The Conference Board of Canada

Ophthalmology in Canada

Why Vision Loss Should Not Be Overlooked

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Contents

Key findings

- In Canada, ophthalmologists performed close to 1.1 million interventions in 2018. And demand is estimated to grow to 1.7 million interventions per year by 2040.

- In 2020, ophthalmic interventions will save a total of $6.4 billion: $1.6 billion in health care costs and $4.8 billion in indirect costs to society. Total savings will more than double by 2040.

- The economic benefits of preserving vision far outweigh the costs of ophthalmic interventions. However, this benefit may not be realized if solutions are not put in place to meet the growing demand.

- There are steps that Canada can take to safeguard the future of eye care: improve workforce planning, support new innovations, and increase collaboration between stakeholders.

Introduction

Maintaining good vision is a vital part of overall health and quality of life. Primary eye care is delivered by a variety of professionals, including ophthalmologists, optometrists, and family physicians. Ophthalmologists are medical doctors who specialize in the diagnosis and treatment of eye disease.[1,2,3] They are the only health care providers who are trained both medically and surgically to treat serious eye disorders.[4]

In 2018, there were 1,249 practising ophthalmologists in Canada, or 3.4 per 100,000 people.[5] Compared with other surgical specialties, ophthalmology is the fourth-largest field of medical specialization.[6] The majority (74 per cent) of ophthalmology services are provided in a private office or clinic settings.[7]

Vision loss in Canada

Vision loss—sometimes referred to as visual impairment or low vision—is defined as reduced vision not correctable by glasses or contact lenses. It is most often assessed using visual acuity, including best corrected visual acuity (BCVA) and Snellen visual acuity. (See “What is vision loss?”)

1 Canadian Medical Association, *Ophthalmology Profile*.
2 Canadian Ophthalmological Society, “What Is Ophthalmology?”
3 There are many subspecialties in ophthalmology, including cornea and external disease, glaucoma, neuro-ophthalmology, ophthalmic pathology, ophthalmic plastic surgery, pediatric ophthalmology, and low vision.
4 Canadian Ophthalmological Society, “What Is Ophthalmology?”
5 Canadian Medical Association, *Ophthalmology Profile*.
6 Campbell and El-Defrawy, “Shaping the Future of Ophthalmology in Canada.”
7 Canadian Medical Association, *Ophthalmology Profile*.

What is vision loss?

Visual acuity is the sharpness of vision, or the ability to distinguish two points in space from a distance. Other important measures of vision include visual field, depth perception, and contrast sensitivity. Depth perception and contrast sensitivity are reported less frequently or consistently in the literature across eye conditions and interventions.

Visual field, however, is an important measure of central and peripheral vision. It is often used to determine the impact and severity of glaucoma on vision. It is also used by governments as part of the definition of legal blindness and eligibility for disability benefits.

The World Health Organization (WHO) defines moderate visual impairment as a presenting visual acuity worse than 6/18 (20/60) to 6/60 (20/200),[8,9] and was applied as a criterion in our analysis whenever possible. It defines blindness as a presenting visual acuity worse than 3/60 (20/400) in the better-seeing eye, or a visual field constricted to less than 10 degrees with both eyes.[10,11]

Source: World Health Organization.

The prevalence of vision loss in Canadian adults is estimated at 5.7 per cent.[12] It varies among provinces, ranging from 2.4 per cent in Manitoba to 10.9 per cent in Newfoundland and Labrador.[13]

Five eye conditions are responsible for the majority of vision loss in Canada:[14]

- age-related macular degeneration (AMD)
- cataract
- diabetic retinopathy (DR)
- glaucoma
- refractive error

If left untreated, AMD, cataract, DR, and glaucoma can lead to severe vision loss or blindness. Vision loss from cataract is reversible; however, vision loss from AMD, DR, and glaucoma is usually non-reversible.

The prevalence of many eye disorders increases with age. Approximately 90 per cent of ophthalmic procedures are performed on Canadians aged 65 and over.[15] The number of cases of vision loss doubles every decade after 40 and triples after age 75.[16] Vision loss in Canada is expected to increase by 30 per cent in the next decade,[17] and the ability to meet this growing demand is of concern.

8 The cut-offs outside brackets are in the metric scale while those inside brackets are in the imperial scale.

9 For context, this is close to the 6/15 (20/50) cut-off used by ministries of transportation as a requirement to obtain a driver's licence (among other visual criteria).

10 World Health Organization, "Blindness and Vision Impairment."

11 World Health Organization, "Universal Eye Health."

12 Aljied and others, "Prevalence and Determinants of Visual Impairment in Canada."

13 Ibid.

14 Access Economics Pty Limited, *The Cost of Vision Loss in Canada: Summary Report.*

15 Hatch and others," Projecting the Growth of Cataract Surgery During the Next 25 Years."

16 National Coalition for Vision Health, The, *Vision Loss in Canada.*

17 Lisa Little Consulting, *Meeting the Eye Health and Vision Care Needs of Canadians.*

The burden of vision loss

Vision loss can greatly impact a person's quality of life. Compared with people of the same age with good vision, those with vision loss are also more likely to experience a fall, suffer from a hip fracture, depression or anxiety, or be admitted to a long-term care facility.[18]

Although older people are at greater risk of many eye disorders, some conditions affect other population groups, such as children or diabetics. For example, strabismus (a condition commonly known as crossed eyes) mostly starts in childhood and can lead to visual impairment and blindness if not corrected at a young age.[19] Eye muscle surgery can improve this condition, and lead to better physical and psychological outcomes for those affected.[20] Among Indigenous and remote communities across Canada, challenges accessing care and a high prevalence of diabetes could result in increased vision loss.[21]

Overall, the economic impact of vision loss is immense. In 2007, the cost of vision loss in Canada was estimated at $15.8 billion and is projected to grow to $30.3 billion by 2032.[22] In 2010, eye conditions made up 5.8 per cent of the direct health care costs in Canada.[23] This was higher than several other disease categories—such as cancers—and almost equivalent to respiratory system disorders.[24]

Research objective

As part of its research series on The Value of Health Services in Canada, The Conference Board of Canada examined the value of ophthalmology from an outcome, efficiency, and societal/economic perspective. This research focused on six important interventions that are high-volume, high-impact, and/or target a specific population (e.g., children, diabetics):

- cataract surgery
- glaucoma surgery
- anti-vascular endothelial growth factor therapy (VEGF) injections for AMD and DR
- corneal transplantations
- eye muscle surgery for strabismus
- vitrectomy surgery for DR

The value of ophthalmology in Canada

The demand for ophthalmology is rising

In 2018, around 1.1 million ophthalmic interventions were performed in Canada (when taking into account the six major eye procedures). Laser surgery was excluded from the current research due to lack of data. (See "Laser surgery for glaucoma and DR.")

18 National Coalition for Vision Health, The, *Vision Loss in Canada*.
19 Ibid.
20 Ziaei and others, "The Impact of Congenital Strabismus Surgery on Quality of Life in Children."
21 Access Economics Pty Limited, *The Cost of Vision Loss in Canada: Summary Report*.
22 National Coalition for Vision Health, The, *Vision Loss in Canada*.
23 Public Health Agency of Canada, "Economic Burden of Illness in Canada, 2010."
24 Ibid.

Laser surgery for glaucoma and DR

National data on the volume of laser surgeries and the number of patients undergoing this procedure for the treatment of glaucoma and DR are currently unavailable. Provincial and territorial billing data on laser procedures may be available for use by authorized researchers, clinicians, and organizations.[25]

Still, a few studies have reported on ophthalmic laser surgery in Canada. One study found that the rates of laser surgery for glaucoma more than doubled between 2001 and 2004, going from around 80 procedures to 140 procedures per 1,000 glaucoma patients.[26] In a report published by the Institute of Health Economics, laser treatment for Albertans with diabetes increased between 1996 and 2001, and then decreased between 2001 and 2009.[27]

Although more recent data may not be available, anecdotal evidence suggests that laser surgery remains—and will continue to remain—an important treatment option for both glaucoma and DR patients.

This means that our research underestimates the current and future value of ophthalmology. By including cases of improved vision from laser surgery, the estimated health and economic value of ophthalmology would be even greater.

Sources: Campbell and others; Rudnisky and others.

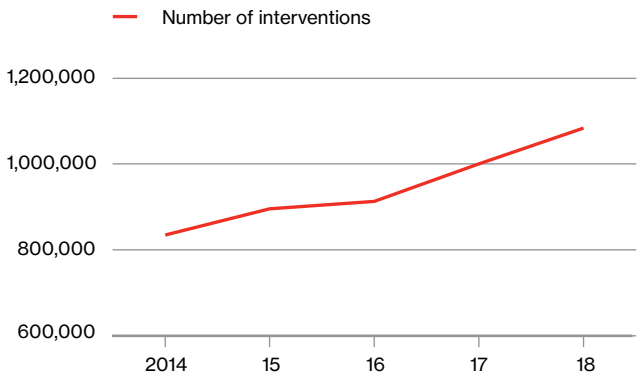
25 These data were not accessible to The Conference Board at the time of the research.

26 Campbell and others, "Glaucoma Laser and Surgical Procedure Rates in Canada."

27 Rudnisky and others, "Chapter 9: Diabetes and Eye Disease in Alberta."

Between 2014 and 2018, the volume of ophthalmic interventions grew by 30 per cent, increasing at an annual rate of 7.5 per cent. (See Chart 1.) Aging of the population and innovation in treatment options and effectiveness, along with recent improvements in wait times for cataract surgeries, are likely driving this steep increase.

Chart 1
Number of opthalmic interventions increasing



Sources: Canadian Institute for Health Information; IQVIA; The Conference Board of Canada.

Although over 631,000 anti-VEGF injections were given in 2018, cataract surgery was the most common operation. (See Table 1.) In fact, cataract surgery is the most frequent surgical procedure in Canada.[28,29] Surgery for diabetic retinopathy and corneal transplantations combined accounted for less than 2 per cent of the six interventions.

28 Micieli and Arshinoff, "Cataract Surgery."

29 Feinberg and others, "Regional Variation in the Use of Surgery in Ontario."

Table 1
Ophtalmologists performed over 1 million opthalmic interventions in 2018

	Number of interventions
Anti-VEGF injections for AMD*	631,129
Cataract surgery	415,923
Glaucoma surgery	18,438
Eye muscle surgery for strabismus	10,429
Vitrectomy surgery for diabetic retinopathy	4,056
Corneal transplantations	3,413
Total	**1,083,388**

AMD: age-related macular degeneration; DR: diabetic retinopathy.
*Includes injections with Lucentis, Eylea, and Avastin. Represents a rough estimation due to lack of comprehensive, national data on the use of anti-VEGF in Canada.
Note: Laser procedures are not included in the analysis due to lack of national data.
Sources: Canadian Institute for Health Information; IQVIA; The Conference Board of Canada.

The number of ophthalmic interventions reflects the number of individual procedures, not the number of persons receiving the intervention. Some patients, for example, require surgery on both eyes, while others need surgery on one eye only. Some people need to have a procedure repeated. The number of patients who undergo ophthalmic interventions each year is therefore lower than the volume of procedures. (See “Medical care and management.”)

Medical care and management

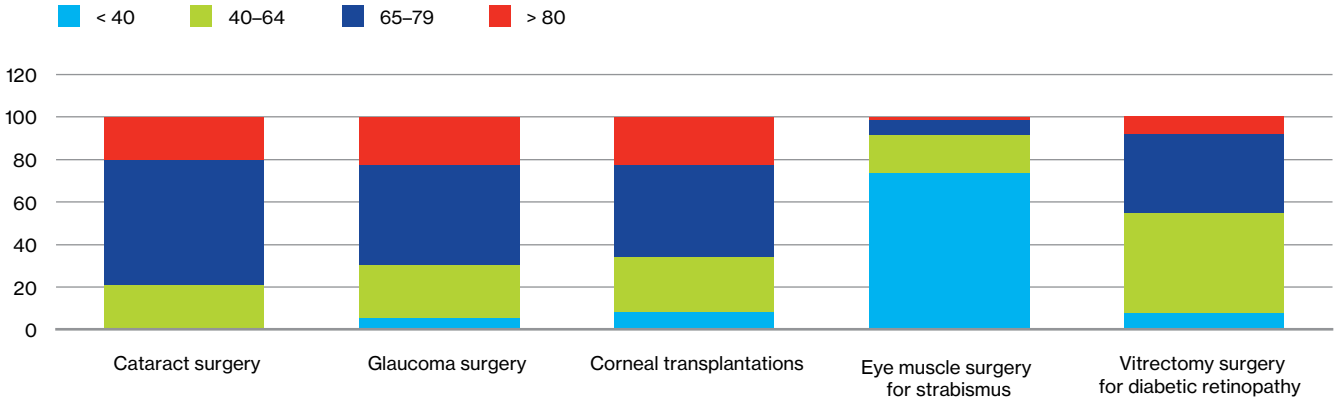
In addition to performing surgeries, ophthalmologists provide medical care and disease management to their patients. This includes many tasks related to diagnosing, treating, and preventing medical eye conditions. For example, ophthalmologists conduct comprehensive eye exams and screening for disease risk factors. They also prescribe and administer medications and consult with patients before and after their surgery. The medical care component of the profession is therefore an important complement to the surgical role of ophthalmologists.

Source: The Conference Board of Canada.

Chart 2

Proportion of individuals with at least one ophthalmic intervention, by age and type of intervention, 2018

(per cent)



Note: Data on the age distribution of individuals undergoing anti-VEGF treatment were not available.
Sources: Canadian Institute for Health Information; IQVIA; The Conference Board of Canada.

Table 2

Many people had at least one ophthalmic intervention in 2018

	Number of people
Cataract surgery	208,755
Anti-VEGF injections for AMD*	63,113
Glaucoma surgery	11,675
Eye muscle surgery for strabismus	6,464
Vitrectomy surgery for diabetic retinopathy	3,089
Corneal transplantations	2,370
Total**	286,602

AMD: age-related macular degeneration; DR: diabetic retinopathy.
*Calculated based on an annual average of 10 injections/patient. Includes injections with Lucentis, Eylea, and Avastin. Represents a rough estimation due to lack of comprehensive, national data on the use of anti-VEGF in Canada.
**A 3% overlap of patients across procedures is removed from the total.
Note: Laser procedures are not included in the analysis due to lack of national data.
Sources: Canadian Institute for Health Information; IQVIA; The Conference Board of Canada.

In 2018, almost 1 per cent of the Canadian population had at least one ophthalmic intervention. (See Table 2.) Cataract surgery changed the lives of over 200,000 people. In addition, surgeries such as corneal transplantations and eye muscle surgery for strabismus improved the quality of life and vision of thousands of people.

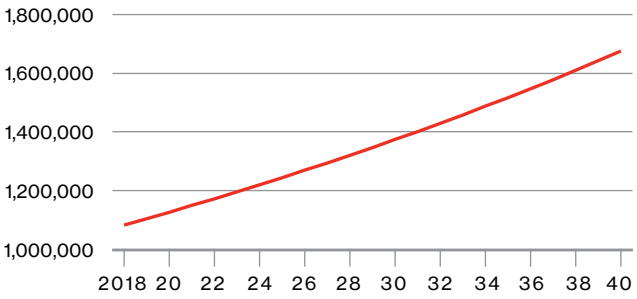
The majority of ophthalmic procedures are performed on those who are 65 years or older, although this varies by type of intervention. (See Chart 2.) For example, eye muscle surgery for strabismus is most often performed on children under 10 years of age.

Population growth and aging, as well as innovation and changes in clinical practice, are expected to increase demand for ophthalmology over the next 20 years. (See Chart 3.) Demand will increase for all six of the interventions in this analysis. (See tables 3 and 4.)

Chart 3

Demand for opthalmic interventions projected to increase

(number of interventions)



Sources: Canadian Institute for Health Information; IQVIA; The Conference Board of Canada.

Table 3

The demand for all opthalmic interventions is projected to increase over the next 20 years

Year	Cataract surgery	Anti-VEGF injections	Glaucoma surgery	Eye muscle surgery for strabismus	Vitrectomy surgery for diabetic retinopathy	Corneal transplantations	Total
2020	432,726	656,627	19,183	10,850	4,220	3,551	**1,127,157**
2030	527,491	800,424	23,384	13,226	5,144	4,329	**1,373,998**
2040	643,009	975,713	28,505	16,123	6,270	5,276	**1,674,896**

AMD: age-related macular degeneration; DR: diabetic retinopathy.
Sources: Canadian Institute for Health Information; IQVIA; The Conference Board of Canada.

Table 4

The number of people with at least one ophthalmic intervention is projected to double

Year	Cataract surgery	Anti-VEGF injections	Glaucoma surgery	Eye muscle surgery for strabismus	Vitrectomy surgery for diabetic retinopathy	Corneal transplantations	Total
2020	217,189	65,663	12,147	6,725	3,214	2,466	**298,181**
2030	264,752	80,042	14,807	8,198	3,918	3,006	**363,481**
2040	322,731	97,571	18,049	9,993	4,776	3,664	**443,081**

*A 3% overlap of patients across procedures is removed from the total.
AMD: age-related macular degeneration; DR: diabetic retinopathy.
Sources: Canadian Institute for Health Information; IQVIA; The Conference Board of Canada.

Value to patients, health care systems, and society

Ophthalmic interventions do not successfully restore vision, or prevent vision loss, for all patients. Their effectiveness ranges from around 65 per cent for vitrectomy surgery to 95 per cent for cataract surgery. (See Appendix A.) When considering how effective each intervention is and how frequently each is conducted, we find that around 263,400 people will have their vision improved in 2020. This number is expected to grow to 391,400 people in 2040.[30]

Restoring vision is life changing. (See "The true value of eye care.") It can also prevent injuries or other health care needs associated with vision loss. People with vision loss are more likely to suffer from negative health outcomes such as falls, hip fractures, depression, anxiety, admission into long-term care, and use of home care or caregiver services. These outcomes are associated with significant hospital, physician, and drug costs. Therefore, treating vision loss leads to direct cost savings to health care systems. It also leads to cost savings for people's drug expenses and public/private prescription drug plans.

30 The time perspective for this section and corresponding analysis is 2020 to 2040.

The true value of eye care

Treated vision loss comes with a dramatic improvement in quality of life. The "See The Possibilities" website showcases how ophthalmology can have a life-changing impact on patients and their families.

Anida's story with diabetic retinopathy

> "I've had a total of six eye surgeries in about two years, and I'd say after the first one I noticed an improvement. Every surgery meant more independence.... Driving for the first time again, what a feeling that was, and someone didn't have to guide me."

Geoffroy's story with glaucoma

> "About five years ago we discovered that my mom had glaucoma ... and that was the first time we realized that glaucoma might be in our family. I took it very seriously and that's when I decided to go see an ophthalmologist. He told me that the thickness of my retina and optical nerve was a little bit different than others. It's been two years that I had the surgery ... I can still do my favorite sports like kitesurfing, snowboarding, and fishing."

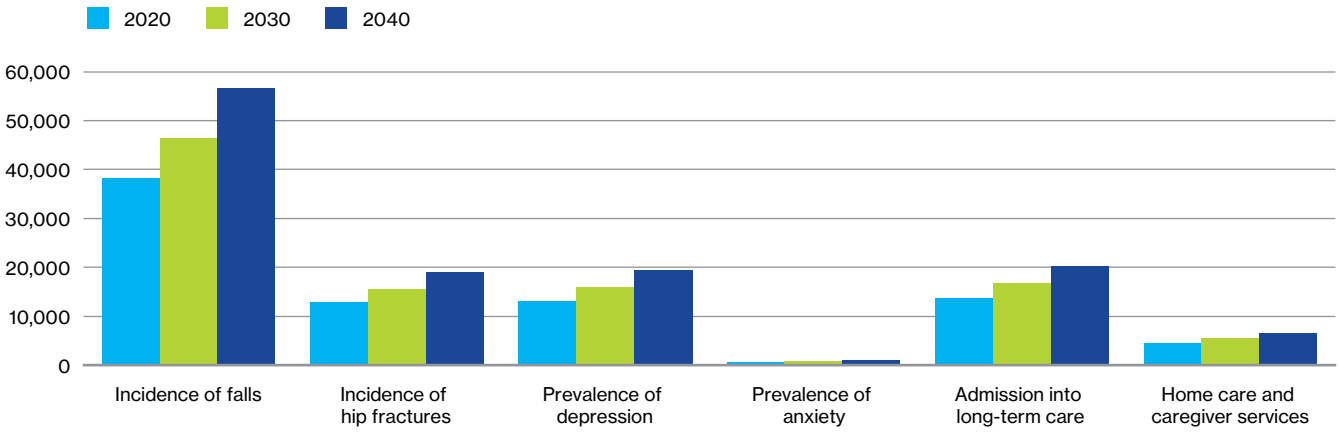
Sources: Canadian Ophthalmological Society; The Conference Board of Canada.

In 2020, an estimated 82,500 medical outcomes will be avoided thanks to corrected vision. By 2040, this will reach 122,600 outcomes per year if the projected demand for interventions is met. Falls represent half of these prevented outcomes, and the other half are from averted admissions into long-term care, hip fractures, and depression cases. (See Chart 4.)

From 2020 to 2040, direct savings from ophthalmic interventions will more than double. (See Table 5.) Most of these savings will come from people not needing long-term care due to vision loss and avoided falls.

Chart 4

Number of medical outcomes averted from treated vision loss
(per cent)



Source: The Conference Board of Canada.

Table 5

Direct medical cost savings from averted medical outcomes
(million $)

Year	Falls	Hip fractures*	Depression	Anxiety	Admission into long-term care	Home care and caregiver services	Total
2020	$246	$238	$32	$1	$1,084	$17	**$1,619**
2030	$384	$372	$49	$2	$1,692	$27	**$2,527**
2040	$600	$582	$77	$4	$2,645	$42	**$3,950**

*The cost per case of falls was removed from the cost per case of hip fractures for the calculation of this outcome to remove overlap.
Source: The Conference Board of Canada.

Table 6
Treating vision loss leads to cost savings
(million $)

Year	Direct cost savings	Indirect cost savings	Total cost savings
2020	$1,619	$4,812	$6,431
2030	$2,527	$7,512	$10,040
2040	$3,950	$11,741	$15,691

Source: The Conference Board of Canada.

Averting vision loss also leads to important indirect cost savings to society.[31] (See Table 6.) These savings stem from a reduced need for vision aids and devices, and informal care. Having normal or near-normal vision is also associated with a higher employment rate, as well as lower absenteeism and presenteeism in the workplace. (See "The impact of having to stop driving.") This increases economic productivity and contributes to higher gross domestic product. In 2020, ophthalmic interventions will therefore save a total of $6.4 billion: $1.6 billion in health care costs and $4.8 billion in indirect costs to society. Total savings will more than double by 2040.

What is the return on investment?

There is a cost associated with delivering ophthalmic interventions. In 2020, the direct costs—including hospital, physician, and pharmaceutical costs—of delivering ophthalmic interventions is estimated at $1.6 billion. (See Table 7.)

To understand the economic impact of interventions in ophthalmology, we determine the potential return on investment (ROI).[32] Taken together, ophthalmic interventions are associated with a positive return of around 300 per cent. (See Table 8.) This means that if the supply of services can keep up with the growing demand, we can expect significant (threefold) net cost savings to society and the economy.

Table 7
Cost of delivering ophthalmic interventions
(million $)

Year	Cataract surgery	Anti-VEGF injections	Glaucoma surgery	Eye muscle surgery for strabismus	Vitrectomy surgery for diabetic retinopathy	Corneal transplantations	Total
2020	$953	$553	$64	$46	$22	$20	**$1,638**
2030	$1,488	$863	$100	$71	$34	$31	**$2,557**
2040	$2,323	$1,348	$157	$111	$53	$48	**$3,993**

AMD: age-related macular degeneration; DR: diabetic retinopathy.
Source: Canadian Institute for Health Information, IQVIA, The Conference Board of Canada.

31 Gordon and others, "The Cost of Vision Loss in Canada."

32 The ROI is conservative given the exclusion of laser surgery—which is a common and relatively low-cost procedure—from the current research.

Table 8

Opthalmic interventions show a positive return now and into the future

(million $)

Year	Total costs of ophthalmic interventions	Total cost savings from our model	Return on investment (based on total cost savings)*
2020	$1,638	$6,431	$4,793
2030	$2,557	$10,040	$7,482
2040	$3,993	$15,691	$11,699

* Calculated by subtracting the total costs of ophthalmic interventions (the investment) with the total cost savings estimated in our model (the return).

The impact of having to stop driving

Across Canada, an individual must have at minimum a BVCA of 6/15 (20/50) in the better-seeing eye to be eligible for a driver's licence. In Canada, an estimated 5.7 per cent of adults have a visual acuity less than 20/40 (even when wearing prescribed glasses or contact lenses).[33] This means that up to 1.7 million Canadians are at risk of not being eligible for a driver's licence in 2020. Visual field loss, for example from glaucoma, is another reason a person could lose his or her driver's licence.

The need to stop driving is associated with direct negative medical outcomes such as depression. It is also associated with indirect outcomes, such as low social participation and loss of independence. This can greatly impact a person's quality of life. A 2016 study revealed that compared with older adults who were able to drive, those who ceased to drive had almost double the risk of depressive symptoms, were nearly five times more likely to enter into long-term care, and had a 68 per cent higher mortality risk.[34]

Declines in physical, mental, and social health have all been associated with having to stop driving.[35] Driving cessation also decreases an individual's participation in the community and the economy. A study in the U.S. documented how driving status reduces older adults' ability to participate in the community and the economy. Compared with elderly drivers, those who do not drive made 15 per cent less trips to the doctor; 59 per cent less shopping trips and restaurant visits; and 65 per cent less leisure trips (e.g., for social, family or religious purposes).[36]

Sources: Aljied and others; Chihuri and others; Bailey.

33 Aljied and others, "Prevalence and Determinants of Visual Impairment in Canada. "
34 Chihuri and others, "Driving Cessation and Health Outcomes in Older Adults."
35 Ibid.
36 Bailey, *Aging Americans*.

Advancing ophthalmology in Canada: challenges and opportunities

Ophthalmology is a constantly evolving field. Each year, new and more effective medications and surgical technologies are developed and brought to market. These innovations bring an ever-increasing potential to improve vision, and can drive demand for services over time.

Several issues are limiting the field of ophthalmology from delivering its full value to Canadian society. Key issues include having enough doctors to meet demand, accessing operating rooms, integrating new innovations into practice, and needing effective collaborative care networks. There is also significant overlap and interdependence between these key issues that ought to be considered.

Workforce planning and development

Removing barriers to meet demand

We need good planning to make sure there are enough health care professionals available to deliver services. Our research shows that the demand for ophthalmology services will continue to grow over the next 20 years due to population aging and innovation. Based on health human resource projections, there is evidence that the current and future supply of ophthalmologists is not following the rise in demand.[37,38]

The number of ophthalmologists has already decreased from approximately 3.7 per 100,000 people in 1995 to 3.4 per 100,000 people in 2018.[39] The supply of ophthalmologists also varies considerably across Canadian provinces and territories. While the national average was estimated at 3.4 ophthalmologists per 100,000 people in 2018, this number ranged from 5.40 in Nova Scotia to 0.89 in the territories.[40] And although the national supply of ophthalmologists is projected to remain stable over the next 10 years, this would not be enough to meet the expected growth in demand from population aging and other factors.[41]

Different factors can explain the growing gap between supply and demand. For example, the number of residency positions being filled in ophthalmology seems to be less than the expected number required to meet the demand in services. In 2017, there were around 36 Canadian residency positions in ophthalmology.[42] Meanwhile, a Canadian study found that 45 residency positions would be required every year to meet the demand for ophthalmologists.[43] The supply of new ophthalmologists is currently limited by the number of residency positions in ophthalmology determined by each province and territory.

37 Bellan and Buske, "Ophthalmology Human Resource Projections."
38 Bellan, "Future Trends in Ophthalmology Health Human Resources in Canada."
39 Canadian Medical Association, *Ophthalmology Profile*.
40 Bellan and others, "The Landscape of Ophthalmologists in Canada."
41 Bellan, "Future Trends in Ophthalmology Health Human Resources in Canada."
42 Kherani and Hurley, *Trends in Canadian Ophthalmology Residency Applications*.
43 Bellan and Buske, "Ophthalmology Human Resource Projections."

Aligning the number of graduating ophthalmologists with the number of surgical opportunities is also important to retain these highly skilled graduates within Canada.[44] Provincial health human resource planning needs to consistently ensure this alignment. This includes examining forecasted populations' needs and aligning the number of operating room positions and the distribution of ophthalmologists within these needs. Health human resource metrics must be accurate to ensure proper health care funding and policy decisions.

The type of ophthalmologists must also match the gaps in subspecialist care. Balancing service provision by ophthalmologists would ensure that all eye diseases can be adequately treated. Clinical, educational, and increased employment prospects appear to be factors influencing a trend toward subspecialization.[45]

There are gaps in pediatric eye care due to shortages in the number of ophthalmologists specializing in this area. These stem, in part, from limited remuneration compared with the high cost of the practice and from strabismus surgery becoming a subspecialized field.[46] Workforce planning and funding should account for the distribution of ophthalmologists between subspecialties. For example, a study found that there may not be enough clinicians specializing in rare or genetic eye diseases.[47] Undertaking a comprehensive analysis of the mix and volume of services—compared with public health

needs—would help to ensure that different patient groups are being served adequately across the country.[48] National funding organizations and provincial governments could then prioritize subspecialties that are found to have a shortage.

Delivering effective care is also limited by resource constraints. As a largely surgical specialty, ophthalmologists require operating room time to perform surgeries and train new specialists.[49] Although this issue is not unique to ophthalmology, recent graduates in this field are finding it increasingly difficult to secure a position with operating room privileges.[50] This could hurt wait times, access to care, and ultimately patient outcomes.

44 Bellan, "Future Trends in Ophthalmology Health Human Resources in Canada."
45 Ibid.
46 Campbell and others, "Strabismus Surgical Subspecialization."
47 Al Ali, Hallingham, and Buys, "Workforce Supply of Eye Care Providers in Canada."
48 Campbell and El-Defrawy, "Shaping the Future of Ophthalmology in Canada."
49 Ibid.
50 Manusow, Buys, and Bellan, "The Underemployed Ophthalmologist."

Various factors can have an impact on operating room capacity, including provincial funding limits and planning. Greater awareness of these issues over the last decade has led to the creation of initiatives such as the Physician Resource Planning Task Force, aimed at improving physician planning.[51] The issue is also being closely monitored by the Canadian Medical Association, the Royal College, and other medical societies.[52]

Measuring outcomes to advance best practices

In Canada, few datasets report on clinical outcomes in ophthalmology. This makes it difficult to measure performance, set benchmarks, and share best practices. Integrating this type of data collection and analysis at the clinic level—for example, within ophthalmology or optometry practices—may be important.

Benchmarking eye care across Canada is a difficult task without better and more transparent outcome data. As an example, some provinces publicly report on wait times for specific eye procedures such as cataract surgery. Nationally, Canadians seem to be waiting longer for cataract surgery. In 2019, 71 per cent of cataract surgeries were performed within the target wait time, down from 76 per cent in 2015.[53] While this is important information, other metrics related to access to services and patient outcomes are lacking. As with other specialties, ophthalmology could benefit from the development of standardized performance management and quality improvement systems.

Opportunities to address these issues

Some of these opportunities include:

- Develop occupational supply and demand models at the provincial/regional level that consider changes in technology, demographics, and other key factors to address shortages of ophthalmologists across Canada.
- Base the number of ophthalmology training positions and operating room resources on projected demand instead of historical rates.
- Build data collection and performance management systems to assess patient and health system outcomes, support continuous quality improvement, and enhance health care funding and prioritization.
- Support national or provincial centres of excellence for treating eye disease, which could lead the development of performance management systems and sharing of best practices.
- Develop disease registries and best practice standards in collaboration with national agencies that can be implemented regionally.
- Improve operating room time planning and funding for practising ophthalmologists and those in training.

51 McGurn and Moineau, “The Future of Medical Education.”
52 Bellan, “Future Trends in Ophthalmology Health Human Resources in Canada.“
53 Canadian Institute for Health Information, “Benchmarks for Treatment and Wait Time in Canada—Cataract.”

Access to and integration of new technology

Modernizing regulation and funding

Ophthalmology is constantly evolving. Each year, new and more effective medications and surgical technologies are developed and brought to market. (See "New and emerging technologies.") Ultimately, innovations have the potential to improve patient and health system outcomes, which can lead to direct and indirect cost savings downstream. Of course, innovation comes at a price. The full value it brings—to patients, health care systems, and society—must be carefully assessed.

New and emerging technologies

Great medical and surgical advances have been made in the treatment of eye diseases. For example, technological advances in corneal transplantations—with the shift from full thickness to lamellar keratoplasty—are helping to fill treatment gaps and improve patient outcomes.[54] Innovations such as multifocal intraocular lenses can now restore near-distance vision in addition to treating cataracts.[55] Gene therapy for retinal diseases is showing great promise and is expected to become available over the next decade.

New technologies that improve patient care can also drive demand. With the advent of anti-VEGF injections, patients with age-related macular degeneration now have a better chance at preserving their vision, which was not the case before this treatment option became available.[56]

Sources: Le and others; Nuzzi and Tridico; Maguire and others.

54 Le and others, "Current Indications and Surgical Approaches to Corneal Transplants."

55 Nuzzi and Tridico, "Comparison of Visual Outcomes."

56 Maguire and others, "Five-Year Outcomes With Anti-Vascular Endothelial Growth Factor Treatment."

In Canada, regulatory and resource allocation issues can make it difficult to access and adopt new technologies. An important challenge stems from having a fragmented system, where regulations vary between provinces and territories. This means that there is not a standard way for ophthalmologists to access and integrate new technologies into their practice.[57] Large variations in funding of ophthalmic procedures and devices between hospitals—even within the same city—have also been reported. For example, the adoption of new technologies and devices is often limited to academic health centres, which typically have larger budgets and supports for innovation than smaller community hospitals. This has a direct impact on standards of care and equitable access to treatment options by Canadians.

Closing the gap in access to medications

Prescription drug formularies vary across provincial/territorial jurisdictions, and coverage is also different between public and private drug plans. In the case of patients receiving anti-VEGF injections for the treatment of AMD or DR, access to medication varies considerably among provinces. Differences in prescription drug coverage—including of innovative medicines—can impact the timely, affordable, and equitable access to ophthalmic treatments for Canadians. They also have financial implications for health care systems (and, more specifically, drug plans) as well as society at large.

Other challenges, such as the way in which medications are priced, may also impact the future access to ophthalmic treatments across the country. (See "Changes to prescription drug pricing in Canada.") For patients who are uninsured or underinsured, gaps in pharmaceutical drug coverage can mean medicines are unaffordable.[58] In turn, these patients may have trouble adhering to their prescription, potentially leading to irreversible vision loss in the case of AMD or glaucoma. Establishing a universal pharmacare program could remove these financial barriers and make access to medications more equitable for all Canadians.

57 MacNeil and others, "Enabling Health Technology Innovation in Canada."
58 Health Canada, *A Prescription for Canada*.

Changes to prescription drug pricing in Canada

Changes to the Patented Medicine Prices Review Board Guidelines and Patented Medicine Regulations, set to come into effect in January 2021, could affect Canadians' access to prescription medications. The goal of these changes is to control the rising costs of innovative medicines in Canada by altering the way pricing is determined for patented drugs.[59] More specifically, the reform would remove the U.S. and Switzerland (which have the highest drug prices globally) from the reference countries used to set prices for patented medicines in Canada and add six other countries with lower drug prices.

The review of patented drug prices would also include three new economic factors. While these changes aim to protect Canadians from high drug prices, concerns have been raised about their potential impact on market behaviour. For example, they may deter global pharmaceutical companies from launching new products in Canada. This also means that future access to innovative ophthalmic treatments, such as new injectable biologics, may be at risk.

Sources: Patented Medicine Prices Review Board; The Conference Board of Canada.

59 Patented Medicine Prices Review Board, "PMPRB Draft Guidelines Consultation."

Investing in eye science research

Despite having excellent researchers and clinicians, Canada is underfunded for fundamental vision science and applied research.[60] Canada ranks below the average of the Organisation for Economic Co-operation and Development countries for its proportion of federal funding attributed to scientific research.[61]

In the U.S., the National Eye Institute, part of the National Institutes of Health, receives dedicated funding for vision science. In comparison, the Canadian Institutes of Health Research does not have an institute dedicated to eye health, nor does it have a peer review committee dedicated to vision research. There is also agreement among researchers and patients that Canada should fund more clinical trials for eye conditions.[62] With Canada lagging significantly behind the U.S. with regard to clinical trials,[63] there are fears that we are at risk of not realizing the full benefits from innovation in eye health and vision science.

Opportunities to address these issues

Some of these opportunities include:

- Develop a collaborative process, with careful conflict of interest guidelines, that brings industry (makers of medical equipment, devices, and pharmaceuticals), ophthalmology, and regulators together to

60 National Coalition for Vision Health, The, *Vision Loss in Canada.*

61 Advisory Panel for the Review of Federal Support for Fundamental Science, *Investing in Canada's Future.*

62 Fighting Blindness Canada, "Canadian Vision 2020 White Paper."

63 Silversides, "Clinical Trials."

facilitate clinical trials, approval, and post-market surveillance to get better drugs and devices to the population as quickly as possible.
- Examine which clinical benchmarks are outdated and should be replaced with new standards of care, ensuring that Canada keeps up with scientific advancements and best practices.
- Prioritize funding for complex eye care and for fundamental and clinical research in vision science.
- Invest in strategies to improve care delivery (e.g., following in the footsteps of the streamlined and cost-effective delivery of high-volume cataract surgery to elderly populations).
- Increase collaboration between drug and medical device regulators at the federal and provincial levels to ensure equitable access to innovations across the country.
- Create better links between the health and innovation policy departments to facilitate support for Canadian health technology innovations.

The need for effective collaborative care networks

Improving collaboration and coordination

Ophthalmologists can only provide the care that the systems in place will allow, and delivery of care is not the same across Canada. Ophthalmologists collaborate with a variety of eye care providers, including family physicians, pediatricians, optometrists, and opticians. To better coordinate care delivery, provinces are developing collaborative eye networks, such as eye health councils.[64] These interprofessional councils coordinate policy with health regulators and government departments. For example, the Eye Health Council of Ontario brings together representatives from ophthalmology, optometry, family medicine, and regulatory bodies to provide interdisciplinary guidance on eye care delivery.[65] In 2011, Nova Scotia also established a collaborative care model between ophthalmologists and optometrists for routine eye care.[66]

Establishing eye health councils in other provinces and territories could help to ensure that eye care resources are optimized and coordinated. By bringing together all relevant stakeholders—including industry, government regulators, clinicians, and patient representatives—collaborative care networks can help improve service delivery and patient care.

Collaborative networks can also help to streamline the service delivery pathway between optometrists and ophthalmologists. Along with primary care physicians, optometrists are a frequent point of entry for eye care in Canada.[67] And while the scope of practice of optometrists has evolved over the past decades,[68] ophthalmologists have a different level of diagnostic and surgical training. Person-centred models can help to ensure that standards

64 Eye Health Council of Ontario, "Eye Health Council of Ontario."
65 Canadian Ophthalmological Society, "Eye Doctors Meet to Discuss Collaborative Eye Care."
66 National Coalition for Vision Health, The, *Vision Loss in Canada*.
67 Ibid.
68 Health Professions Regulatory Advisory Council (HPRAC), *A Report to the Minister of Health and Long-Term Care on Interprofessional Collaboration Among Eye Care Health Professionals*.

of care are maintained by accounting for the complementary expertise provided by the two professions.[69]

Guidelines that help to define clinical pathways and collaboration between ophthalmologists and primary care physicians are also important. By acting as an accessible entry point, primary care physicians play a vital role in eye care. Along with emergency room doctors, primary care physicians refer patients to ophthalmology. Given the importance of this entryway, there is an opportunity to clarify and refine how patients are referred to ophthalmology. This could be done through continued training or improved communication and collaboration between primary care and ophthalmology.

Remote access to care

Ophthalmologists practise within a variety of settings and delivery models. Technology has also allowed the field of ophthalmology to transition from an inpatient setting to an outpatient setting. For Canadians living in Northern, remote, or rural areas, access to ophthalmologists—and the surgical and medical services they provide—can be challenging. In 2012, there was no practising ophthalmologist in 29 per cent of the 148 census areas in Canada.[70] In these areas, establishing close relationships with different primary care providers is even more essential for delivering eye care.

Different telehealth programs connect ophthalmologists with Northern, remote, or rural communities. For example, Ontario Telehealth Network's (OTN) teleophthalmology program provides timely and accessible retinal screening for patients with diabetes.[71] OTN's program also enables clinical support to local primary care providers who deliver eye care to patients. This helps to optimize the use of health care resources and bridge (some of) the gaps in eye care service delivery in remote areas.[72]

69 Nicolela and others, "Model of Interprofessional Collaboration in the Care of Glaucoma Patients and Glaucoma Suspects
70 Al Ali, Hallingham, and Buys, "Workforce Supply of Eye Care Providers in Canada."
71 Ontario Telehealth Network, "Teleophthalmology."
72 Ibid.

But some eye care services can only be conducted in person. Still, telehealth networks could be further developed to increase patient access across the country.

Opportunities to address these issues

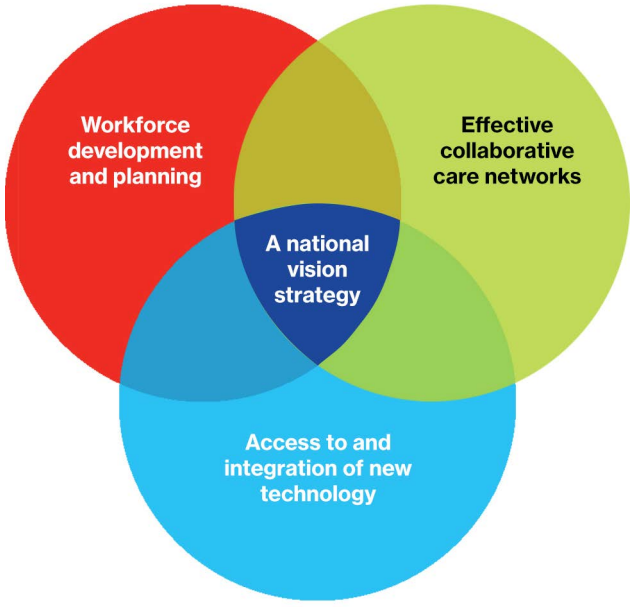
Some of these opportunities include:

- Develop a National Vision desk at the federal level (e.g., within Health Canada or the Public Health Agency of Canada) and provincial eye health councils to improve service delivery and integration.
- Improve coordination between ophthalmologists and referring care partners.
- Leverage and improve remote care services such as telehealth to lessen geographic and other barriers to eye care.
- Improve referral practices through professional development and training of primary care providers and optimize the delivery of effective eye care within appropriate roles.
- Increase access to care through innovations such as the CNIB Foundation's Eye Van, which delivers ophthalmic care to remote regions of Ontario.

Is it time for a national vision strategy?

Establishing a National Vision Strategy would be an opportunity to recognize and further build upon the value that ophthalmology brings to the Canadian population and society. It could be a platform to address the key challenges and opportunities. Given the significant overlap between areas of improvement, having an overall strategy would help to guide efforts and action. (See Exhibit 1). It would also provide a unified strategy to address the challenges brought on by the COVID-19 pandemic. (See "Impacts of COVID-19 on service delivery and demand.")

Exhibit 1
Interplay of key issues warranting a national vision strategy



Source: The Conference Board of Canada.

Impacts of COVID-19 on service delivery and demand

Many ophthalmic procedures were postponed or cancelled during the peak of the first COVID-19 outbreak between March and June 2020. Since then, demand for ophthalmology services has increased. COVID-19 also brought about changes in clinical practice and delivery of care for ophthalmology. A National Vision Strategy would provide an opportunity to assess and further improve temporary or permanent changes in eye care delivery.

Source: The Conference Board of Canada.

A Canadian National Vision Strategy can help to guide the comprehensive workforce planning necessary to meet the growing eye care needs of Canadians. This could lead to better and more equitable access to services. A National Vision Strategy could also help to measure performance, track outcomes, set benchmarks, and share best practices in eye care across the country. A national lens is also needed to integrate innovative therapies and devices into clinical practice. And it could help improve and scale teleophthalmology programs across Northern, remote, and rural communities. Developing a National Vision Strategy should involve all relevant partners to ensure balanced representation and action.

Conclusion

Ophthalmologists play a critical and vital role in eye care. This will continue to grow as the demand for eye care increases with the aging population and continued evolution of effective treatment options. The model presented in this research quantifies the value of ophthalmology from a population health, health care system, and broader societal perspective.

As the demand for ophthalmic procedures continues to increase, so will the benefits associated with treating and preventing vision loss. Ophthalmologists need a variety of strategies to keep up with this growing demand, including planning health human resources, optimizing the regulatory environment for innovations, and improving service delivery models and coordination with other health care professionals. With the help of a clear national vision, the future of eye care in Canada can be bright.

Appendix A
Methodology

Data on volume of patients, interventions, and direct health care costs

The Canadian Institute for Health Information (CIHI) provided data on five ophthalmic interventions: cataract surgery, glaucoma surgery, corneal transplantation, eye muscle surgery for strabismus, and vitrectomy surgery for diabetic retinopathy. Data were sourced from the following databases:

- Discharge Abstract Database (DAD)[1]
- Hospital Morbidity Database (HMDB)[2]
- National Ambulatory Care Reporting System (NACRS)[3]
- Canadian Management Information System Database (CMDB)[4]

More specifically, data included the number of ICD-10-CA/CCI[5] ophthalmologic procedures performed in Canada (acute and day surgery), reported in DAD-HMDB and NACRS for fiscal years 2014/15 to 2018/19. The data were aggregated by ophthalmologic procedure, fiscal year, and five-year age cohorts. Data on unique patients by procedure, by age, for fiscal year 2018/19 were sourced from the same databases. (See Appendix B for the list of ICD-10-CA/CCI ophthalmologic procedures include in the data extract.)

The average cost of the entire hospital stay for fiscal year 2018/19 by procedure of interest was calculated by CIHI based on the CMDB—by using the provincial cost of a standard hospital stay (CSHS) indicator and the resource intensity weights (CSHS x RIW). These data cover all provinces and territories except Quebec and Nunavut. Costs from the CMDB include only hospital costs. The average physician and pharmaceutical costs per case were therefore estimated for each procedure of interest by leveraging cost ratios presented in the Cost of Vision Loss study.[6] (See Table 1.)

Claims volume of anti-vascular endothelial growth factor (VEGF) injections in 2018 was sourced from IQVIA, Canada Inc.'s PharmaStat and PharmaStat Plus databases. These databases provide information by payer (public, private, and out-of-pocket) for each province, except public claims for Prince Edward Island. PharmaStat Plus uses both claims and dispensed prescription data to project to total market. Data were extracted for the two anti-VEGF medications approved by Health Canada for the treatment of age-related macular degeneration (AMD) and diabetic retinopathy (DR)—Lucentis (ranibizumab)

1 Canadian Institute for Health Information, Discharge Abstract Database Metadata (DAD).
2 Canadian Institute for Health Information, Hospital Morbidity Database.
3 Canadian Institute for Health Information, National Ambulatory Care Reporting System Metadata (NACRS).
4 Canadian Institute for Health Information, Canadian Management Information System Database Metadata.
5 Canadian Institute for Health Information, Canadian Coding Standards for ICD-10-CA and CCI.
6 Access Economics Pty Limited, *The Cost of Vision Loss in Canada; Summary Report.*

Table 1
Average cost per case of delivering ophthalmic interventions

	Cataract surgery	Anti-VEGF injection for AMD and DR	Glaucoma surgery	Corneal transplantation	Eye muscle surgery for strabismus	Vitrectomy surgery for DR
Hospital	$983.05	-	$1,496.75	$2,482.39	$1,878.07	$2,302.67
Physicians	$533.28	$1,000	$811.95	$1,346.63	$1,018.80	$1,249.14
Pharmaceuticals	$569.68	$6,975	$867.37	$1,438.54	$1,088.34	$1,334.40
Total	$2,086.00	$7,975	$3,176.06	$5,267.56	$3,985.21	$4,886.20

AMD: age-related macular degeneration; DR: diabetic retinopathy.
Sources: Canadian Institute for Health Information; IQVIA; The Conference Board of Canada.

and Eylea (aflibercept)—and for Avastin (bevacizumab). In Canada, Avastin is used off-label since it has not been approved by Health Canada for the treatment of eye disorders.

The most comprehensive coverage of Avastin is offered in British Columbia through the Provincial Retinal Diseases Treatment Program. In 2018, approximately 152,000 drug therapy injections were administered in British Columbia for the treatment of AMD, DR, and retinal vein occlusion.[7] Based on expert opinion, an estimated 125,000 of these injections were for anti-VEGF medication, and are believed to be for Avastin. Since these drugs were reimbursed directly through the Provincial Retinal Diseases Treatment Program, this volume of anti-VEGF injections was added to the PharmaStat/PharmaStat Plus data.

Lastly, an adjustment was made to account for anti-VEGF prescriptions dispensed by hospital pharmacies, since PharmaStat/PharmaStat Plus includes only retail pharmacy data. According to the Canadian Medical Association, 14 per cent of ophthalmologists have a hospital-based practice. We therefore added an additional 14 per cent to anti-VEGF injection volume.

The number of unique patients receiving anti-VEGF injections was estimated by applying a median of 10 injections/patient/year[8] to the volume data. Since the recommended number of injections varies between eye conditions (AMD and DR) and by year of treatment, this represents a rough estimate of patient numbers. Given the lack of comprehensive data on the use of anti-VEGF medications across the country, the numbers presented in the current study represent rough estimates of utilization. The derived direct and indirect cost outcomes, as well as the return-on-investment analysis, should therefore be used with caution.

Reimbursement costs for anti-VEGF medications were based on the average annual treatment cost by product presented in a 2017 Patented Medicine Prices Review Board report.[9] Since average annual costs vary considerably between anti-VEGF products (i.e., around $8,500 for Lucentis and Eylea, and $400 for Avastin in 2017/18[10]), a weighted reimbursement cost was calculated based on estimated utilization by product. This means that including Avastin in our analysis is driving down the average annual reimbursement cost for anti-VEGF treatment.

Average physician costs were added to this amount by using an approximate physician reimbursement of $100 per injection.[11] Again, fees vary between provinces (e.g., Alberta is $111 and Ontario is $90 per injection). However, in provinces where the injection fee is lower, physicians can usually charge other fees such as a visit fee, diagnostic fee, and/or tonometry (eye pressure measurement) fee. In general, this is not

7 Provincial Health Services Authority, *The Provincial Retinal Diseases Treatment Program*.
8 Diabetic Retinopathy Clinical Research Network, "Aflibercept, Bevacizumab, or Ranibizumab for Diabetic Macular Edema."
9 Patented Medicine Prices Review Board, "Market Intelligence Report."
10 Ibid.
11 This factors in the second eye being paid at 85 per cent.

the case for provinces that allow a higher injection fee such as Alberta. The average fee of $100 per injection is therefore used to capture costs associated with the injection as well as other fees that may be billed in certain provinces. This average fee per injection was multiplied by 10 (the average number of injections/year/patient) in order to estimate average annual physician fees. (See Table 2.) This represents a rough approximation of annual physician and pharmaceutical costs associated with anti-VEGF medications.

Table 2
Effectiveness of ophthalmic interventions at treating vision loss

Eye condition	Intervention	Proportion of individuals with treated vision loss (effectiveness)	Definition of treated vision loss in source study	Sources
Cataract	Phacoemulsification	95	BCVA 20/40 or better	Olson and others, "Cataract in the Adult Eye Preferred Practice Pattern"; Baltussen, Sylla, and Mariotti, "Cost-Effectiveness Analysis of Cataract Surgery."
Glaucoma	Trabeculectomy & tube shunts	90	Target pressure achieved	Gedde and others, "Treatment Outcomes in the Tube Versus Trabeculectomy (TVT) Study."
Damaged cornea	Full thickness corneal transplant (PKP)	43	BCVA 20/40 or better	Williams and others, "How Successful Is Corneal Transplantation?"
Damaged cornea	Lamellar keratoplasty (LK)	85	BCVA 20/40 or better	Singh and others, "Corneal Transplantation in the Modern Era".
Damaged cornea	Weighted average between PKP and LK[6]	69	BCVA 20/40 or better	Le and others, "Current Indications and Surgical Approaches to Corneal Transplants."
Strabismus	Eye muscle surgery	83	Re-establishment of binocular vision	Kumari and others, "Prognostic Preoperative Factors for Successful Outcome of Surgery in Horizontal Strabismus."
Diabetic retinopathy	Vitrectomy surgery	65	BCVA 20/40 or better	Gupta and others, "Visual and Anatomical Outcomes Following Vitrectomy."
AMD, Diabetic retinopathy	Anti-VEGF injection	71	BCVA 20/40 or better	Maguire and others, "Five-Year Outcomes with Anti-Vascular Endothelial Growth Factor Treatment."

*BCVA – Best Corrected Visual Acuity
**A Canadian study was used to derive the overall effectiveness for corneal transplantations. The study found that 61 per cent were LK and 39 per cent were PKP. This was applied to the effectiveness of each procedure to derive the overall weighted average (of 69 per cent).
Source: The Conference Board of Canada.

Projecting utilization to 2040

Canadian population estimates and projections by five-year age groups for 2018 to 2040 were sourced from The Conference Board of Canada. The rate of ophthalmic interventions and share of patients by five-year age groups were calculated for 2018. In order to forecast the volume of interventions and patients to 2040, rates by five-year age groups were applied to population projections (and held constant over the forecast period). Volume data by age were not available for anti-VEGF injections. We know that individuals with AMD are generally older than the average ophthalmic patient, while those with DR are younger on average. In order to "meet in the middle," the age distribution of glaucoma patients (sourced from CIHI data) was applied to anti-VEGF volume for the purpose of the forecast.

Projecting utilization based on population estimates leads to around a 1 per cent annual increase in utilization, driven by population growth and aging. An additional 2 per cent annual growth rate was added (for a total of 3 per cent), to account for increased utilization due to innovation and changes in clinical practice. This is in line with the expected increase in health care demand in Ontario and elsewhere, and slightly lower than the 4 per cent annual growth in ophthalmic interventions between 2014 and 2018 from the CIHI data.

Treatment effectiveness

A review of the literature on the effectiveness of each intervention was first conducted to determine the proportion of those with treated vision loss. (See Table 2.) Although the current study aimed to use a best corrected visual acuity (BCVA) of 20/60 to define vision loss, most of the evidence available uses the North American cut-off of a BCVA of 20/40 or greater. The effectiveness assumptions in this table were applied to the volume of ophthalmic patients by intervention to estimate the number of treated vision loss cases.

Estimating direct medical outcomes and costs

A review of the literature was also conducted to determine the frequency of direct medical outcomes due to vision loss and the average cost per case of each outcome. (See Table 3.) The frequencies represent the incremental occurrence of medical outcomes for people with vision loss, compared with those without vision loss. The frequency assumptions in this table were applied to the volume of treated vision loss cases to estimate the number of averted medical outcomes and associated direct cost savings. Since the available literature focuses on older populations, medical outcomes were assumed to occur for patients aged 65 and over only.

Indirect (non-medical) outcomes and costs

The 2017 *Cost of Vision Loss in Canada* report found that every case of vision loss incurred $16,850 in indirect costs to society and the broader economy.[12] This number was estimated using the same methodology as the 2009 *Cost of Vision Loss in Canada* study.[13] Indirect costs included different outcomes such as the use of aids and devices, informal care, employment status, absenteeism, and presenteeism. In our study, the indirect (non-medical) cost per case was multiplied by the number of treated vision loss cases to estimate social and economic cost savings.

12 CNIB, *The Cost of Vision Loss in Canada 2017.*

13 Access Economics Pty Limited, *The Cost of Vision Loss in Canada: Summary Report*.

Table 3
Frequency of direct medical outcomes and average cost per case

Direct medical outcomes	Frequency of outcome due to vision loss*	Average cost per case**	Sources
Incidence of falls	19%	$5,572 (2010)	Crews and others, "Falls Among Persons Aged ≥65 Years"; Parachute, "The Cost of Injury in Canada."
Incidence of hip fractures	6.4%	$21,600 (2010)	Felson and others, "Impaired Vision and Hip Fracture"; Tarride and others, "The Burden of Illness of Osteoporosis in Canada."
Prevalence of depression	6.5%	$1,872 (2003)	Evans, Fletcher, and Wormald, "Depression and Anxiety in Visually Impaired Older People"; Lim and others, "A New Population-Based Measure of the Economic Burden of Mental Illness in Canada."
Prevalence of anxiety	0.3%	$1,872 (2003)	Evans, Fletcher, and Wormald, "Depression and Anxiety in Visually Impaired Older People"; Lim and others, "A New Population-Based Measure of the Economic Burden of Mental Illness in Canada."
Admission into long-term care	6.8%	Average annual cost: $75,000 (2017)	Evans, Smeeth, and Fletcher, "Risk of Admission to a Nursing Home"; Gibbard, *Sizing Up the Challenge*."
Home care and caregiver services (publicly funded)	2.2%	Average annual cost: $3,933 (2020)	Aljied and others, "Visual Impairment and the Use of Formal and Informal Home Care in Canada."

*Proportions represent the incremental occurrence of outcomes for individuals with vision loss (compared to without vision loss).
**Costs were inflated to 2020 dollars.
Source: The Conference Board of Canada.

All direct and indirect costs were adjusted using The Conference Board of Canada's Health Care Expenditures Price Index forecasts. This means we inflated the cost estimates over the forecast period (2020 to 2040) using the projected rate of price growth.

Key informant interviews

To inform the policy discussion, five key informant interviews were conducted with individuals with a clinical, health systems and policy, and/or research background in ophthalmology or optometry. The interviews were supplemented by summary notes from an industry roundtable—featuring 10 industry representatives—organized by the Canadian Ophthalmological Society. Participants of the key informant interviews and industry roundtable were asked the following questions:

1. When thinking about the field of ophthalmology, what seems to be working well?
2. When thinking about the field of ophthalmology, what needs to be improved?
3. What changes—for example, to the policy environment, access to services, or clinical practice—would help to improve the field of ophthalmology?
4. What is your understanding of the current capacity of ophthalmologists to meet the demand for services in Canada? If you identify capacity issues, please explain the issue, source of the issue(s), its impacts on patients and health care function, and possible solutions from your perspective?

In your opinion, what are some of the key challenges and opportunities related to **the future** of ophthalmology in Canada?

Responses were transcribed and coded for key themes, which were subsequently used to inform the discussion on challenges and opportunities. Despite the small sample of key informant interviews, similar themes emerged across interviews. Supporting evidence from gray and published literature was used to contextualize and validate parts of the discussion whenever possible. Although the qualitative analysis performed as part of this research is not exhaustive, it serves to highlight some key areas that may warrant further consideration.

Appendix B
Ophthalmic procedures included in the analysis

The ICD-10-CA/CCI[1] procedure codes for the five ophthalmologic procedure groups sourced from CIHI data are presented below.

Cataract surgery

- 1.CL.89.^^ Excision total, lens
- 1.CL.59.^^ Destruction, lens

Glaucoma surgery

- 1.CJ.52.^^ Drainage, anterior chamber (of eye)
- 1.CD.52.^^ Drainage, sclera
- 1.CG.59.^^ Destruction, ciliary body
- 1.CH.87.^^ Excision partial, iris
- 2.CZ.28.XK Pressure measurement, eye NEC with provocative tests (for glaucoma)—NOT mandatory to capture if performed.

Corneal transplantations

- 1.CC.85.^^ Transplant, cornea

Eye muscle surgery for strabismus

- 1.CQ.78.^^ Repair by decreasing size, ocular muscles and tendons
- 1.CQ.83.^^ Transfer, ocular muscles and tendons

Vitrectomy surgery for diabetic retinopathy

- Records where both the ICD-10-CA/CCI Procedure Code 1.CM.89.^^ (Excision total, vitreous) and one of the following diagnosis codes (E codes) are captured on the same abstract:
  - E10.30 Type 1 diabetes mellitus with background retinopathy
  - E10.31 Type 1 diabetes mellitus with preproliferative retinopathy
  - E10.32 Type 1 diabetes mellitus with proliferative retinopathy
  - E10.33 Type 1 diabetes mellitus with other retinopathy
  - E11.30 Type 2 diabetes mellitus with background retinopathy
  - E11.31 Type 2 diabetes mellitus with preproliferative retinopathy
  - E11.32 Type 2 diabetes mellitus with proliferative retinopathy
  - E11.33 Type 2 diabetes mellitus with other retinopathy
  - E13.30 Other specified diabetes mellitus with background retinopathy
  - E13.31 Other specified diabetes mellitus with preproliferative retinopathy
  - E13.32 Other specified diabetes mellitus with proliferative retinopathy
  - E13.33 Other specified diabetes mellitus with other retinopathy
  - E14.30 Unspecified diabetes mellitus with background retinopathy
  - E14.31 Unspecified diabetes mellitus with preproliferative retinopathy
  - E14.32 Unspecified diabetes mellitus with proliferative retinopathy
  - E14.33 Unspecified diabetes mellitus with other retinopathy

1 Canadian Institute for Health Information, *Canadian Coding Standards for ICD-10-CA and CCI*

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