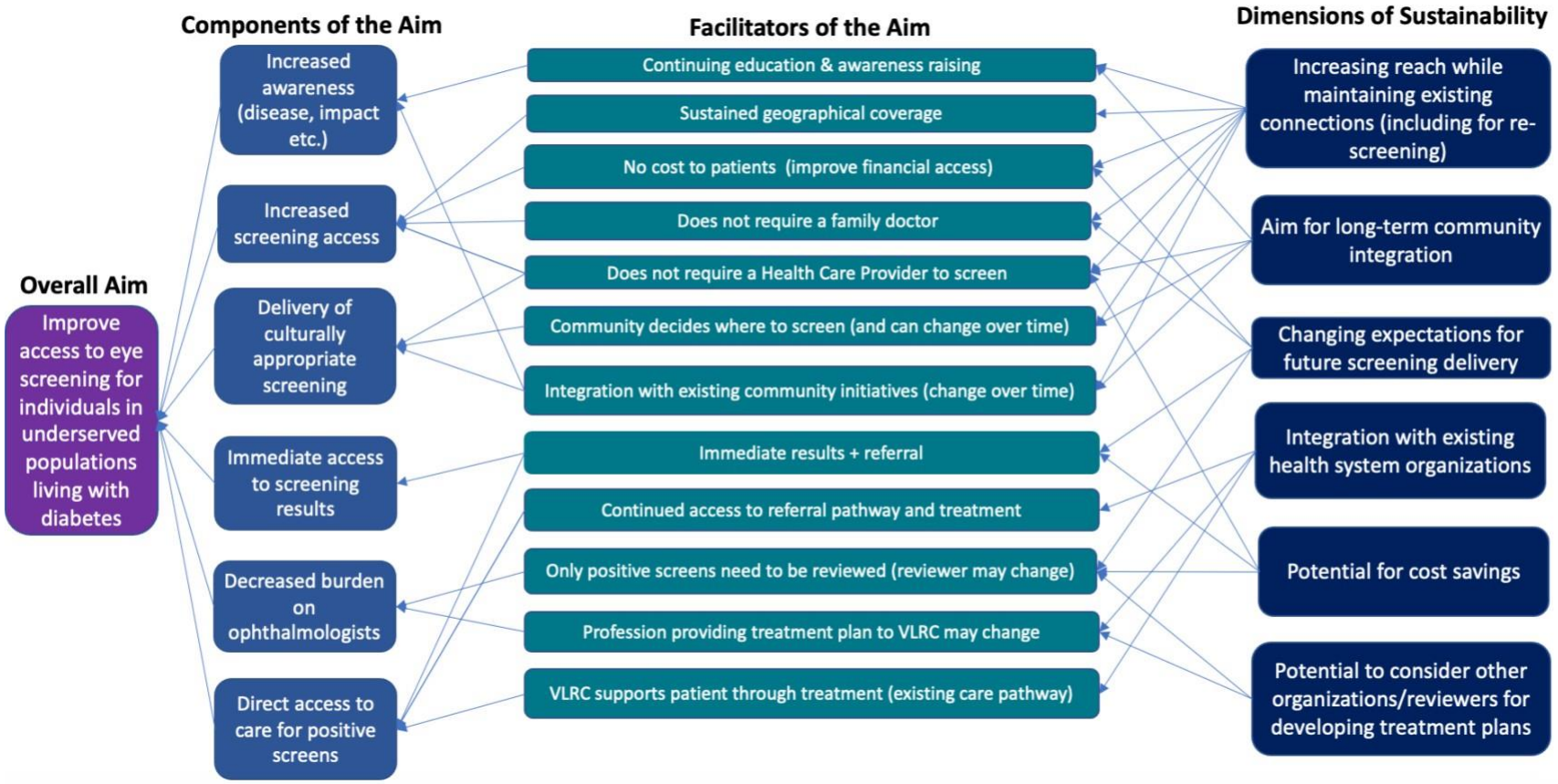
49. Indigenous Diabetes Health Circle: 2021-2022 Annual Report Indigenous Diabetes Health Circle. https://idhc.life/wp-content/uploads/2022/08/Annual-Report-2021-2022-for-IDHC.pdf. Published 2022. Accessed 9 February, 2023.
50. Santos WJ, Graham ID, Lalonde M, Demery Varin M, Squires JE. The effectiveness of champions in implementing innovations in health care: a systematic review. *Implementation Science Communications.* 2022;3(1):80.
51. Sayal AP, Ahmed Y, Popovic MM, et al. Supply and demographic characteristics of Ontario's ophthalmologists from 2010 to 2019: a population-based analysis. *CMAJ Open.* 2022;10(4):E1067.
52. Membership Information. Eye Physicians and Surgeons of Ontario. https://www.epso.ca/about-epso/membership-information/. Published 2023. Accessed 24 February, 2023.
53. Annual Report 2021. College of Optometrists of Ontario. https://collegeoptom.on.ca/wp-content/uploads/Annual-Report-2021.pdf. Published 2021. Accessed 13 January, 2023.
54. Ontario Optometrists Rally To Demand Government Take Action On Ontario's Eye Care Crisis [press release]. Ontario Association of Optometrists2021.
55. Eyenuk Secures the First European Union MDR Certification for Autonomous AI Detection of Diabetic Retinopathy, Age-Related Macular Degeneration, and Glaucoma [press release]. Eyenuk2023.
56. HEIA: Health Equity Impact Assessment. Ontario Ministry of Health and Long Term Care. https://www.health.gov.on.ca/en/pro/programs/heia/. Published 2021. Accessed 24 February, 2023.
57. Kanjee R, Dookeran RI, Mathen MK, Stockl FA, Leicht R. Six-year prevalence and incidence of diabetic retinopathy and cost-effectiveness of tele-ophthalmology in Manitoba. *Can J Ophthalmol.* 2017;52 Suppl 1:S15-s18.
58. Vision Loss Rehabilitation Canada: Eye Van. Vision Loss Rehabilitation Canada. https://visionlossrehab.ca/en/resources/eye-van. Published 2023. Accessed 24 February, 2023.
59. Diabetic Retinopathy: Causes, Symptoms and Treatment. Orbis. https://can.orbis.org/en/avoidable-blindness/diabetes-blindness. Accessed 30 March, 2023.

APPENDICES

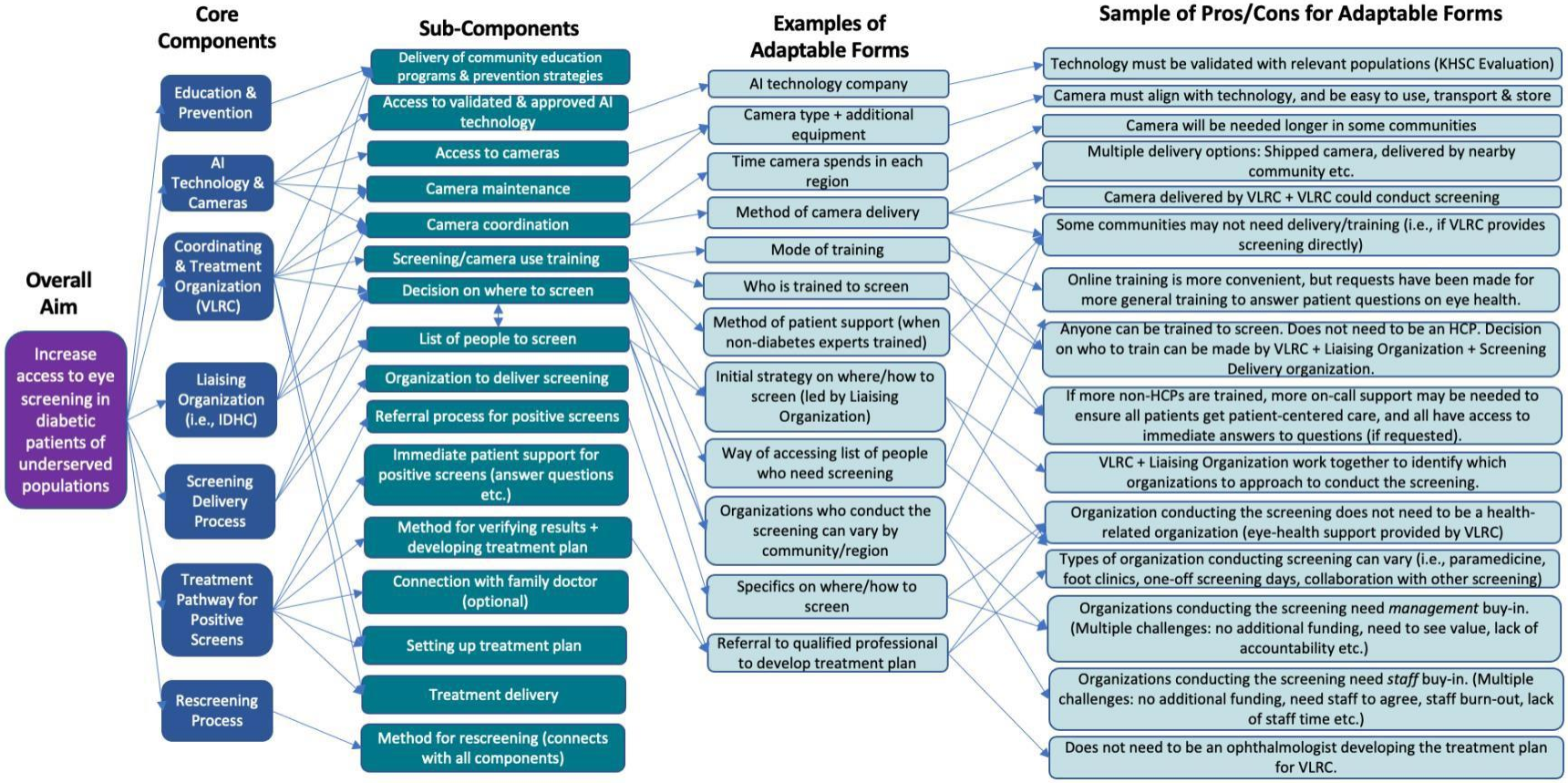
Appendix A: *Detailed version of contributing factors to consider when planning for scalability.*



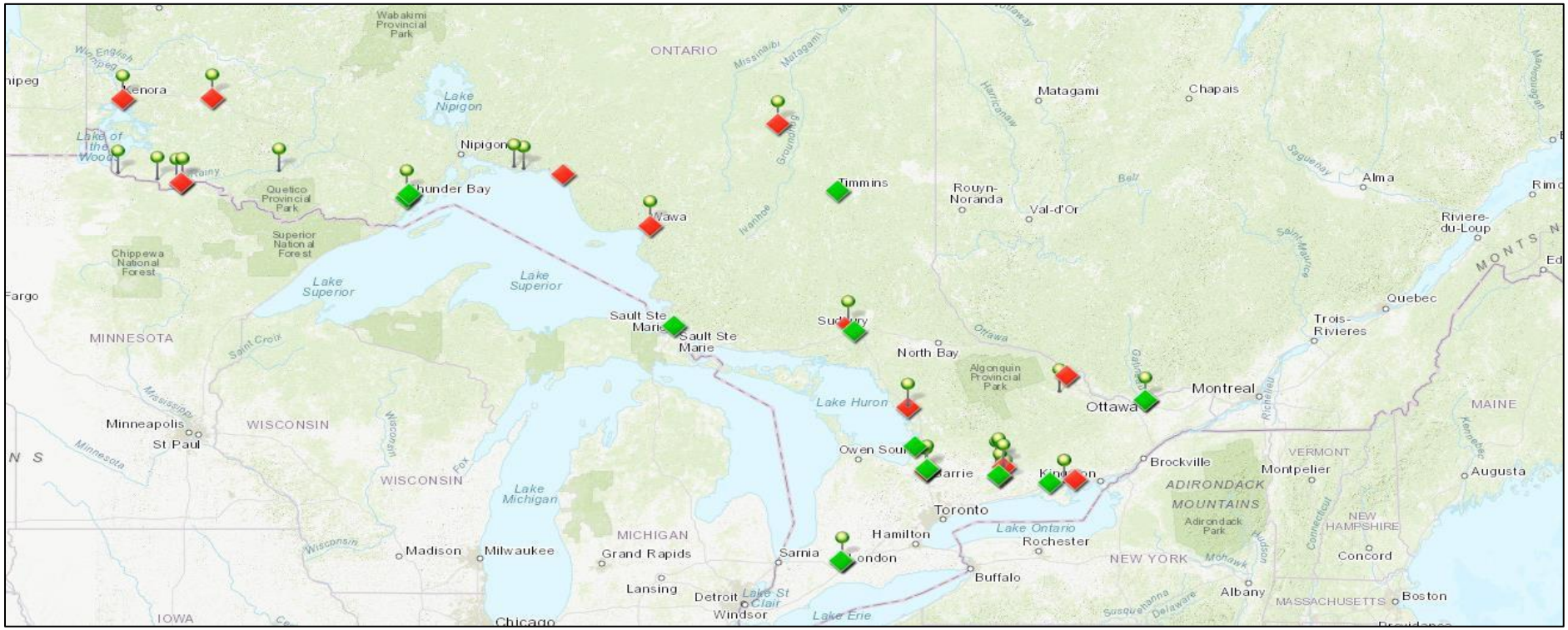
Appendix B: *Detailed version of contributing factors to consider when planning for sustainability.*



Appendix C: *Detailed examination of core components, sub-components, examples of adaptable forms, and a sample of pros and cons within the sample adaptable forms.*



Appendix D: *Map of travel distances required to visit an optometrist or ophthalmologist.*



Communities

Optometrist

Ophthalmologist