Chapter 1
Terminology, Demography, and Epidemiology of Low Vision

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Rationale for the Vision Rehabilitation Evidence-Based Review

The Vision Rehabilitation Evidence-Based Review (VREBR) is a comprehensive evidence-based review of rehabilitation interventions and services for people who are blind or have low vision. It is designed to serve as an authoritative reference to unmet research needs and opportunities to transfer scientific knowledge to clinical practice and service delivery.

Evidence-based practice in human services attempts to translate the results of research studies (evidence) into practice, with the presumed goal of improving the outcomes from interventions and services. An empirically validated knowledge base has the potential to substantially increase the confidence of service providers in their intervention plans. The knowledge base provides the best assurance that an alternative plan is unlikely to produce a superior or similar result with less professional effort and cost.

Low vision rehabilitation researchers, service providers, administrators, educators, funding agencies and individuals, and policy makers currently do not have access to a comprehensive presentation of knowledge that classifies research evidence according to the quality of the design and methods that produced it.

It is expected that the VREBR will yield the following benefits to the field of low vision rehabilitation:

- An indispensable, authoritative guide for the evaluation and development of programs and services.
- A credible mechanism for setting the research agenda.
- An important educational tool.
- A compelling stimulus for partnerships among agencies with allied interests in vision health.
- An excellent vehicle for improving research capacity.

What are examples of unmet needs for research that might be prioritized through the VREBR?
Without prejudging the outcomes from the VREBR, a number of areas of unmet need pop up from a cursory look at the published literature. For example, according to data collected from the Lighthouse National Survey on Vision Loss[1], low vision clinical services, rehabilitation training in activities of daily living, and recreational services for persons with vision problems were each used by only 1% of persons age 45 and older with a self-reported vision problem. Furthermore, only 2% of respondents reported using job placement and/or placement services, and 2% reported to have received counseling to help adjust emotionally to their vision problem. Only 6% of respondents who reported some form of vision problem used any type of vision rehabilitation service.

With regard to technical aids, the same survey identified that only 30% of adults (age 45 and older) with self-reported vision impairments report using an optical device (such as a magnifier or telescope). Large print materials are used by 21% of adults with self-reported vision impairments. Other adaptive devices (talking books and clocks, for example) are used by an even smaller minority (under 5%).

Vision impairment is responsible for 18 percent of hip fractures by older Americans at a cost of treatment of $2.2 billion each year, according to the landmark Framingham Eye Study[2 3], an internationally recognized, population-based epidemiological study funded by a grant from the Robert Wood Johnson Foundation. If vision rehabilitation could prevent just 20 percent of such hip fractures, it is estimated that US$441 million would be saved annually.

There are notable developments in sensitizing ophthalmologists concerning the legitimacy, relevance, and importance of low vision rehabilitation services as an adjunct to the routine clinical care of individuals who have unresolvable vision loss. They are part of a growing movement to sensitize health care professionals about low vision rehabilitation. They include the Low Vision Education Program introduced by the National Eye Institute[4], including THE EYE SITE: A Traveling Exhibit on Low Vision for Shopping Centers[5], and also the SmartSight initiative of the American Academy of Ophthalmology[6].

To date, the VREBR planning group has produced a list of areas to be examined that includes the following:

- Cost-effectiveness of treatments for low vision conditions (e.g., macular degeneration).
- Driving and low vision.
- Educational models for children with vision impairments.
- Effectiveness of telemedicine.
- Employment and job-related issues for people with vision impairments.
- Gaps in service provision (fragmentation).
- Impact of screening procedures.
- Interventions and services for patients with moderate and severe vision impairment.
- Lack of follow through with patients.
- Need for a "matrix of care" regarding maintenance of functionality following vision loss.
- School-to-work transitions for adolescents with vision.
- Services to rural (including farming) and geographically isolated communities.

A credible VREBR, as we envision it, would significantly enhance capabilities for attracting research funding from leading granting agencies. It would do so by becoming a "proving ground" for testing ideas for research questions, designs and methodologies, and also for developing effective working relationships among vision health researchers, that are essential for preparing grant competitive applications to these agencies.

The review will focus primarily on research topics identified and prioritized by leading vision researchers and providers of vision rehabilitation services. VREBR "chapters" are forthcoming, critical syntheses of the quality and strength of findings in each topic area within low vision rehabilitation (for example, assistive devices, driving, orientation and mobility training, and self-management techniques). As the chapters are developed, leading international experts are invited to review the drafts and participate in finalizing them, including co-authorship on the chapters and ensuing peer-reviewed publications.

For the first phase of the project, we have developed this report in order to present background information relevant for the VREBR. It focuses on the terminology, demography, and epidemiology for vision loss and rehabilitation. The demographic and epidemiologic information contained within this chapter was captured from the published scientific literature on low vision and blindness rehabilitation available to the authors at the time. The sources included experimental and non-experimental studies, professional guidelines and standards, census data, statistical reports, evidence-based review centre reports, and electronic sources devoted to the subjects of low vision and blindness rehabilitation. The intention of this report is to help us prepare the most defensible strategies for selection, evaluation and interpretation of the literature, while also providing an introduction to the methods that will be used to evaluate the research evidence.

In the next phase (and currently in progress), we will evaluate research publications using the aforementioned review and selection methods. In order to find the best evidence our searches will include not only diagnostic, medically-based low vision research, but also research that points to the rehabilitative aspects of low vision. Some of these topics are as follows:

- ✓ Specific impairments such as *reduced acuity, visual field loss, contrast sensitivity defects, photo recovery, and glare defects*.
- ✓ Disability issues such as *reading, daily living, orientation and mobility, and driving with low vision.*
- ✓ Additional categories such as *age, education, and vocation.*

It is important to note that in our search for randomized controlled trial (RCT) and non-RCT studies in the field of low vision and blindness rehabilitation, we will look for those in which the research participants had *uncorrectable and untreatable vision loss*. As we explain later in this report, there are important implications associated with how one decides to define low vision.

In conclusion, the desired outcome of this report is to show an overall picture of the current state of low vision and blindness rehabilitation. It is also intended that this report will help us arrive at a consensus for definitions of key terms such as low vision, blindness, and rehabilitative processes associated with low vision and blindness. Using sources devoted to demography, epidemiology, guidelines and standards for low vision assessment and treatment—as well as models and definitions of low vision rehabilitation primarily in North America (Canada and the United States)—we have tried to assemble the best available information needed for understanding the issues, scope, and significance of research on the effectiveness of low vision rehabilitation.

Low Vision and Blindness—An Overview

Key Concepts and Terminology†

When it comes to defining *low vision*, there are many variations within the field. For the purposes of this review, and to reduce confusion, we will incorporate definitions of low vision and blindness found in the *Visual Standards—Aspects and Ranges of Vision Loss* report[7], prepared for the International Council of Ophthalmology, Sydney Australia (2002). In addition to these definitions, we have used the World Health Organization's International Classification of Diseases, 9th and 10th Revisions (ICD-9, -10, and ICD-9-CM) standard ranges of visual acuity loss (see Appendix I).

Low vision indicates that the person is not blind and that the vision is less than normal. These individuals are best helped with low vision devices such as large print, magnifiers, and illumination.[7] In addition, the following aspects should be considered when defining low vision: Low vision may result from many different ophthalmologic and neurological disorders and may cover a wide range. Low vision is a visual impairment that may interfere with a person's ability to carry out daily living and leisure activities, as well as performing work.

Vision loss is not dichotomous, but occurs as a continuum ranging from modest low vision to total blindness. Reconciling the results from many international reports is difficult because of complications with the definition of "low vision." There are confounding factors that skew demographic descriptions of low vision populations due to rather subtle semantic differences in definitions. The consequences in terms of data are fairly predictable. One gets much bigger numbers with some definitions, and different profiles of causes with others. To help make sense of the information presented in this document, it is important that the reader better understands how the various studies may reflect different views of potentially similar populations, apart from obvious ethnicity and age demographic differences.

The basic premise of most low vision definitions is that the presence of a disorder or disease does not necessarily translate into a low vision condition. Most definitions require the disease or disorder to interfere with function (it must create a tested seeing deficit such as loss of visual acuity or visual field). Some definitions accept this as being *low vision*; other definitions stipulate the cause of the vision loss must be *untreatable* which is not the same as being *untreated*; other definitions require the lost function (acuity or field loss) to interfere with the performance of common age-appropriate seeing tasks (such as reading); others may require this loss of function to be significant to the individual (in other words, a loss of reading ability that is of no consequence to the individual does not qualify as low vision).

The problem becomes evident if we compare the causes of "low vision" that are reported by various studies. International studies often describe *refractive error* and *cataracts* to be major causes of "low vision." Both conditions are often "treatable," but they are clearly "untreated" in these populations for various reasons. Hence, people with these conditions are reported to be "low visioned." By comparison, many North American studies report *cataracts* as a major cause of low vision, but never report *refractive error* as a cause. Both conditions are "treatable" in North America. Presumably, the rationale is that people with uncorrected refractive errors are not low visioned because it is more readily treatable than unoperated cataracts in North America. Since both may be "untreated" in the population under study, it presents an interesting contradiction if the definition revolves around the treatability of the causal disorder.

† In this review, visual acuity units are expressed first in metric notation and then in U.S./British notation, in parentheses. For example, 6/60 (20/200). Please refer to Appendix I for a complete chart of visual acuity measurements and their associated ranges of vision.

The following are some considerations for delineating the potential factors that influence the data that have been reported by the studies cited in this document.

Injury and disease can affect the eyes and/or their neural connections. The effects are normally detected by clinical examination or self-recognition of vision deficit. Do they necessarily constitute "low vision?" There are invariably two essential qualifiers in all definitions of low vision. The first relates to the *treatability* of the causal disorder. The second is an *impact on visual function*. In the generic case, low vision describes any condition marked by an unresolved inconsistency between an individual's visual abilities and her or his visual ambitions.

There are several possible outcomes associated with deciding whether or not a condition of vision loss is *treatable*:

	Treatable	**Treatable**	**Not treatable**
	Can be resolved by treatment so that little or no functional deficit persists.	*Treatment can improve vision to lessen the level of vision loss but residual, problematic deficit remains.*	*The condition is not amenable to treatment.*
Treated	Presumably, this would ***not*** be considered low vision.	Low vision	
Not treated	Low vision	Low vision	Low vision

There are several possible interpretations of a decision about whether or not a clinical vision deficit has an *impact on functional performance*:

Impact on functional performance *(i.e., Vision loss is present and interferes with functional seeing activities, such as reading.*	**No impact on functional performance** *(i.e., Vision loss is present but hidden)*
Loss of function is of limited consequence to the individual. (The individual is poorly motivated to resolve problem.)	Affects one eye only.
Loss of function is of significant consequence to the individual. (The individual is highly motivated to resolve problem.)	Affects measurable dimensions of vision, but these do not result in any perceived impact on functional performance of the individual.

For the purpose of this review, *low vision* describes any condition of diminished vision uncorrectable by standard glasses, contact lenses, medication or surgery that disrupts a person's ability to perform common age-appropriate visual tasks.§ Irresolvable low vision results from uncorrectable and untreatable conditions, whereas unresolved low vision results from correctable but uncorrected, and treatable but untreated, conditions.

§ According to the National Eye Institute, low vision is a visual impairment not correctable by standard glasses, contact lenses, medication, or surgery. This loss of vision disrupts a person's ability to perform everyday activities. The NEI website describes low vision as follows: Low vision means that even with regular glasses, contact lenses, medicine, or surgery, people find everyday tasks difficult to do. Reading the mail, shopping, cooking, seeing the TV, and writing can seem challenging. See http://www.nei.nih.gov/nehep/what.asp#1

Legal Blindness

"Legal blindness" describes arbitrary criteria that are established by national governments (within most developed countries) to determine a citizen's eligibility for government-sponsored benefits and services for people with disabilities. Legal blindness describes neither low vision nor functional blindness, but may include individuals from either category; it does not necessarily indicate a person's *ability* to function. Legal blindness criteria often are described in related legislation, such as The Social Security Act of 1935 (U.S.) or The Blind Persons Act (Canada). The definitions and requirements are common to both countries, and are as follows:[8 9 10]

> "Central visual acuity is 20/200 or less in the better eye with corrective glasses or central visual acuity of more than 20/200 if there is a visual field defect in which the peripheral field is contracted to such an extent that the widest diameter of the visual field subtends an angular distance no greater than 20 degrees in the better eye."

In the UK, an individual may be *registered* as blind if their visual acuity is 3/60 or worse (can see at three metres, or less, what a person with normal vision can see at 60 metres); or 6/60 if your field of vision is very restricted and you do not have full range of sight. An individual may be registered *partially sighted* if their visual acuity is between 3/60 and 6/60 with a full field of vision, or up to 6/18 (18 is the number of the fourth line down on the Snellen eye chart) if your field of vision is very restricted.[11] The legal definition of blindness in the UK is included in the National Assistance Act of 1948 which says that "a person can be certified as blind if they are so blind that they cannot do any work for which eyesight is essential." [11]

In Australia there a subtle differences between accepted definitions of legal blindness. According to the Royal Victoria Institute for the Blind (RVIB)—and the criteria for government services and benefits—legal blindness is defined as having a "visual acuity of less than 6/60 with best corrected vision and both eyes open and/or a visual field of less than 5 degrees of central vision, or central vision loss of greater than 10 degrees." [12] According to Retina Australia, it is defined as having "less than 6/60 in the good eye (with corrective lenses) or a field of vision constricted to 10 degrees or less." [13]

Overview of Current Statistics

The demographic features and subsequent data on functional blindness and low vision are fairly consistent in all developed countries, with some exceptions regarding gender, ethnicity, regional factors (rural vs. urban), and personal environment (home, facilities, and/or access to health care). According to a recent review of epidemiological studies by Evans and Rowlands (2004),[14] correctable visual impairment (VI) affects about 10% of people aged 65-75, and about 20% of those aged 75 or older. Most, but not all studies have found worse vision in women than men. Evans and Rowlands reviewed population-based studies concentrating on low vision conditions and populations in the UK, Australia, and the U.S. Their report also found overwhelming evidence that there is a very large population of older people with low vision who are not receiving appropriate health care.[14]

It is obvious from the research that the incidence of low vision conditions is increasing dramatically as baby boomers approach ages with increased risk of sight-limiting conditions. It should be noted that prevalence information derived from survey data suggests a much higher prevalence: 2.6% for Health Activities Limitation Survey (HALS) in Canada;[15] 2.8% in the United Kingdom;[16] and 1.7% for the United States.[17] These data may be corrupted by the fact that as much as 60% of the reported "disability" conditions may be caused by uncorrected refractive error or other treatable ocular conditions.[18] Misclassification rates from the HALS and the Statistics Canada National Health Survey have been reported.[19 20] The predicted positive value of the HALS has been estimated to be 57%.[20]

Client statistics from the Canadian National Institute for the Blind (CNIB) show an increase in those in need of services from their organization; and these numbers are considered to be conservative because data collection is a result of self-report and collected from individuals who participate in their services. Significant highlights within CNIB client statistics include the following:

- In 2002, the total number of new clients for the CNIB was 11,064.
- In 2002, more than 74% of new CNIB clients were aged 70 or over. This age group represents about 65% of total clients, again indicating a shift to older clients.
- The most common diagnosis among new clients was macular degeneration, an especially common condition among older clients. It causes loss of reading and fine detail vision, while side vision remains intact.

Overall in the year 2002, the CNIB served 104,187 blind, visually impaired, and deaf blind Canadians. This almost doubles the number of people served as recently as 1987 (see Appendix II for detailed client statistics). It is well established that the Canadian population is aging and that this trend will continue until at least the year 2021. In 1981 there were only 2.4 million Canadians over the age of 65 but it is projected that this number will increase to between four and five million by the year 2021. These projections suggest that a significant increase in the number of visually impaired and blind individuals will occur over the next twenty to thirty years.[21]

In Australia, over 480,000 people are visually impaired in both eyes (visual acuity < 6/12), over 50,000 of these people are blind (visual acuity < 6/60, or visual field < 10° diameter), and nearly 300,000 Australians have visual impairment because of under-corrected refractive error. However, 180,000 Australians have visual impairment due to other causes that cannot be corrected by spectacles.[22]

The most prevalent condition presented at low vision clinics is age-related macular degeneration, which accounts for approximately 40% of all the patients seen. Glaucoma and cataract are the next most common low vision conditions, and over 60% of the patients seen are over 65 years of age. The leading cause of adventitious vision loss in the adult population between the ages of 21 and 65 years is diabetic retinopathy. Within a younger low visioned population (under 20 years of age) the most prevalent conditions are optic atrophy, retinopathy of prematurity, congenital cataracts, juvenile macular degenerations, and other genetic or developmental disorders.[23]

Low Vision and Blindness Rehabilitation

The following text was taken from Margrain, TH. (2000). *Helping blind and partially sighted people to read: the effectiveness of low vision aids*. British Journal of Ophthalmology. 84, 919-921.

> "The number of people with impaired sight that cannot be improved with the use of spectacles or other treatments is growing. Demographic data suggests that the numbers of people with impaired vision are likely to increase at least until 2021 because the main causes of low vision are age related. Medical intervention is unlikely to reduce significantly the numbers of people with impaired vision in the foreseeable future because there is currently no treatment for the primary cause of visual impairment, age related macular degeneration (ARMD).[24 25] Given that it will not be possible to cure visual impairment the emphasis must be on providing an effective rehabilitative "low vision service". Unfortunately, low vision service provision [in the U.K.] is a lottery.[26] Some areas have a comprehensive service and others none at all. Furthermore, it appears that up to two thirds of people who would benefit from this service do not have access to it."[27]

The primary role of vision rehabilitation for all patients is to maximize functional independence, to maintain quality of life, and to help the patient adapt to the psychosocial aspects of vision loss. Before and during rehabilitation, the patient's existing medical eye condition is evaluated and treated by means of standard ophthalmologic techniques to maintain and maximize the patient's visual potential.

Vision rehabilitation trains patients to use their residual vision or alternate compensatory techniques effectively and to make practical adaptations in their environment to facilitate activities of daily living, ensure safety, and maintain independence[28].

Many patients have other physical impairments that impact the rehabilitation process. Hearing, mobility, and neurological deficits, for example, can alter the patient's ability to utilize some standard devices and to participate in some rehabilitation techniques. According to the American Academy of Ophthalmology's rehabilitation guidelines, therapy should be individualized to meet each patient's particular goals, limitations, and resources (for example, transportation, finances for purchase of devices, and caregivers).

Patient Outcomes
Patient outcome criteria for vision rehabilitation include the following:

- Improved understanding of emotional and psychological adjustments to vision loss.
- Improved ability to complete independently activities of daily living.
- Improved knowledge of available adaptive devices and resources.

Ideally, the rehabilitation process and procedures listed above would be standard practice everywhere in the world and would fulfill each individual's need for low vision care. However, knowledge about the availability of vision rehabilitation in an individual's community is seriously lacking, creating a huge gap between the need for services and access to services.[1] For example, more than one-third (35%) of middle-age and older Americans are unaware of public or private agencies in their community that provide services for people with vision impairments and another 21% report that there are no services. Lack of awareness regarding the availability of vision rehabilitation services is more pronounced among those who may be considered to need vision rehabilitation the most: elderly (43% of those age 65-74 years and 40% age 75 and older); the least educated (40% of those without a high school degree); and those with severe vision impairments (42%).[1]

For older adults, financial and transportation limitations are frequent barriers to use of ophthalmologic and optometric service providers. A variety of factors may hinder the rate and success of adoption and use of rehabilitation strategies. There is inadequate investment in research for vision rehabilitation, limiting the quantity and quality of research being conducted. Rehabilitation research findings are not widely distributed or published in mainstream journals. Furthermore, there is limited research on the cost-effectiveness of vision rehabilitation.[29] According to a recent Australian report entitled, *The Economic impact and Cost of Vision Loss in Australia* (2004)[22], the total real financial costs (direct and indirect) of visual impairment are over $5 billion in 2004. The real indirect financial costs of visual impairment are estimated at $3.2 billion, around 76% more than total direct health costs ($1.8 billion). In addition, there were $850 million of transfer payments—both lost revenue (tax foregone for people with visual impairment and their families and caregivers) and expenditure (caregivers and other welfare payments).

Despite deficits in the quantity and quality of the research, vision rehabilitation can drastically reduce the costs associated with an injury and loss of independence due to vision loss. Beyond these easily quantified savings, the benefits of vision rehabilitation include prolonged productivity by people able to stay active and continue working despite vision loss.[22]

Vision rehabilitation includes a range of interventions that can have significant direct and indirect effects on seniors' physical and mental health, the well-being of families, and the demand for other healthcare services. Although there are very few controlled evaluations of vision rehabilitation services, there is an emerging literature supporting the positive effects of these interventions on functional and psychosocial status and general quality of life.[30]

Other Terminology Associated with Low Vision and Blindness

Visual Impairment
The term "visually impaired" is used when the vision loss is defined in terms of organ functions, such as visual acuity loss or visual field loss. An individual can have visual impairment in one eye, while the other eye is normal.[30]

Severe Vision Impairment
Defined as an inability to recognize a friend at arm's length even when wearing glasses or contact lenses, or cannot read ordinary newspaper print even when wearing glasses or contact lenses, or reports poor or very poor vision even when wearing glasses or contact lenses, or is blind in both eyes.[1] Severe visual impairment is a condition where best-corrected visual acuity is less than 6/48 (20/160), including 6/60 (20/200), to 3/60 (20/400), or the visual field diameter is 20 degrees or less (largest field diameter for Goldmann isopter III4e, 3/100 white test object, or equivalent). Severe visual impairment in both eyes is the minimum requirement to be considered legally blind, which has traditionally determined disability benefits in Canada and the United States.[28]

Functional Vision
This term should be used when the vision loss is defined in terms of the individual's abilities with regard to Activities of Daily Living (ADLs, reading ability, orientation and mobility, for example). Functional vision applies to the individual, and it can not be applied to the eyes separately.[28]

Functional Blindness
Functional blindness is defined as having no useful vision: Clinically measured light perception or less.[31] A student who is visually impaired is functionally blind if the student will use tactual media (which includes Braille) as a primary tool for learning to be able to communicate in both reading and writing at the same level of proficiency as other students of comparable ability.[32]

Blindness
This term should be reserved for individuals who are actually blind (no light perception) or who have so little vision that they must rely mainly on other senses (vision substitution skills); even mere light perception can still be an adjunct for orientation and mobility. Since there are many different definitions of "blindness" used in different contexts, and since it is unrealistic to expect these definitions to disappear any time soon, it is recommended that the term blindness—when used in reports—be followed by its regional definition: for example, "legal blindness is defined as having a visual acuity of ≤ 6/60 in Australia", or "legal blindness (≤ 20/200 in the United States)." [32]

Legally Blind
In the United States and Canada, "legal blindness" is typically defined as visual acuity with best correction in the better eye worse or equal to 6/60 (20/200), or a visual field extent of less than 20 degrees in diameter. Even though the term "legal blindness" remains an artificial distinction and has little value for rehabilitation, it is important in determining eligibility for certain disability benefits from government programs. See section on *Legal Blindness* above.

Additional Definitions

Vision Loss
A general term that can be applied to the impairment as well as to the ability or activity aspect, to total loss (blindness), and partial loss (low vision).[7]

Mild, Moderate, Severe, Profound Vision Loss
Refer to the ranges listed in Appendix I of this report.

Literature Search and Review Strategy

Keyword Selection and Search Parameters

The search process is an ongoing activity for the VREBR project. Rehabilitative and medical/diagnostic-based literature searches are being conducted using specific keyword categories. See Appendix III for a detailed breakdown of keyword categories and sub-categories. It is our mission to perform exhaustive searches for appropriate literature using all possible keywords and combinations thereof. It should be noted that our keyword search criteria is predicted to expand and evolve as the project progresses.

The search date range criteria include the 1980s through 2005. Age parameters will include children as well as adults. Non-English language abstracts are being excluded. All references resulting from searches are being entered, organized, and managed in Reference Manager 10 databases.

Databases and Other Sources

The following databases, libraries, searchable bibliographies, journals, and miscellaneous sources are being used to locate experimental and non-experimental low vision rehabilitation abstracts. An important and obvious source is *Low Vision: The Reference,* a searchable bibliographic database of low vision literature edited by Gregory Goodrich, Ph.D., F.A.A.O. and Aries Arditi, Ph.D., F.A.A.O.[33]

- CINAHL
- Cochrane Databases
- EMBASE
- PsychInfo
- Pub Med
- Low Vision: The Reference
- Libraries: University of Western Ontario, including interlibrary loan system (Ontario Council of University Libraries[34]); Parkwood Hospital Library

Reference Search Results and Categorization Process

Our initial search results have been categorized in table format, and are presented in Appendix IV. These searches were conducted in November through December, 2004 and April through May, 2005. After the November through December, 2004 literature search was completed, the references were organized and categorized by RCT and non-RCT headings, and then further disseminated into *medical* (diagnostic, or “treatable”) and *rehabilitation* sub-categories. The results were tabulated within each category. For example, for age-related macular degeneration, 16 RCTs and 7 non-RCTs were found; within those two study categories, 1 *rehabilitation* RCT and 15 *medical* RCTs were located. The April through May, 2005 search focused specifically on low vision and driving. Again, these results are presented in Appendix IV.

To date, there have been very few high quality studies showing the effectiveness of low vision rehabilitation. It is also difficult to determine if certain low vision and blindness rehabilitation studies “qualify” as true RCTs. To find the best low vision rehabilitation evidence, it will require both a diligence for finding these details as well as some consensus building when deciding which studies are to be considered for systematic review.

Critical Appraisal and Review Strategy

The VREBR study selection strategy entails a systematic review of those studies deemed as showing the best evidence of low vision and blindness rehabilitative processes. The following types of experimental and non-experimental studies are being assessed for systematic review by experts in low vision rehabilitation, ophthalmology, psychology, and clinical research:

- Randomized controlled trials (RCTs)
- Meta-analyses of controlled trials
- Clinical Trials
- Multicenter studies
- Cohort studies
- Prospective and non-prospective studies
- Case Reports
- Reviews

Each study selected for review will follow a process of assessment by researchers and experts, who will in turn use specific assessment tools such as evidence-based checklists and rating scales. These assessment tools, checklists, and scales are also being researched and tested for their effectiveness and reliability in determining the strength of evidence of a particular study. The review process follows a specific pattern and we can expect a timely cycle of study selection, independent review, quantitative assessment (rating scales), and finally, a written assessment of those findings.

Evidence Rating Tools

Rating Scales Selection Process

When determining which rating tools to use for the project, the VREBR team assessed a number of methods to rate the evidence found in experimental and non-experimental studies. The team reviewed methods found in the following studies and reports: Jovell and Navarro-Rubio (1995)[35] (strength of evidence scale), the Agency for Healthcare Research and Quality's (AHRQ)[36] Systems to Rate the Strength of Evidence report, the Veterans Administration Technology Assessment Program's (VATAP) report on optical devices for adults with low vision[37], a strength of evidence rating method included in the American Academy of Ophthalmology report on vision rehabilitation for adults[28], a quality checklist developed by Downs and Black (1998)[38], and a rating scale to measure physiotherapy evidence, entitled PEDro[39].

The project team determined that the study quality checklist developed by Downs and Black is a useful tool in assessing the quality of both RCT and non-RCT studies. The checklist, consisting of 27 questions, is primarily tailored to rating randomized controlled trials, cohort, and case-control studies. Questions are grouped within study categories such as "reporting," "external validity," and "internal validity—bias," and "power." The VREBR project will use the same set of checklist questions for rating the quality of a particular study, as it pertains to low vision rehabilitation evidence.

In addition to presenting the checklist in a format such as Microsoft Word, a Microsoft Access version is being used to display the checklist questions with a "form" interface. When a reviewer assesses a study using this version, the responses from each of these checklist questions is entered into the Access database and given a total "quality score" from which the quality of evidence for each experimental and non-experimental design can be rated. The Access version was designed to enhance the collection of study rating scores, and to increase the automation and collection of review data.

Prevalence and Incidence Data

In a recent review of the studies on the prevalence of low vision, Evans and Rowlands (2004) concluded that *correctable visual impairment (VI)*, affects about 10% of people aged 65-75, and 20% of those aged 75 or older. Their literature review revealed that between 20 and 50% of older people have undetected reduced vision. The authors also found overwhelming evidence that there is a very large population of older people with low vision who are not receiving appropriate health care.[14]

The following statistics, from the National Eye Institute (U.S.) represent the prevalence of blindness and low vision in Canada and the United States, as well as low vision conditions. It should be noted however, that there is a scarcity of reliable Canadian data on the prevalence and incidence of blindness and low vision.

Summary of Eye Disease Prevalence Data[40]

Prevalence of Blindness and Low Vision among Adults 40 Years and Older in the U.S.

Age,	Blindness**		Low Vision††		All Vision Impaired	
Years	Persons	(%)	Persons	(%)	Persons	(%)
40-49	51,000	0.1%	80,000	0.2%	131,000	0.3%
50-59	45,000	0.1%	102,000	0.3%	147,000	0.4%
60-69	59,000	0.3%	176,000	0.9%	235,000	1.2%
70-79	134,000	0.8%	471,000	3.0%	605,000	3.8%
>80	648,000	7.0%	1,532,000	16.7%	2,180,000	23.7%
Total	937,000	0.8%	2,361,000	2.0%	3,298,000	2.7%

** Blindness as defined by the U.S. definition is the best-corrected visual acuity of 6/60 or worse (=20/200) in the better-seeing eye.

†† Low vision is defined as the best-corrected visual acuity less than 6/12 (<20/40) in the better-seeing eye (excluding those who were categorized as being blind by the U.S. definition.)

Prevalence of Cataract, AMD, and Open-Angle Glaucoma among Adults 40 Years and Older in the U.S.

Age,	Cataract		Advanced AMD		Intermediate AMD		Glaucoma	
Years	Persons	(%)	Persons	(%)	Persons	(%)	Persons	(%)
40-49	1,046,000	2.5%	20,000	0.1%	851,000	2.0%	290,000	0.7%
50-59	2,123,000	6.8%	113,000	0.4%	1,053,000	3.4%	318,000	1.0%
60-69	4,061,000	20.0%	147,000	0.7%	1,294,000	6.4%	369,000	1.8%
70-79	6,973,000	42.8%	388,000	2.4%	1,949,000	12.0%	530,000	3.9%
≥80	6,272,000	68.3%	1,081,000	11.8%	2,164,000	23.6%	711,000	7.7%
Total	20,475,000	17.2%	1,749,000	1.5%	7,311,000	6.1%	2,218,000	1.9%

Prevalence of Diabetic Retinopathy among Adults in the U.S.

Age,	Type 1 Diabetes		All Diabetes — 40 Years and Older	
Years	Persons	(%)	Persons	(%)
18-39	278,000	0.3%	NA	NA
40-49	172,000	0.4%	589,000	1.4%
50-64	317,000	0.4%	1,582,000	3.8%
65-74			1,068,000	5.8%
≥75			824,000	5.0%
Total	767,000	0.4%	4,063,000	3.4%

Estimated Prevalence of Myopia and Hyperopia in the U.S.

Age,	Myopia (Nearsightedness)		Hyperopia (Farsightedness)	
Years	Persons	(%)	Persons	(%)
40-49	15,460,000	36.4%	1,534,000	3.1%
50-59	7,355,000	23.3%	2,325,000	7.7%
60-69	3,459,000	17.0%	2,538,000	13.2%
70-79	2,481,000	15.2%	3,112,000	19.3%
≥80	1,603,000	17.5%	2,168,000	23.6%
Total	30,358,000	25.4%	11,677,000	9.9%

Summary of Incidence Rates of Low Vision and Blindness

The text and data on low vision incidence rates, cited on the following pages (19-23), is from Robert Massof's article entitled "*A model of the prevalence and incidence of low vision and blindness among adults in the U.S."*[41].

Incidence rate, i.e., the growth rate, is the first derivative of the prevalence rate as a function of age. Figure 1 below illustrates estimates of the annual incidence rate of low vision and blindness (≤ 6/21 (20/70) in the better eye) for white and black populations that were derived by differentiating the functions fit to the prevalence data rate in Fig. 2 A and B. The estimated incidence rate for blacks under age 77 years is greater than the estimated incidence rate for comparably aged whites. The difference undoubtedly is due to the higher incidence of visual impairment caused by glaucoma in blacks. The estimated incidence rate for whites is greater than the estimated incidence rate for blacks among the very old (>77 years). This difference for the older population most likely is due to an accelerating incidence of ARMD in whites, a condition rarely seen in blacks.[42]

The only published study of the incidence of visual impairments is the 5-year follow-up to the Beaver Dam Eye Study.[43] That study reported 5-year incidence of visual acuity loss to < 6/12 (20/40) and 5-year incidence of legal blindness ≤ 6/60 (20/200). Figure 3 illustrates the annual incidence model for whites as a function of age plotted along with estimates of annual incidence rate of < 6/12 (20/40) (open circles) and ≤ 6/60 (20/200) (filled circles) vs. age from the Beaver Dam follow-up data. The model, based on a visual acuity criterion of ≤ 6/21 (20/70), falls between the two sets of estimates.

The number of new low vision and blindness cases per year can be computed using the estimates of incidence rate together with the 1990 and 2000 U.S. census data. Figure 4 illustrates for 2000 the annual growth in low vision and blindness for both black and white populations as a function of age. The number of new cases of low vision and blindness is greatest for people over age 65 years. Based on the model, the estimated total number of new cases of low vision and blindness in 1990 was 245,000 and in 2000 were 256,000. The unpublished follow-up study concluded that the annual incidence of low vision and blindness in the U.S. is approximately 250,000 people.

The U.S. population is aging. As illustrated in Figure 5, the incidence of low vision will continue to grow over the next three decades. Assuming the incidence rate of low vision and blindness from age-related eye disease does not change over the next 25 years and factoring in the death rate for each age group, the number of new cases of low vision and blindness per year will increase to 500,000 by 2025. Figure 6 illustrates the expected growth in the prevalence of low vision and blindness for each age group over the next 30 years.

The total number of Americans with low vision and blindness in 1995 was approximately 1.3 million, and that number grew to 1.5 million in 2000. Incorporating the high death rates for older age groups, the expected net growth in the prevalence of low vision and blindness is approximately 36,000 cases per year until 2025. These estimates are based on a ≤ 6/21 (20/70) visual acuity criterion for low vision and blindness. However, the annual incidence, the number of new cases added each year, will grow from the current 256,000 to 500,000 in 2025.

The models presented here, and the data on which they are based, suffer several shortcomings. First, the studies mainly focused on white populations. Two studies evaluated black American samples, but none of the studies looked at other racial groups. Second, all of the conclusions are based on *visual acuity loss*. Vision disability depends on visual acuity, but visual field loss and other visual impairments can also contribute to low vision. The exclusive reliance on visual acuity as a surrogate for vision disability undoubtedly underestimates the prevalence and incidence of vision disability, particularly for blacks among whom glaucoma, which produces visual field loss, is the leading cause of visual impairment. Third, the estimated prevalence and incidence in the study samples include an unknown number of cases of cataract for the visual acuity criteria chosen. Because cataract can be

corrected surgically, not all cases should be counted when estimating the prevalence and incidence of low vision and blindness.

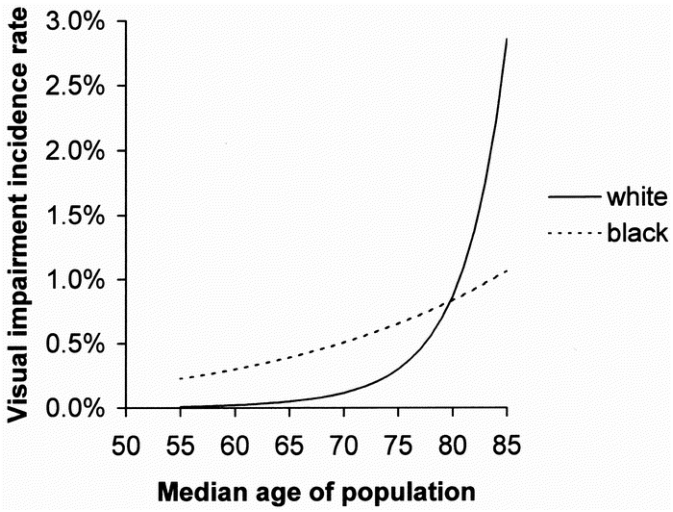


Figure 1. Estimated annual incidence rate of low vision for the white (solid line) and black (dashed line) populations. These curves were obtained by differentiating the curves fit to the prevalence data in Fig. 2. (Massof R, 2002).

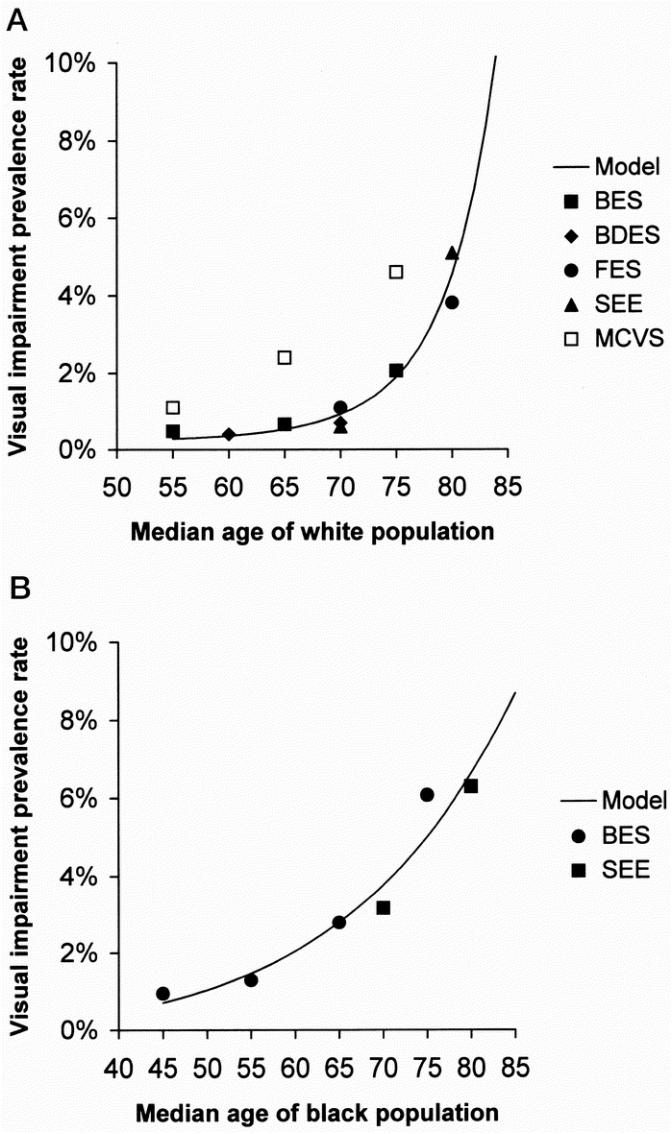


Figure 2.
A. Prevalence rate of visual impairment as a function of median age of the age categories for the white population. Data for only the bounded age categories are plotted for each study. The acuity criteria were 6/24 (20/80) for the Framingham Eye Study (FES) and the Beaver Dam Eye Study (BDES) and 6/18 (20/60) for the Baltimore Eye Survey (BES), the Mud Creek Valley Study (MCVS), and the Salisbury Eye Evaluation Study (SEE).

B. Prevalence rate of visual impairment as a function of median age for the black population. Data shown are bounded age categories only. (Massof R, 2002).

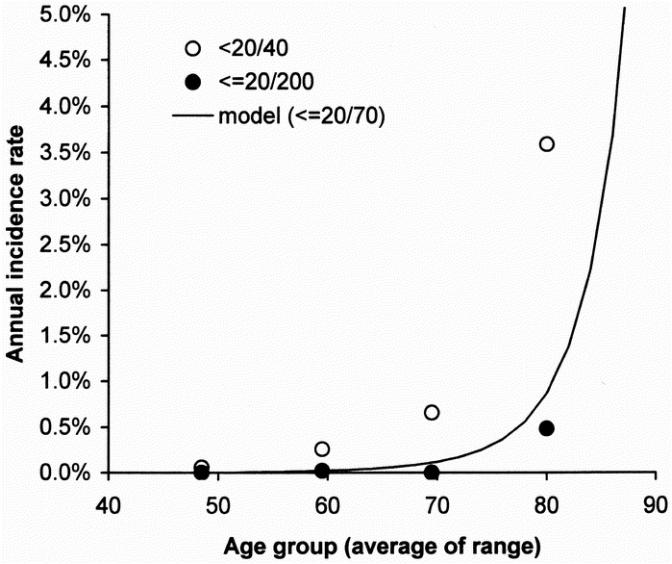


Figure 3. Estimated annual incidence rate of visual impairments < 6/12 (20/40) (open circles) and visual impairments ≤ 6/60 (20/200) (filled circles) from the 5-year incidence data for the Beaver Dam Eye Study. (Massof R, 2002).

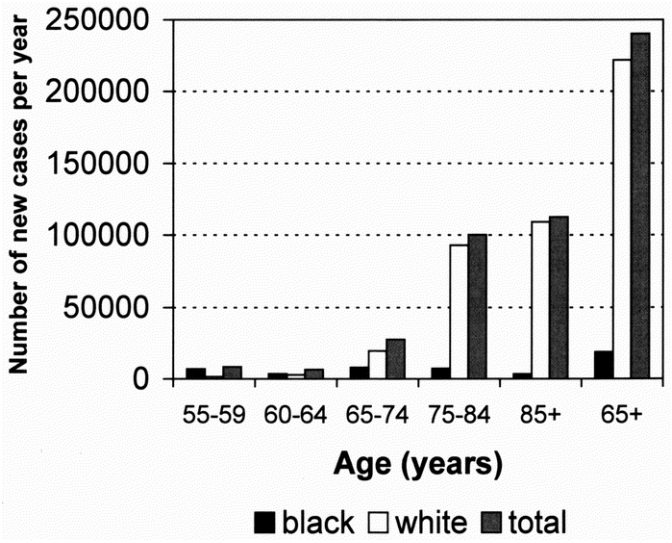


Figure 4. Estimated number of new cases of low vision per year in each age group. The last bars are estimated of new cases of low vision among people 65 years and older. These estimates are based on the annual incidence rate estimates shown in Figure 1 and on 2000 census data. (Massof R, 2002).

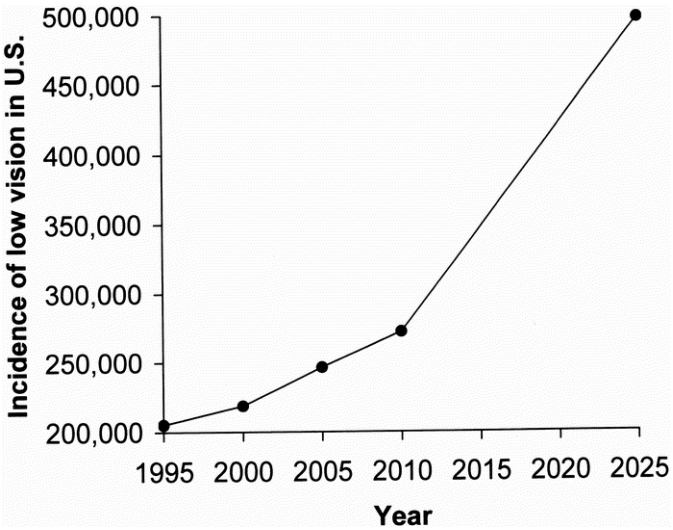


Figure 5. Annual incidence of low vision projected for each quinquenniade through the year 2025. This growth function is bases on the projected change in age demographics over time in the U.S. and assuming no change in low-vision incidence rate as a function of age. (Massof R, 2002).

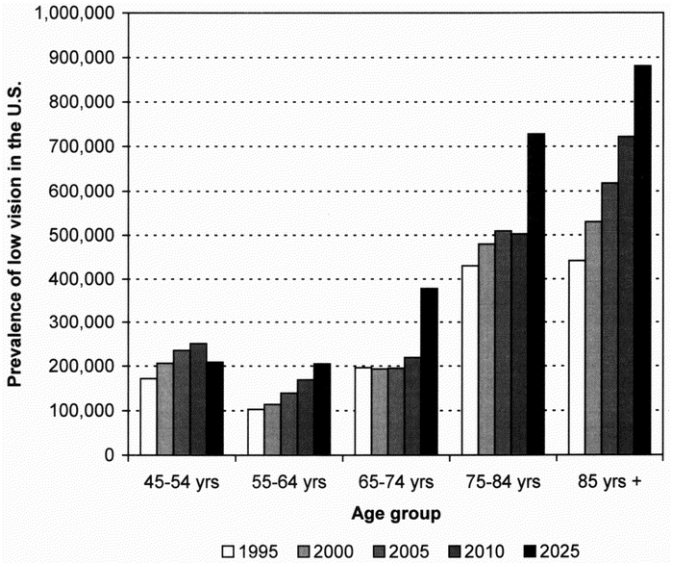


Figure 6. Histograms of the estimated number of low vision cases in each age category from 1995 to 2025. (Massof R, 2002).

Comparison of Canadian and U.S. Statistics on Low Vision and Blindness

The VREBR focuses primarily on the status of low vision and blindness rehabilitation in North America (Canada and the U.S.), but will assess the quantity and quality of experimental and non-experimental studies conducted in the field of low vision and blindness rehabilitation found worldwide. The following statistical comparisons between Canada and the United States have been outlined below because of the VREBR's focus on this particular North American population. However, the project must take into consideration the considerable amount of research conducted in the UK and Australia (and potentially other countries with significant data), as they have very similar demographic and epidemiologic features; they have also conducted experimental and non-experimental studies in the field of low vision rehabilitation.

Low vision and blindness conditions and their respective data are very much the same for both countries, with the exception of the following demographic differences: population size, ethnicities and those conditions associated with specific ethnic groups, age, and gender. There are also differences in the number of population-based studies that have been conducted between the two countries.

Statistics and Conditions	Canada	US
Estimated prevalence of aging populations, predicted increases in low vision rehabilitation needs, and their associated conditions.	▪ The number of Canadians over the age of 65 is projected to increase to between four and five million by the year 2021. These projections suggest that a significant increase in the number of visually impaired and blind individuals will occur over the next twenty to thirty years. ▪ According to Statistics Canada, seniors will make up 21% of the population by 2026 (one in five), compared to 13% in 2000. ▪ The HALS post-census survey (data collected in 1991) predicted that by the age of 65, one in nine Canadians will experience severe vision loss. By the age of 85, this figure increases to one in four Canadians. There are currently (as of 2002) 105,000 Canadians registered with CNIB as blind or severely visually impaired. This number is increasing by 1000 per month—a rate that will lead to a doubling of the number of blind and severely visually impaired Canadians in the next 10 years.	▪ The over-65 age group is expected to increase from 33.2 million in 1994 to 80 million in 2050, and as the proportion of elderly in the population increases, the number of individuals with low vision is likely to increase as well. ▪ The National Aging and Vision Network estimate that there are more than four million people in the U.S. who are 55 or older and experiencing severe vision loss. Only thirty years ago that number was just two million; the number is expected to double again by 2030. Vision loss will eventually affect almost everyone. "By age 85, 1 in 4 older people cannot read a newspaper with best corrected vision," the National Aging and Vision Network reported to the U.S. Congress in 1997.[45]

Statistics and Conditions	Canada	US
	▪ According to PALS (Participation and Activity Limitation Survey, 2001—Statistics Canada, Post-censal survey)[44] data: the prevalence of vision disabilities for adults aged 15 years and over was 594,350, or 2.5%. *The survey describes a seeing disability as having difficulty seeing ordinary newsprint or clearly seeing the face of someone from 4 metres (12 feet).* The PALS findings confirm that the prevalence of vision loss (among other types of disabilities such as mobility, agility, hearing loss, and pain) rises increasingly with age—the rate reaches 31.5% for persons aged 65 and over.	
Leading causes of vision impairment and blindness	**Diabetic retinopathy** Coincides with the increase in diabetes in Canada) **Age-related macular degeneration** Most common cause of blindness and vision impairment in Canadians aged 60 and older. The number of AMD cases is predicted to grow at a rate of 77,000/year. **Cataracts** Most common surgical procedure performed in North America. **Glaucoma** At least 300,000 Canadians are affected with this disease, and 50% of patients are unaware that they have it.	**Diabetic retinopathy** Affects over 5.3 million Americans age 18 and older, or just over 2.5% of the population. Prior to age 40, DR affects Whites more frequently than other races. In later decades, Hispanics are most commonly affected by the disease. **Age-related macular degeneration** Over 1.6 million Americans age 50 and older have late AMD—all cases of wet form are considered late AMD. Age-specific prevalence rates are initially comparable between races, but advance more significantly for Whites after age 75. In Blacks, the disease is more prevalent in women until about age 75, as well. **Cataracts** Cataract affects nearly 20.5 million Americans age 40 and older, or about 1 in 6 people in this age range. By age 80, more than half of all Americans have

Statistics and Conditions	Canada	US
		cataract. *Even though cataract is considered a "conquered disease" because of the availability of surgical treatment, it still accounts for a significant amount of vision impairment in the U.S., due to older people having difficulty accessing appropriate eye care due to cost, availability, and other factors.* **Glaucoma** According to the Glaucoma Foundation (2001), approximately 3 million people in the U.S. have glaucoma, including 6% of those over the age of 65.
Blindness	There are currently 105,000 Canadians registered with CNIB as blind or severely visually impaired. That number is currently increasing by 1000 per month - a rate that will lead to a doubling of the number of blind and severely visually impaired Canadians in the next 10 years.[46]	Blindness affects more than 1 million Americans over 40. Blindness affects Blacks more frequently than Whites and Hispanics. The prevalence of blindness and vision impairment increases in later years, particularly after age 75.

Race/Ethnicity	The following groups appear to have the most collected data on low vision and blindness conditions:
	▪ Caucasian
	▪ Asians (a few studies)
	▪ Aboriginal (few)
	
	There is a deficit in study quantity on the following groups:
	▪ Aboriginal
	  o First Nations
	  o Status Indians
	  o Non-status Indians
	  o Métis
	  o Inuit
	▪ Asian
	▪ Hispanic
	▪ Black
	▪ Other races
	▪ Recent immigrants
		The following ethnic groups appear to have the most collected data on low vision and blindness conditions:
		▪ Caucasians
		▪ Blacks
		▪ Hispanics
		▪ Aboriginal groups (few)
		
		There is a deficit in study quantity on the following groups:
		▪ Aboriginal
		▪ Asian
		▪ Recent immigrants
		▪ Other

Statistics and Conditions	Canada	US
Population-Based Studies	There is strong evidence of a *deficit* of high-quality randomized controlled studies as well as large-scale population-based eye studies—focusing on low vision and blindness—in Canada. In Canada, some studies have been conducted within areas of Quebec, Ontario, Asian and Aboriginal/First Nations groups, but among the latter group, no large-scale population-based studies have been conducted.	Since 1977, five major, population-based (urban and rural) prevalence studies have been conducted: 1. The Framingham Eye Study (Framingham, Massachusetts) 2. The Beaver Dam Eye Study (Beaver Dam, Wisconsin) 3. The Baltimore Eye Survey (Baltimore, Maryland) 4. The Mud Creek Valley Study (Kentucky) 5. The Salisbury Eye Evaluation Study (Salisbury, Maryland) Even though these studies represent large-scale population based studies, there is still strong evidence pointing to a *deficit* of high-quality randomized controlled studies (with experimental methods thoroughly examined and explained) in the field of low vision and blindness rehabilitation in North America and worldwide.

Overview of Canadian Population-Based Studies on Blindness

Note: The information cited on this page (28) is from Susan Lewallen's article entitled, *Blindness and gender in the industrialized countries: A review of the literature with special attention to Canada*.[47]

To our general knowledge, there have been no large population-based studies of blindness in Canada. Extrapolation of data from the large population-based studies (U.S.-based studies) to Canada must be done with caution. The studies were predominantly Caucasian populations, which likely represent the Caucasian population of Canada, but Canada is multicultural, with more and much larger groups of ethnic minorities than are represented in the studies. Predominantly Caucasian-inclusive studies and their respective data can be translated easily for Canadian Caucasian populations. However, this does not translate well for the multicultural fabric of the country (i.e. Chinese, Indian, Aboriginal, Inuit, etc.)

The leading causes of blindness, AMD and cataract, probably apply overall in Canada, although there are no population-based data to verify this. Data from the CNIB indicate that the leading causes of blindness in both males and females in their clientele is 1) AMD; 2) retinal disease (of which diabetic retinopathy makes up roughly 35% and, presumably, the remainder includes a number of genetic cases), and 3) glaucoma. Females make up 60% of the clientele. Among the registered blind of Newfoundland and Labrador, genetic disease (which included some retinal diseases), diabetes, and AMD were the leading three causes in 1980-4. Not only do rates of blindness vary among subgroups, it is likely that causes do also. For example, in the Canadian Inuit population- based survey mentioned above, the causes of blindness included trauma, corneal diseases, cataract and angle closure glaucoma. The prevalence of AMD varies among ethnic groups. Late stage disease has been documented to be lower in those of African descent compared to Caucasian and suggested to be lower in Chinese-Canadians, but there are no population-based data from Asian populations.

The high prevalence of angle closure glaucoma among Chinese and Inuit, and especially among females, could lead to excess blindness from this disease, especially if utilization of services by females in these groups is low. A study among Canadian Eskimo reported a prevalence of angle closure glaucoma of 2.5% in male and 3.3% in females over age 40. In the group of females over 60 year old the prevalence was 11.4%. Fifty percent of the affected eyes were blind. There is no published data on the prevalence of angle closure glaucoma among Chinese Canadians.

Amongst the First Nations people, health care providers report that they are "battling an epidemic of diabetes". A prevalence study (chart-review) of diabetic retinopathy among the Moose Factory Cree in Ontario revealed that 66% of subjects (n=187) with diabetes were female. The female elevated prevalence is most likely due to screening for gestational diabetes--men do not seem to have the same access to this test. The prevalence of diabetic retinopathy was 29%, but neither univariate nor multivariate analyses revealed an increased risk for retinopathy based on sex.

Epidemiologic and Demographic Data

Leading Causes of Low Vision and Blindness

Age-Related Macular Degeneration (AMD)

According to the World Health Organization (WHO)[48], macular degeneration is the most common non-avoidable cause of vision impairment. It is estimated that 8 million persons worldwide are blind or severely visually impaired due to macular degeneration. AMD is the leading cause of visual impairment among persons age 75 and older. It is the most common cause of new cases of visual impairment among those over age 65[49].

As the U.S. population ages, more elderly persons will become blind from AMD than from glaucoma and diabetic retinopathy combined[50]. The Canadian population is aging and research is needed on how this demographic shift will affect the prevalence/incidence of AMD.[51]

Glaucoma

Glaucoma is the third leading cause of blindness worldwide and is responsible for about 5.2 million cases of blindness. Estimates of the number of persons worldwide who have glaucoma range from 67 million to about 105 million "suspect" cases of glaucoma[48]. According to the Glaucoma Foundation, approximately 3 million people in the U.S. have glaucoma, including 6% of those over the age of 65[52].

Glaucoma prevalence is clearly related to race and age. In general, glaucoma is more common in Blacks, Hispanics, and with increasing age. In the 65-69 age group, the prevalence rate is three times higher at 4.8%. For those aged 80 and older, glaucoma affects more than 10% of Black men and Hispanic women[53]. Glaucoma appears to be more common initially in women, but by age 65, prevalence becomes more comparable between the sexes[53].

Cataract

According to the WHO[48], cataracts are the leading cause of blindness in the world. Cataract accounts for an estimated 16 million cases of blindness worldwide; it accounts for one half of all cases in most countries of Africa and Asia[48]. Cataract affects 20.5 million (1 in 6) Americans age 40 and older. By 80 years of age, more than one half of Americans have cataract[49].

There appears to be a higher prevalence among females. According to estimates of Americans age 40 and older, a higher proportion of females have cataracts (20%) as compared to males (14%)[49].

Diabetic Retinopathy

An estimated 17 million people in the U.S. have diabetes, which is the leading cause of new cases of legal blindness among adults 20 to 74 years of age[54]. Approximately 40% (6 million) of all people with diabetes have diabetic retinopathy. An estimated 5% of persons with diabetes have the sight-threatening form of this disease[55].

Refractive Errors
Myopia and hyperopia are the most common refractive errors[53]. Myopia is a very common disorder affecting more than 30.5 million Americans age 40 and older. Prevalence is greater in women through age 60 when rates become more comparable between genders[53]. Because of the higher threshold for significance, hyperopia is less common, affecting 12 million older Americans. Prevalence of hyperopia generally increases with age[53].

Amblyopia
Amblyopia is correctly described as monocular vision impairment[56], but does not qualify as a low vision condition for the purposes of this review. Its inclusion would introduce a huge volume of spurious research literature related to amblyopia diagnosis and treatment issues. Analogous "blindness" situations exist following monocular enucleation. This might correctly be described as monocular blindness, but individuals with one eye are not included in epidemiological profiles of functional blindness.

Other Causes of Low Vision and Blindness

Retinitis Pigmentosa
Retinitis pigmentosa (RP) is the most common cause of inherited blindness[57] and an estimated one out of 80 people carry the recessive gene. RP affects 100,000 Americans.[58]

Usher Syndrome
Approximately 3-6 percent of all deaf children and perhaps another 3-6% of children with hearing impairments have Usher syndrome. In developed countries such as the United States, about 4 babies in every 100,000 births have Usher syndrome.

Congenital and Developmental Conditions
The leading causes of visual impairment among infants and children are retinopathy of prematurity (ROP), cortical visual impairment, and structural ocular abnormalities, such as cataract and coloboma. These conditions occur during infancy and early childhood, when it is difficult to assess their effects on vision and quality of life. In addition, many of these conditions occur with increased prevalence in children with neurodevelopmental delay, further complicating the assessment of level of vision and the evaluation of quality of life. More boys than girls are visually impaired. Additionally, increasing numbers of infants are born very prematurely and survive. These children are at high risk for multiple disabilities, including visual deficits, and will substantially increase the number of Americans with visual impairment.[59]

Retinopathy of Prematurity (ROP)
The incidence of ROP varies by birth weight. Because of improved neonatal facilities and better survival rates for premature infants, there has been an increase in ROP. ROP incidence and prevalence statistics in the United States are as follows:

- ✓ One third of infants weighing < 1500 grams at birth may show evidence of retinopathy of prematurity.
- ✓ 65.8% of infants weighing less than 1251 grams at birth, and 81.6% of those weighing less than 1000 grams.
- ✓ Babies with a birth weight of 1001-1500 grams, 2.2% will develop cicatricial changes as a complication of ROP and 0.5% of them will be blind.
- ✓ 5.1 % of premature infants with birth weights < 1251 grams will have vision of 20/200 or worse after 5 1/2 years of follow-up.

Developmental Disabilities
Children who have developmental delays, cerebral palsy, or Down syndrome have a higher incidence of refractive errors and other ophthalmologic problems than children without disabilities. Children with

cerebral palsy have a higher incidence of nearsightedness, visual field loss, and strabismus. With Down Syndrome, there is a greater chance of having serious refractive errors which require prescriptive glasses, and lesser chance of actual "legal" blindness. About 70 percent of children with visual impairments have an additional disability.

Corneal Disease
Diseases and injury to the cornea are the leading cause of visits to physicians for medical eye care in the United States[50].

AIDS-Related Visual Impairment
The estimated proportion of persons with AIDS who will develop CMV retinitis ranges from 20%[60] to approximately 40%[61].

Cancer
Retinoblastoma is the most common intraocular malignancy of childhood. There are between 300 and 400 new cases diagnosed annually[50], and approximately 1,500 new cases of choroidal melanoma are diagnosed annually[50].

Brain Injury
Vision can be lost or damaged as a result of head injuries, brain damage and stroke. Signs and symptoms can include reduced visual acuity, visual field, or contrast sensitivity, blurred vision, eye misalignment, poor judgment of depth, glare sensitivity, confusion when performing visual tasks, difficulty reading, double vision, headaches, dizziness, abnormal body posture, and balance problems.[62] About two million head injuries of all types (including skull and facial fractures) occur each year in the U.S. (175 to 200 per 100,000 population).[63] An estimated 62.3 per 100,000 adults age 15 and over are living in the community with enduring functional impairments due to TBI (excludes most survivors of mild TBI).[64]

Eye Injuries
Eye injury is a leading cause of monocular blindness in the United States, and is second only to cataract as the most common cause of visual impairment. The following statistics are based on estimates from the United States Eye Injury Registry[65] (selected data from 1988 through 2000):

Causes of Eye Injury
Blunt objects account for about 31% of eye injuries, 18% are caused by sharp objects, 9% by motor vehicle crashes, with the remainder caused by bb/pellet guns (6%), nails (5%), hammer on metal (5%), fireworks (5%), guns (5%), falls (4%), explosion (3%), and other (8%).

Age
The majority of all eye injuries occur in persons under thirty years of age (57%). Persons with an eye injury are an average age of 29 years (median age=26 years).

Place of Injury
The highest proportion of eye injuries occur in the home (40%), followed by street/highway (13%), industrial (13%), playing a sport (13%), other (12%), and 9% are unknown.

Work-Related Eye Injuries
20% of eye injuries are work-related with 95% occurring among males; the leading occupation reported was construction.

Low Vision and Blindness Statistics

Age

Elderly and Middle Aged Adults[1]
The prevalence of vision impairment increases with age as indicated in the following estimates:[66]

- 15% of Americans age 45-64 years report some form of vision impairment, representing 9.3 million persons.
- 17% of Americans age 65-74 years and older report some form of vision impairment, representing 3.1 million persons.
- 26% of Americans age 75 years and older report some form of vision impairment, representing 4.3 million persons.
- Among persons age 65 and older, an estimated 21% report some form of vision impairment, representing 7.3 million persons.

The vast majority of middle-aged and older Americans who report vision impairment are partially sighted rather than totally blind. Only 2% of all Americans age 45 and older report that they are blind in both eyes.

In Canada, CNIB clients (blind or low vision) are mainly 65 years and older. The prevalence of clients under 65 years old will remain relatively constant; however, the prevalence of older clients will increase dramatically (72%).

Severe Vision Impairment
Approximately 8.7 million Americans age 45 and older (9%) report severe vision impairment, and roughly 11% of people age 65 and older (3.8 million) report severe vision impairment (as defined in the low vision definitions section above).

Estimates Based on Visual Acuity
Approximately 2.4 million Americans age 40 years and older have a *best corrected visual acuity of worse than 20/40 but better than 20/200 in the better eye*[53]. An estimated 3.4 million Americans age 40 years and older have a *best corrected visual acuity of worse than 20/40 in the better eye*[53]

Legal Blindness
More than one million Americans age 40 and older are legally blind (*clinically measured visual acuity with best correction in the better eye worse than or equal to 20/200 or a visual field of less than 20 degrees*)[53]. Among individuals age 65 and older, approximately 713,000 are legally blind (*clinically measured visual acuity of 20/200 or less*)[67].

Persons under Age 45[1]
Nationally, 1.7% of persons under age 45 (3 million) self-report a visual impairment, defined as *blindness in one or both eyes or any other reported trouble seeing even when wearing glasses or contact lenses*[68].

Among young adults age 18-44, 2.4% or 2.6 million persons report a visual impairment defined as *blindness in one or both eyes or any other reported trouble seeing even when wearing glasses or contact lenses*[68.]

Among working age adults age 21-64, an estimated 3.7 million report having difficulty *seeing words and letters in ordinary newsprint even when wearing glasses or contact lenses*. Of these 3.7 million working age adults, 669,000 are unable to see words and letters in ordinary newsprint even when wearing glasses or contact lenses[69].

Legal Blindness
An estimated 163,000 Americans age 20-44, and 174,000 age 45-64 are legally blind[67].

Leading Cause of Vision Loss
According to the American Diabetes Association, diabetes is the leading cause of blindness in persons age 20-74. An estimated 12,000 to 24,000 people lose their sight each year because of diabetes.

Young & Working Age Adults[1]
Visual Impairment
Among young adults age 18-44, 2.4% or 2.6 million persons report a visual impairment defined as *blindness in one or both eyes or any other reported trouble seeing even when wearing glasses or contact lenses*[68.] Among working age adults age 21-64, an estimated 3.7 million report having *difficulty seeing words and letters in ordinary newsprint even when wearing glasses or contact lenses*. Of these 3.7 million working age adults, 669,000 are unable to see words and letters in ordinary newsprint even when wearing glasses or contact lenses[69].

Legal Blindness
An estimated 163,000 Americans age 20-44, and 174,000 age 45-64 are legally blind[67].

Leading Cause of Vision Loss
According to the American Diabetes Association, diabetes is the leading cause of blindness in persons age 20-74. An estimated 12,000 to 24,000 people lose their sight each year because of diabetes.

Children and Adolescents[1]
Visual Impairment
Based on data from the 1996 National Health Interview Survey less than 1% (0.6%) of persons under the age of 18 is visually impaired, defined as *blindness in one or both eyes, or any other trouble seeing even when wearing glasses*, representing 448,000 children and youths[68].

Severe Visual Impairment
Based on data from the Survey of Income and Program Participation (1997)[70], 264,000 children 6-14 years of age have difficulty seeing words and letters in ordinary newsprint even when wearing glasses or contact lenses. Of those, 45,000 have a severe vision impairment (unable to see words and letters in ordinary newspaper print), and 219,000 have a non-severe vision impairment[69].

Legal Blindness
In 1990, data on legal blindness indicated that approximately 2,600 children less than 5 years of age and approximately 51,000 between the ages of 5-19 were legally blind[67].

Blindness among Children[71]
As blindness in children is relatively rare, accurate prevalence data are difficult to obtain, because very large samples are required for population-based prevalence surveys. The incidence of blindness in children is very difficult to ascertain, requiring very large longitudinal studies, accurate registries of the blind, or reliable active surveillance systems. In industrialized countries, the incidence of blindness resulting from acquired conditions has declined over the last few decades. In developing countries, a high proportion of children who become blind die within a few years of becoming blind, either from systemic complications of the condition causing blindness (e.g. vitamin A deficiency, measles, meningitis, and congenital rubella syndrome), or because poor parents have more difficulty in caring for their blind children than their sighted siblings.

Causes of Blindness among Children
Among children under 5 years of age, prenatal cataract is the leading cause of legal blindness, accounting for 16% of all cases. This is followed by optic nerve atrophy (12% of all cases) and

retinopathy of prematurity (9% of all cases)[72].

Blindness occurs mainly among children with birth weights below 1,000 grams (2 lbs, 3 oz) at rates of 5% to 6%[73].

Retinopathy of Prematurity (ROP) is the leading cause of blindness among premature infants in developed, and rapidly developing, countries[48].

World-wide Estimates

An estimated 1.4 million children (age 14 and under) in the world are classified as blind, defined as a corrected visual acuity in the better eye of less than 3/60 or a corresponding visual field loss in the better eye with best possible correction[74].

World-wide, vitamin A deficiency is the leading cause of childhood blindness, responsible for an estimated 70% of the 500,000 children who become blind each year[74].

Among persons with juvenile diabetes, 25% will have diabetic retinopathy after 5 years; almost 60% after 10 years; and 80% after 15 years[55].

The leading causes of visual impairment in infants and children are retinopathy of prematurity, deficits in the visual centers of the brain, and structural ocular abnormalities such as cataract and retinal abnormalities.[75]

Ethnicity

After a review of current population-based literature and statistical summaries, the authors of this report found the most information on the following ethnic groups. Data on other ethnic groups could not be listed reliably due to a lack of available data, specifically as it relates to low vision and ethnic background.

Canada and the U.S.

Caucasian

- Age-specific prevalence rates (for AMD) are initially comparable between races, but advance more significantly for Whites after age 75[55].
- Cataract affects Whites somewhat more frequently than other races, particularly with increasing age[55].
- Prior to age 40, diabetic retinopathy affects Whites more frequently than other races[55].
- Myopia affects more Whites than other races, and is generally less frequent with age. Hyperopia is more frequent in Whites, but also affects Hispanics more often than Blacks[55].

African-American/Blacks

- Blacks are twice as likely to suffer from diabetic-related legal blindness[76].
- Almost 4% of Blacks (409,643), age 40 and over, are reported to have glaucoma as compared to about 1.7% of Caucasians (1.6 million) and 1.5% of Hispanics (131,654)[55].
- Based on findings from the Baltimore Eye Survey, the prevalence of vision impairment due to glaucoma is four to six times higher among Blacks than Caucasians[77]
- In Blacks, the disease (AMD) is more prevalent in women until about age 75[55].
- Blindness affects Blacks more frequently than Whites and Hispanics[55].

Hispanic

- The prevalence of diabetic retinopathy among Mexican Americans who have diabetes is 32-40%[78].
- Research on a population-based sample found that glaucoma is the leading cause of blindness among Hispanics[79].
- Hispanics have higher rates of visual impairment than other races[55].
- Hispanics over 40 years of age are most commonly affected by diabetic retinopathy[55].

Specific Populations in Canada

Note: The following discussion of diabetes within aboriginal populations is included because complications from the disease commonly lead to low vision conditions.

Aboriginal Peoples[80 81]
Rates of diabetes among Aboriginal people in Canada are three to five times higher than those of the general Canadian population. Aboriginal children are also now being diagnosed with type 2 diabetes, a condition that in the past occurred mainly in older persons. Inuit rates of diabetes are not as high as those of other Aboriginal populations; however, there is concern that the rates of type 2 diabetes are increasing among Inuit as well.

Evidence also suggests that complications from diabetes have been more severe in Aboriginal populations. As the data from the Aboriginal People's Survey conducted in 1991 demonstrates, not only do more First Nations peoples suffer from one or more complications (noted in the survey as high blood pressure, heart disease, and *vision problems*), but the onset of these complications affects First Nations peoples at an earlier age.

Diabetes causes diabetic retinopathy, which is the leading cause of adult-onset blindness in North American adults. People with diabetes also have higher rates of cataracts. The National Institutes of Health in the United States indicates that approximately half those with diabetes have some form of eye disease, and just over 10% report serious retinal disease. In the Pima of Arizona, however, serious retinopathy has a frequency rate of 18%, and at Kahnawake (Quebec) 50% of patients had retinopathy after 10 to 15 years of the disease.

Assessment and Treatment

Assessment Methods

There is a wide variation in national estimates of vision impairment as a function of differences in both assessment methods and definitions of impairment.[30] According to the major population-based eye studies completed in the United States, there is a discrepancy between the assessment acuity criterion and how these translate to the populations studied.

Assessment methods fall into 2 broad categories: clinical assessments of visual functions and self-report of vision problems. Clinical assessments typically define vision impairment on the basis of visual acuity in the better eye. Almost all U.S. studies use the criteria of 20/200 for legal blindness. Legal blindness, however, has no functional meaning relevant to rehabilitation and only serves to establish eligibility for services (Prevent Blindness America: Vision Problems in the U.S. Schaumburg, IL: Prevent Blindness America; 1994.) Most epidemiological studies in the U.S. select a visual acuity criterion around 20/40 because 20/40 is the criterion in most states for unrestricted driving licenses. The World Health Organization uses criteria of 20/70 to 20/400 to define low vision and 20/400 or worse as blindness, making international comparisons difficult.[82]

In addition, various eye studies differ in their acuity criterion when defining visual impairment. For example, the Beaver Dam Eye Study used best-corrected visual acuity of 20/40 or worse in the better eye to define visual impairment. The Salisbury Eye Evaluation studied the same population (older persons aged 65-84 years), but used the acuity criteria of worse than 20/40 to better than 20/200 to define impairment. Using the same criteria, but including persons 85 years and older, the Baltimore Eye Survey found their numbers to be higher (4.2% of whites and 6.3% of African Americans with visual impairment, as opposed to the Salisbury Eye Evaluation which came up with 3.0% of whites and 5.6% of African Americans).[30]

Low Vision Rehabilitation Clinicians and Specialists

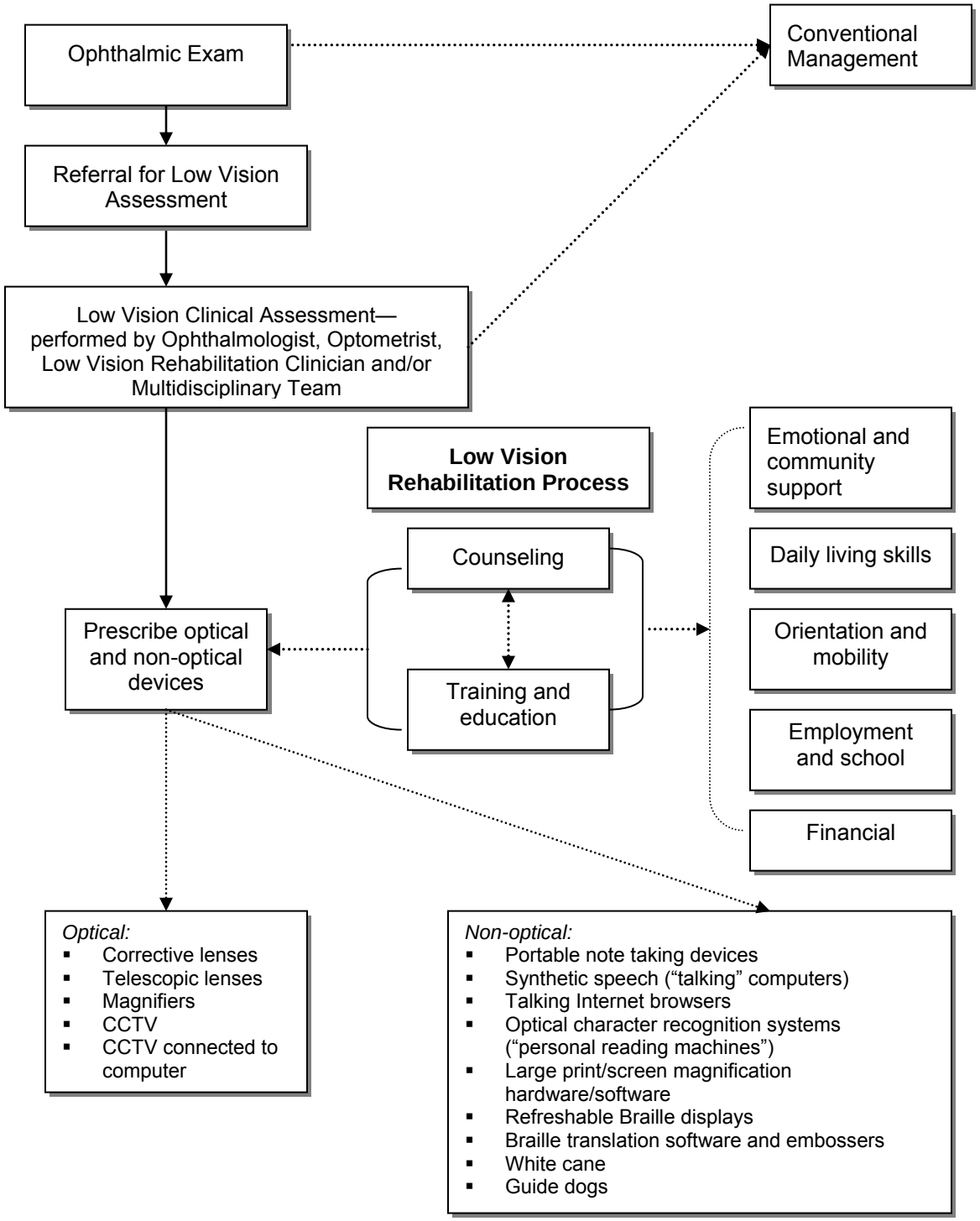
Ophthalmologist or optometrist
The most common pathway through the low vision rehabilitation process begins with an assessment by an ophthalmologist or optometrist. At this stage, a full ocular assessment is conducted, including the patient's history, duration of the vision problem, and how the problem has affected their daily life. The evaluation includes vision and eye testing, glare testing, testing to determine the need for standard glasses/contact lenses, peripheral vision testing, contrast-sensitivity testing, and color vision testing. A glaucoma test and a retinal exam are also common, along with anterior eye structure examination.[29]

Multidisciplinary treatment team
When the individual is referred for low vision rehabilitative services, they may be assigned to a multidisciplinary team composed of low vision therapists, ophthalmic technicians trained in the field of low vision, occupational therapists, and/or therapists within hospital rehabilitation departments. Nonmedical vision rehabilitation professionals may also be part of the team. Some examples include psychologists and social workers, rehabilitation teachers, and orientation and mobility specialists.

Service agencies
Most people in Canada receiving low vision services are not seen in the hospital rehabilitation setting. Referred by ophthalmologists and optometrists following diagnosis and any treatment, service agencies for persons who are blind or low visioned, such as the CNIB, use a team of medical personnel and vision rehabilitation therapists. These can include nurses as well as nonmedical professionals (e.g., Vision Rehabilitations Workers, VRWs). VRWs teach visually impaired clients to effectively use their remaining vision, and may recommend appropriate optical (e.g. magnifiers) and non-optical aids (e.g. lighting) to help the client reach his or her goals such as reading. These techniques, when incorporated into activities of daily living, are designed to help the client to do many of the activities he or she previously enjoyed. Other services can include counselling and referal to

other agencies, orientation and mobility training, technical aids, career development and employment, and library services.

Assessment and Treatment Flowchart



Assessment and Treatment Table

According to the American Academy of Ophthalmology's clinical practice guidelines, a multidisciplinary team approach is recommended because it is most effective in addressing the various functional and psychological problems caused by vision loss.[28]

	Assessments	Interventions
Low Vision	**American Academy of Ophthalmology's recommended steps for rehabilitative assessment and care:** ▪ Initial evaluation, including patient history (functional history) ▪ Evaluation of visual performance o Measurement of visual acuity o Measurement of visual field and scotomas o Testing contrast sensitivity **Optometric Clinical Practice Guideline for Care of the Patient with Low Vision[83]:** ▪ Diagnosis of visual impairment ▪ Patient history ▪ Ocular examination o Visual acuity measurement o Refraction o Ocular motility and binocular vision assessment o Visual field assessment ▪ Ocular health assessment ▪ Supplemental testing **Visual information processing skills** ▪ Visual information processing refers to a group of visual cognitive skills used for extracting and	**Optical** **American Academy of Ophthalmology's recommendations:** ▪ Revise spectacle prescription if necessary ▪ Contact lenses ▪ Lighting ▪ Contrast enhancement ▪ Glare control ▪ Magnification ▪ Scotoma identification and eccentric fixation training ▪ Surgical treatments **Optometric Clinical Practice Guideline for Care of the Patient with Low Vision[83]** ▪ Available treatment options o Magnification for near ▪ Spectacle-mounted reading lenses ▪ Telemicroscopes ▪ Hand magnifiers ▪ Stand magnifiers ▪ Electronic devices (e.g. CCTV) o Magnification for distance ▪ Telescopes ▪ Electronic devices o Management strategy for central visual field defects o Management strategy for peripheral visual field defects ▪ Prisms

	Assessments	Interventions
	organizing visual information from the environment and integrating this information with other sensory modalities and higher cognitive functions.[84]	▪ Mirrors ▪ Reverse telescopes and minus lenses o Management strategy for reduced contrast sensitivity and glare sensitivity **Non-optical** [Refer to flow chart above] ▪ Non-optical adaptive devices ▪ Training in adaptations for daily living activities ▪ Counseling and support groups (including employment) ▪ Local and national resources ▪ Patient education
Blindness	Same assessment procedures as listed above, with particular attention paid to the progression of vision loss due to the following conditions (major examples): ▪ AMD ▪ Cataract ▪ Glaucoma ▪ Diabetes complications ▪ Retinitis pigmentosa ▪ AIDS ▪ Retinal detachment ▪ Floaters and flashing lights	**Optical** Same intervention techniques and therapies as listed for low vision, and additional procedures such as: ▪ Surgical interventions o Corneal transplants o Ocular implants **Non-optical** Same intervention techniques and therapies as listed for low vision, and: o Education and training (community organizations) o White cane o Guide dogs

Interventions and Assistive Devices

Low Vision Devices (LVDs) and Aids

One aspect of a comprehensive low vision service is the provision of suitable low vision aids. For the most part, these devices help people to *read* and are likely to be beneficial because the inability to read is the chief complaint of patients with impaired vision.[85] However, even the benefits of low vision aids are poorly recognized.[86] This is not surprising, as there have been relatively few studies of the effectiveness of low vision aids. Those that have been conducted have used survey techniques to evaluate the performance of low vision aids, and they have not objectively quantified the reading performance before and after low vision aid provision.[87] [88]

Orientation and Mobility

To maintain travel independence, it is essential for a visually impaired adult to learn new orientation and mobility skills to compensate for reduced visual information. Orientation and mobility instruction, which is a component of vision rehabilitation, aims to maintain independence of travel by teaching visually impaired adults to ambulate and negotiate the environment safely and independently. The common mobility devices that have been used in orientation and mobility training are long and support canes.[89] The traditional, straight long cane is the most widely used mobility aid for the visually impaired in spite of modern technology-based devices.[90] [91]

Anecdotal evidence reported by orientation and mobility instructors and visually impaired adults indicates that orientation and mobility instruction does improve mobility skills. However, there have been few studies directly investigating the benefits of orientation and mobility training.[89]

Education, Vocational and Awareness Programs

There are health education programs that aim to assist clients with developing daily living skills and coping with tasks associated with everyday life. Programs also include vocational and educational assessment and guidance.

Unfortunately, not all low vision rehabilitation programs are available to meet the needs of its clients. Despite pleas for policy change, Medicare and secondary major medical insurance (in the U.S.) cover other rehabilitation services (occupational and physical therapy) but do not cover all facets of vision rehabilitation.[92] [93] In addition, studies have reported healthcare's failure to refer individuals with visual impairment to community vision rehabilitation resources when acute care ceases to be a viable treatment option.[94] [95]

Advanced Technology

For Clients

Adaptive Technology
Most adaptive technology is divided into one of two categories: either low or high technology solutions. Typically, high technology access equipment involves computerized access as part of a total computer package or as a stand-alone or interfaceable (ability to transfer information to and/or from a computer) product. Some examples include: Braille displays, embossers, and translation software; DOS speech computer access; electronic magnifiers CCTVs; electronic note takers; electronic reading devices; miscellaneous; music software; orientation and mobility devices/software; scanning and reading software OCR and OBR; screen magnification software; screen reading software; speech synthesizers; stand alone electronic reading systems; tactile graphics; voice recognition organizers; and Web access software.[96]

Telehealth Applications
Although telehealth applications for diabetes exist, the concept of patients controlling their own

ophthalmic imaging and records is becoming increasingly of interest to practitioners and their clients. Ophth Web is an example of a Web-based patient ophthalmic electronic record designed and reported by ophthalmologists in Singapore. It captures secure multimedia patient data such as digital retinal images which the patient can access or share with caregivers in other settings.[97]

For Providers

Ophthalmic electronic applications
Examples include: Visual field assessment software; embedded software for phacoemulsification machines (standard for surgical cataract extractions); digital imaging of the retina before laser treatment of AMD and diabetic retinopathy is performed with fluorescein angiography using specialized software for processing and storage; laser machines used to correct refractive error or to treat eye disease.

Advancing software is evident in acuity and refractive measurement instruments. Peripheral field assessment has proceeded through several generations of improving software. Less attention has been given to developing software for central field assessment and manipulation of eccentric viewing for vision rehabilitation. This is primarily because eccentric training and central vision assessment are relative newcomers to clinical vision rehabilitation and at this point lack wide acceptance. Less attention has also been given to common clinical assessment of contrast sensitivity. Contrast sensitivity, or the ability to see shades of the same color, is an important variable in the ability to drive safely. Efficient software to assist in measuring these two clinical parameters (central field assessment and contrast sensitivity) of vision would be very useful in ophthalmology.[97]

Electronic medical record (EMR) and practice management software
Although there are pockets of success in utilizing electronic health records in Canada, general uptake has been slow compared with other sectors such as banking for commerce. Multiple EMRs specifically designed for ophthalmic or optometric offices exist. However, fewer than 10% of Canadian ophthalmologists use EMRs. The explanation lies in various realms including funding, the complexity of demands in the health arena, privacy concerns, perceived return on investment and other human variables such as resistance to change.[97]

Telehealth applications
Telehealth applications exist for diabetes in various Canadian settings. These research initiatives show good potential to become more common. They incorporate existing technology such as fluorescein angiography and digital imaging which is familiar to practitioners. They facilitate ophthalmic consultation at a time when a scarcity of ophthalmologists to service the aging Canadian population is anticipated.[97]

Appendix I—Ranges of Visual Acuity Loss[82]

Named Ranges of Vision Loss (ICO, 1978 and ICD-9-CM)		Numbered Ranges (WHO, ICD-9)		Commonly Used Definitions of "Blindness" and Low Vision				Visual Acuity			Linear Scales	
								Decimal notation	U.S. notation	6m notation	Letter Count	Log MAR
(Near-) Normal Vision	Range of Normal Vision	(The ICD does not code normal conditions)						1.6	20/12	6/4	110	-0.2
								1.25	20/16	6/5	105	-0.1
								1.0	**20/20**	**6/6**	100	0
								0.8	20/25	6/7.5	95	0.1
	Mild Visual impairment (near-normal vision)							0.63	20/32	6/10	90	0.2
								0.5	20/40	6/12	85	0.3
								0.4	20/50	6/15	80	0.4
								0.32	20/63	6/18	75	0.5
Low Vision	Moderate Visual Impairment	Low Vision -- WHO	Group 1	Special Education Benefits -- USA		Low Vision – ICD-9, -10	Low Vision – ICD-9-CM	0.25	20/80	6/24	70	0.6
								0.2	20/100	6/30	65	0.7
								0.16	20/125	6/36	60	0.8
								0.125	20/160	6/48	55	0.9
	(20/200) Severe Visual Impairment		(6/60)					**0.1**	**20/200**	**6/60**	**50**	**1.0**
			Group 2		Legal Blindness Benefits – USA Blindness – ICD 6, -7, -8			0.08	20/250		45	1.1
								0.063	20/300		40	1.2
								0.05	20/400	3/60	35	1.3
	Profound Visual impairment	Blindness -- WHO	Group 3			Blindness –ICD-9, -10		0.04	20/500		30	1.4
								0.032	20/600	2/60	25	1.5
								0.025	20/800		20	1.6
								0.02	20/1000		15	1.7
(Near-) Blindness	Near-Blindness		Group 4				Blindness ICD-9-CM	Less	Less	1/60 or less	10	1.8
											5	1.9
	Blindness		Group 5					0.0	NLP	NLP	0	2.0

Appendix II—CNIB Client Statistics[46]

The statistics shown below represent CNIB's clientele at the end of 2002. These tables focus on the total CNIB client population by age group, and on the most common causes (diagnoses) for low vision.

Note: The following numbers are conservatively estimated to capture only 50 per cent of Canadians with severe vision loss. The true prevalence and incidence of blindness and visual impairment is really unknown because registration with the CNIB is voluntary.

Most Common Diagnoses by Age Group of New CNIB Clients in 2002

Age Group	Macular Degener-ation	Diabetic Retinopathy	Other Retinal Disorders	Glaucoma	Visual Pathway	Cataract	Corneal Sclera	Refraction	Other	Total	%
0-5	12	1	30	5	32	7	8	6	170	271	2.45
6-17	5	1	45	4	41	8	10	17	173	304	2.75
18-29	3	11	32	4	22	2	6	6	88	174	1.57
30-49	25	90	119	25	59	20	30	14	291	673	6.08
50-59	51	141	92	34	41	15	17	8	230	629	5.69
60-69	162	223	70	47	34	30	14	10	202	792	7.16
70-79	1,271	262	132	165	38	71	29	8	408	2,384	21.55
80-89	2,958	115	152	289	34	163	48	8	567	4,334	39.17
90 +	1,059	9	39	112	16	46	19	0	203	1,503	13.58
Total	5,546	853	711	685	317	362	181	77	2,332	11,064	
%	50.13	7.71	6.43	6.19	2.86	3.27	1.64	0.69	21.08		100

Total CNIB Client Population by Age Group in 2002

Division	0-5	6-17	18-29	30-49	50-59	60-69	70-79	80-89	90 +	Total	%
NF-LAB	27	160	223	336	235	243	314	421	202	2,161	2.07
NS-PEI	9	113	238	582	366	392	683	1,391	822	4,596	4.41
NB	5	86	167	442	283	281	516	926	538	3,244	3.12
QUE	22	289	391	1,455	1,084	1,005	1,429	1,918	1,264	8,857	8.50
ONT	353	1,670	1,886	4,979	3,458	3,767	7,864	15,066	9,545	48,588	46.64
MAN	66	185	192	516	378	361	725	1,619	1,024	5,066	4.86
SASK	49	187	195	414	285	278	660	1,737	1,270	5,075	4.87
AB-NWT-NUN	116	479	494	1,104	701	730	1,312	2,718	1,476	9,130	8.76
BC-YUKON	51	509	612	1,587	1,194	1,099	2,448	5,755	4,215	17,470	16.77
Total	698	3,678	4,398	11,415	7,984	8,156	15,951	31,551	20,356	104,187	
%	0.67	3.53	4.22	10.96	7.66	7.83	15.31	30.28	19.54		100

Appendix III—Keyword Strategy

The following tables are intended to help the reader understand the procedures being used for performing literature searches. They are not presentations of final results, and the reader should not draw conclusions from them; the search processes as well as the determination of which keywords will be used will more than likely evolve as the project progresses.

Keyword Strategy
The following keywords and combinations were originally used when performing literature searches. They represent general, overall categories from which searches were performed. The keyword strategy and resulting search evolved further into more detailed subcategories (see below).

Initial Keyword Search

Primary keyword	+ and/or	Secondary keyword	+ And/or	Tertiary keyword(s)
Diagnostic/medical conditions				
Low vision Visual impairment Vision impairment		Rehabilitation		Randomized or *randomised* controlled trial
Blindness				
Age-related macular degeneration				
Cataract				
Diabetic Retinopathy				
Glaucoma				
Refractive error [uncorrectable, but rehab-able]				
Retinitis pigmentosa				
Usher's syndrome				
Uveitis				
Inflammation [+ eye/vision]				
Birdshot retinopathy				
Pars Planitis				
Eye trauma/injury				

Primary keyword	+ and/or	Secondary keyword	+ And/or	Tertiary keyword(s)
Specific visual impairments				
Reduced [visual] acuity		Rehabilitation		Randomized or *randomised* controlled trial
Visual field loss				
Contrast sensitivity defects				
Photo recovery				
Glare defects				

Primary keyword	+ and/or	Secondary keyword	+ And/or	Tertiary keyword(s)
Disability—Functioning				
Reading		Rehabilitation		Randomized or *randomised* controlled trial
Daily living				
Orientation and mobility				
Driving with low vision				

Primary keyword	+ and/or	Secondary keyword	+ And/or	Tertiary keyword(s)
Assessment/Evaluation Methods and Technical Aids				
Visual functioning assessments and evaluation methods		Rehabilitation		Randomized or *randomised* controlled trial
Low vision technical aids and devices				

Primary keyword	+ and/ or	Secondary keyword	+ And/or	Tertiary keyword(s)
Education, Self-help, Therapy, and Training				
Low vision and education/self help/therapy/training		Rehabilitation		Randomized or *randomised* controlled trial

Secondary Keyword Search [specific to Low Vision and Driving]
The primary keywords listed in the table below were joined with a secondary keyword: driving. The keywords were combined with "randomized or clinical trial."

Impairment	
Primary Keywords	**Primary Keywords**
Acuity	**Field**
Low vision	Homonymous hemianopia
Impaired central visual field	Homonymous hemianopsia
Scotoma	Homonymous hemianopic field defects
Central scotoma	Homonymous hemianopic field deficit
Para central scotoma	Visual field defects
Mesopic visual acuity	Visual field deficit
Visual acuity	Visual field loss
Dynamic visual acuity	**Attention**
Reduced visual acuity	Visual attention
Stereo acuity	**Perception**
Photo recovery	Photopsia
Visual impairment	Metamorphosia
Contrast	Color perception
High contrast acuity	
Contrast sensitivity	
Reduced contrast sensitivity	
Low contrast acuity	

Disability	
Primary Keywords	**Primary Keywords**
Function	**Rehabilitation**
Glare disability	Blindness rehabilitation
Glare sensitivity	Partial vision rehabilitation
Glare discomfort	Low vision rehabilitation
Glare recovery	Vision rehabilitation
Multiple visual dysfunctions	
Visual function	
Fixation	

Etiology
Primary Keywords
Age-related maculopathy
AMD
ARMD
Age-related macular degeneration
Maculopathy
Juvenile macular dystrophies
Diabetic retinopathy
Retinal diseases
Retinitis pigmentosa
Cataract
Glaucoma
Stroke

Aging
Primary Keywords
Aging population
Elderly
Elderly drivers
Very old drivers

Technical Aids
Primary Keywords
Telescopes
Spectacles
Bioptic amorphic lenses
Bioptic telescopes
Bioptic telescopic spectacles
Telescopes
Prisms
Fresnel prisms
Field prisms
Mirrors
Sectorial prisms
Image enhancement

Technical Aids
Primary Keywords
Contrast enhancement
Electronic low vision aids
Vision aids
Night vision aids

Other
Primary Keywords
Blind mobility
Legal blindness
Visual factors
Visual status
Visually handicapped

Appendix IV—Reference Search Results

Initial Search Results (Categorized Totals)
The following table displays initial search results conducted on CINAHL, PubMed, EMBASE, PsychInfo, and Evidence Based Medicine (EBM) databases: Cochrane Database of Systematic Reviews (CDSR), American College of Physicians (ACP) Journal Club, Database of Abstracts of Reviews of Effectiveness (DARE), and Cochrane Controlled Trials Register (CCTR). The search results listed below were conducted from August through November 2004. References obtained from the search results were copied to Reference Manager databases.

Notes:
"Non-RCT" studies include: studies where it could not be determined if they were "true" RCTs or not; clinical trials; case control; prospective; cohort; multicenter; evaluation; etc.

"D" in parentheses represents a duplicate that was found in more than one category (for example, the same study came up with search results for low vision rehabilitation, AMD, glaucoma, etc.) These duplicates are not included in the overall combined totals.

	Overall Totals			**Rehabilitation§**		**Medical**	
Study Category/keyword(s)	**RCT**	**Non-RCT**	**Combined**	**RCT**	**Non-RCT**	**RCT**	**Non-RCT**
Overall Low Vision Category ↴							
Low vision	5	12	**17**	5	12	0	0
Visual impairment	4 (2D)	3 (8D)	**7 (10D)**	4 (2D)	1 (8D)	0	2
Low Vision Conditions ↴							
Age-related macular degeneration	16 (4D)	7 (5D)	**23 (9D)**	1 (3D)	0 (5D)	15 (1D)	7
Cataract	14 (1D)	2 (6D)	**16 (7D)**	0 (1D)	0 (4D)	14	2 (2D)
Diabetic retinopathy	2 (1D)	0 (3D)	**2 (4D)**	0 (1D)	0 (3D)	2	0
Glaucoma	3 (1D)	1 (4D)	**4 (5D)**	0 (1D)	1 (3D)	3 (1D)	0

§ *Rehabilitation* refers to those studies in which the research participants had uncorrectable and untreatable vision loss.

	Overall Totals			Rehabilitation§		Medical	
Study Category/keyword(s)	**RCT**	**Non-RCT**	**Combined**	**RCT**	**Non-RCT**	**RCT**	**Non-RCT**
Refractive error	14 (7D)	3 (4D)	**17 (11D)**	1 (1D)	0 (2D)	13 (6D)	3 (2D)
Uveitis	2 (2D)	1 (1D)	**3 (3D)**	0	0 (1D)	2 (2D)	1
Inflammation	0 (2D)	0	**0 (2D)**	0	0	0 (2D)	0
Birdshot retinopathy	0	0	**0**	0	0	0	0
Pars planitis	0	0	**0**	0	0	0	0
Eye/vision injury/trauma	1	3 (1D)	**4 (1D)**	0	0 (1D)	1	3

	Overall Totals			Rehabilitation		Medical	
Study Category/keyword(s)	**RCT**	**Non-RCT**	**Combined**	**RCT**	**Non-RCT**	**RCT**	**Non-RCT**
Blindness [overall]	3	5 (6D)	**8 (6D)**	2	5 (4D)	1	0 (2D)
Retinitis Pigmentosa	0	0 (1D)	**0 (1D)**	0	0 (1D)	0	0
Usher's Syndrome	0	0	**0**	0	0	0	0

	Overall Totals			Rehabilitation		Medical	
Study Category/keyword(s)	**RCT**	**Non-RCT**	**Combined**	**RCT**	**Non-RCT**	**RCT**	**Non-RCT**
Specific Visual Impairments ↴							
Reduced [visual] acuity	2	1 (2D)	**3 (2D)**	1	0 (1D)	1	1 (1D)
Visual field loss	0	0 (3D)	**0 (3D)**	0	0 (2D)	0	0 (1D)
Contrast sensitivity [defects]	2 (4D)	2 (3D)	**4 (7D)**	0	1 (2D)	2 (4D)	1 (1D)
Photo recovery	0	0	**0**	0	0	0	0
Glare defects	0	0	**0**	0	0	0	0

	Overall Totals			Rehabilitation		Medical	
Study Category/keyword(s)	**RCT**	**Non-RCT**	**Combined**	**RCT**	**Non-RCT**	**RCT**	**Non-RCT**
Disability—Functioning ↴							
Reading	0	0 (3D)	**0 (3D)**	0	0 (3D)	0	0
Daily living	0 (1D)	0 (4D)	**0 (5D)**	0 (1D)	0 (4D)	0	0
Orientation and mobility	0 (1D)	0 (2D)	**0 (3D)**	0 (1D)	0 (2D)	0	0
Driving	0 (1D)	0 (1D)	**0 (2D)**	0 (1D)	0 (1D)	0	0

	Overall Totals			Rehabilitation		Medical	
Study Category/keyword(s)	**RCT**	**Non-RCT**	**Combined**	**RCT**	**Non-RCT**	**RCT**	**Non-RCT**
Assessment/Evaluation Methods and Technical Aids ↴							
Low vision/visual function/visual impairment assessment and evaluation	4 (1D)	0 (5D)	**4 (6D)**	1 (1D)	0 (4D)	3	0 (1D)
Low vision technical aids and devices	0	3 (4D)	**3 (4D)**	0	3 (4D)	0	0
Lenses/eyeglasses	0	0 (1D)	**0 (1D)**	0	0 (1D)	0	0

	Overall Totals			Rehabilitation		Medical	
Study Category	**RCT**	**Non-RCT**	**Combined**	**RCT**	**Non-RCT**	**RCT**	**Non-RCT**
Education, Self Help, Therapy & Training	0	0 (2D)	**0 (2D)**	0	0 (2D)	0	0

	Overall Totals			Rehabilitation		Medical	
	RCT	**Non-RCT**	**Combined**	**RCT**	**Non-RCT**	**RCT**	**Non-RCT**
Grand Totals	72 (28D)	43 (69D)	**115 (97D)**	15 (13D)	23 (58D)	57 (16D)	20 (10D)

Secondary Search Results—Specific to Low Vision and Driving (Categorized Totals)
The following table includes results from a secondary search conducted on PubMed, CINAHL, EMBASE, and LVTR (Low Vision: The Reference), and specific to the category of *low vision and driving*. Search parameters were limited to the following criteria: Journal, English language, Human, Age 9+ years, and between 1985 and 2005. The totals represent merged results from all databases when the respective primary keyword was joined with the secondary keyword (driving). RCT represents references identified by PubMed and CINAHL as either a randomized or clinical trial. EMBASE identified references as journal articles only. The "total number of unique articles" refers to numbers when all duplicates were removed within each category. For example, within the category "acuity," the search results displayed the same study for low vision, central scotoma, and visual acuity.

Primary Keywords	Total Non RCT	Total RCT
Impairment		
Acuity		
Low vision	21	1
Impaired central visual field	1	0
Scotoma	8	1
Central scotoma	5	1
Para central scotoma	4	1
Mesopic visual acuity	13	2
Visual acuity	338	18
Dynamic visual acuity	12	2
Reduced visual acuity	26	3
Stereo acuity	3	0
Photo recovery	0	0
Visual impairment	126	7
Total (unique articles within acuity)	**373**	**20**
Contrast		
High contrast acuity	23	0
Contrast sensitivity	130	5
Reduced contrast sensitivity	14	3
Low contrast acuity	18	0
Total (unique articles within contrast)	**101**	**5**
Field		
Homonymous hemianopia	**13**	**0**
Homonymous hemianopsia	**4**	**0**
Homonymous hemianopic field defects	**3**	**0**
Homonymous hemianopic field deficit	**0**	**0**
Visual field defects	**20**	**1**
Visual field deficit	**2**	**0**

Primary Keywords	Total Non RCT	Total RCT
Impairment		
Visual field loss	**29**	**0**
Total (unique articles within field)	**52**	**1**
Attention		
Visual attention	144	12
Perception		
Photopsia	0	0
Metamorphosia	0	0
Color perception	19	1
Total (unique articles within impairment)	**536**	**31**

Primary Keywords	Total Non RCT	Total RCT
Disability		
Function		
Glare disability	20	3
Glare sensitivity	37	4
Glare discomfort	3	0
Glare recovery	3	0
Multiple visual dysfunctions	0	0
Visual function	290	20
Fixation	65	0
Total (unique articles within function)	**351**	**20**
Rehabilitation		
Blindness rehabilitation	4	0
Partial vision rehabilitation	0	0
Low vision rehabilitation	9	1
Vision rehabilitation	77	5
Total (unique articles within rehabilitation)	**77**	**5**
Total (unique articles within disability)	**381**	**20**

Primary Keywords	Total Non RCT	Total RCT
Etiology		
Age-related maculopathy	17	0
AMD	20	1
ARMD	15	1
Age-related macular degeneration	21	1
Maculopathy	9	0
Juvenile macular dystrophies	2	0
Diabetic retinopathy	31	0
Retinal diseases	37	0
Retinitis pigmentosa	12	0
Cataract	76	4
Glaucoma	46	2
Stroke	141	5
Total (unique articles within etiology)	**302**	**12**

Primary Keywords	Total Non RCT	Total RCT
Aging		
Aging population	59	0
Elderly	1739	63
Elderly drivers	621	15
Very old drivers	87	5
Total (unique articles within aging)	**1776**	**66**

Primary Keywords	Total Non RCT	Total RCT
Technical Aids		
Telescopes		
Spectacles	31	1
Bioptic amorphic lenses	1	0
Bioptic telescopes	5	1
Bioptic telescopic spectacles	1	0
Telescopes	5	0
Total (unique articles within telescopes)	**35**	**2**
Prisms		
Fresnel prisms	0	0
Field prisms	0	0

Primary Keywords	Total Non RCT	Total RCT
Technical Aids		
Mirrors	14	0
Sectorial prisms	0	0
Image enhancement	30	2
Contrast enhancement	8	0
Electronic low vision aids	0	0
Vision aids	0	0
Night vision aids	0	0
Total (unique articles within prisms)	**50**	**2**
Total (unique articles within technical aids)	**83**	**4**

Primary Keywords	Total Non RCT	Total RCT
Other		
Blind mobility	1	0
Legal blindness	10	0
Visual factors	150	4
Visual status	75	6
Visually handicapped	10	0
Total (unique articles within other)	**210**	**8**

Appendix V—References

[1] The Lighthouse national survey on vision loss: The experience, attitudes, and knowledge of middle-aged and older Americans. Report prepared by The Lighthouse Inc. 1995. New York.

[2] AMD Alliance press release found on Lighthouse International web site. Retrieved May 10, 2005 from: http://64.233.167.104/search?q=cache:oItGBj6dOlQJ:www.lighthouse.org/press/pr_medicare.htm+hip+fractures+framingham+eye+study&hl=en

[3] Kahn HA, Leibowitz HM, Ganley JP, et. al. The Framingham Eye Study. I. Outline and major prevalence findings. *Am J Epidemiol*. 1977;106:17-32.

[4] National Eye Institute web site. See: http://www.nei.nih.gov/nehep/summer2000/outlook_1.asp

[5] National Eye institute web site. See: http://www.nei.nih.gov/nehep/eyesite/host/infopk_text.asp

[6] American Academy of Ophthalmology web site. See: http://www.aao.org/aao/patient_ed/smartsight.cfm

[7] Colenbrander A. Visual Standards—Aspects and Ranges of Vision Loss. Report prepared for the International council of Ophthalmology at the 29th International Congress of Ophthalmology. 2002. Sydney, Australia.

[8] Hoppe E. Evaluating the laws defining blindness. *J Am Optom Assoc.* 1992;63(6):390-4.

[9] Corn AL and Spungin SJ. Free and appropriate public education and the personnel crisis for students with visual impairments and blindness. (COPSSE Document No. IB-10). Gainsville, FL: University of Florida, Center on Personnel Studies in Special Education. Retrieved from http://www.coe.ufl.edu/copsse/pubfiles/IB-10.pdf

[10] Koestler FA. The unseen minority: A social history of blindness in the United States. Retrieved from: http://www.afb.org/unseen/book.asp?ch=Koe-31edchron

[11] Royal National Institute of the Blind (RNIB) web site. Retrieved May 10, 2005 from http://www.rnib.org.uk/xpedio/groups/public/documents/PublicWebsite/public_rnib003702.hcsp

[12] Royal Victorian Institute for the Blind (RVIB) web site. Pensions, benefits, and concessions for people who are blind or vision impaired. Retrieved on May 10, 2005 from http://www.rvib.org.au/publications/pensions.shtml#bli

[13] Retina Australia web site. Retrieved on May 10, 2005 from http://www.retinaaustralia.com.au/Living.htm

[14] Evans BJ and Rowlands G. Correctable visual impairment in older people: a major unmet need. *Ophthal Physiol Opt.* 2004;24:161-180.

[15] Naeyaert KM, Grace G. Prevalence and causes of blindness and visual impairment in Canada. *JVIB*. 1990;84:361-363.

[16] Robinson JR. A survey of blind and partially sighted adults in Britain. *JVIB*. 1993;87: 78-79.

[17] Nelson KA, Dimitrova E. Severe visual impairment in the United States and in each state. *JVIB*. 1993;87:80-85.

[18] Elliott, DB, Strong JG, Trukolo-Ilic M, Pace R, Plotkin A., Bevers P. Comparison of low vision clinic data with low vision survey and blindness registration information. *Opt Vis Sci*. 1998;75: 272-278.

[19] Djafari F, Gresset JA, Boisjoly HM, et. al. Estimation of the misclassification rate of self-reported visual disability. *Can J Public Health*. 2003; 94:367-71.

[20] Gresset J and Baumgarten M. Prevalence of visual impairment and utilization of rehabilitation services in the visually impaired elderly population of Quebec. *Opt Vis Sci*. 2002;79:416-23.

[21] Elliott DB, Strong JG. Predicted optometric patient changes in the 21st century: the increasing elderly and low vision population. *Pract Opt.* 1998;9:222-227.

[22] Centre for Eye Research Australia. The economic impact and cost of vision loss in Australia*.* Report prepared by Access Economics Pty Limited. 2004. Melbourne, Australia.

[23] Elliott DB, Trukolo-Ilic M, Strong JG, Pace R, Plotkin A, Bevers P. Demographic characteristics of the vision-disabled elderly. *Invest Ophth Vis Sci.* 1997;38*:*2566-2575.

[24] Ciulla, TA, Danis RP, Harris A. Age-related macular degeneration: a review of experimental treatments. *Surv Ophthalmol*. 1998;43:134-46.

[25] Leibowitz H, Krueger D, Maunder L, et al. The Framingham Eye Study monograph: An ophthalmological and epidemiological study of cataract, glaucoma, diabetic retinopathy, macular degeneration, and visual acuity in a general population of 2631 adults, 1973-1975. *Surv Ophthalmol*. 1980;24:335-610.

[26] Ryan B, Culham L. Fragmented vision: Survey of low vision services in the UK. London: Royal National Institute for the Blind, 1999.

[27] Lomas GM. Low vision in the UK toward a framework for delivering low vision care. London: The Partially Sighted Society, 1998.

[28] Vision rehabilitation for adults. Report prepared by the American Academy of Ophthalmology, Preferred Practice Pattern Series. 2001. San Francisco, CA.

[29] Studebaker J and Pankow L. History and evolution of vision rehabilitation. Parallels with rehabilitation medicine, geriatric medicine, and psychiatry. *Top Geriatr Rehabil*. 2004;20:142-153.

[30] Horowitz, A. The prevalence and consequences of vision impairment in later life. *Top Geriatr Rehabil*. 2004;20:185-195.

[31] Community Services for the Blind and Partially Sighted web site. See http://www.csbps.com/info/default.shtml

[32] Spring Branch, Texas Department of Special Education web site. See http://sped.springbranchisd.com/documents/FIE/Condition%20Reports/VI-CONDITION%20REPOPRT.doc

[33] Vision Connection web site. See http://www.visionconnection.org/Content/Research/VisionScience/BooksPeriodicalsandDatabases/LowVisionTheReference/default.htm?TRK=ResearchLVTR

[34] Ontario Council of University Libraries (OCUL) is a consortium of twenty university libraries in the province of Ontario. Member libraries provide information services through resource sharing, collective purchasing, and document delivery. http://www.ocul.on.ca/abocul.html

[35] Jovell AJ and Navarro-Rubio MD. Evaluation of the scientific evidence [in Spanish]. *Medicina Clinica*. 1995;105:740-743.

[36] Agency for Healthcare Research and Quality. Systems to rate the strength of scientific evidence. Prepared by Research Triangle Institute—University of North Carolina Evidence-Based Practice Center. 2002. Research Park, North Carolina.

[37] Adams E., et al. Optical devices for adults with low vision: A systematic review of published studies of effectiveness. Veteran's Administration Technology Assessment Program. 2003. Boston, MA. Retrieved from http://www.va.gov/vatap.

[38] Downs S and Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Comm H*. 1998;52:377-384.

[39] The Physiotherapy Evidence Database (PEDro) scale is an evidence rating tool developed by the Centre for Evidence-Based Physiotherapy (CEBP) in Australia. See http://www.pedro.fhs.usyd.edu.au/FAQs/Scale/scaleitems.htm.

[40] National Eye Institute web site. Statistics and Data. See: http://www.nei.nih.gov/eyedata/

[41] Massof, R. A model of the prevalence and incidence of low vision and blindness among adults in the U.S. *Opt Vis Sci.* 2002;79:31-38.

[42] Friedman DS, Katz J, Bressler NM, Rahmani B, Tielsch JM. Racial differences in the prevalence of age-related macular degeneration: the Baltimore Eye Survey. *Ophthalmology.* 1999;106:1049-55.

[43] Klein R, Klein BE, Lee KE. Changes in visual acuity in a population: the Beaver Dam Eye Study. *Ophthalmology.* 1996;103:1169-78.

[44] A profile of disability in Canada, 2001. Prepared by Housing, Family and Social Statistics Division, Statistics Canada. 2002.

[45] American Foundation for the Blind web site. See http://www.afb.org

[46] CNIB client statistics. Prepared by CNIB. 2002.

[47] Lewallen, Susan, MD. (n.d.) Blindness and gender in the industrialized countries: A review of the literature with special attention to Canada. British Columbia Centre for Epidemiologic and International Ophthalmology, Department of Ophthalmology, University of British Columbia. See: http://www.interchange.ubc.ca/bceio/gender_paper.htm

[48] World Health Organization, 1997.

[49] Prevent Blindness America, 1998-2000.

[50] National Advisory Eye Council. Vision research - A national plan: 1999-2003**.** (NIH Publication No. 98-4120).1998. Bethesda, MD: National Institutes of Health.

[51] Public Health Vision Task Force: Determining the information needs for prevention of vision loss strategies in Canada. Vision Health Research Council. 2002. From http://vhrc.net/pages/oldjournal/phvtf.htm

[52] Glaucoma Foundation (2003a). Glaucoma myths mask need for eye exam that can save sight. Retrieved July 5, 2004, from http://www.glaucomafoundation.org/news_story.php?i=11.

[53] Prevent Blindness America and the National Eye Institute. Vision Problems in the U.S. 2002.

[54] American Diabetes Association (n.d.). National diabetes fact sheet. Retrieved July 7, 2004, from http://www.diabetes.org/diabetes-statistics/national-diabetes-fact-sheet.jsp.

[55] Prevent Blindness America. Vision Problems in the U.S. 1994. Schaumburg, IL: Prevent Blindness America.

[56] Brown SA, Weih LM, Fu CL, Dimitrov P, Taylor HR, & McCarty CA. Prevalence of amblyopia and associated refractive errors in an adult population in Victoria, Australia. *Ophthal. Epidemiol*. 2002;7:249-258.

[57] National Advisory Eye Council. Vision research - A national plan: 1994-1998. (NIH Publication No. 95-3186). 1993. Bethesda, MD: National Institutes of Health.

[58] The Foundation Fighting Blindness. (2004). Retrieved August 2001 from http://www.blindness.org.

[59] National Eye Institute (last updated 2004). Report of the Visual Impairment and its Rehabilitation Panel. Retrieved October 18, 2004 from http://www.nei.nih.gov/resources/strategicplans/neiplan/frm_impairment.asp

[60] Jabs, D.A., Davis, C.L., & Mowyer, R. Mortality in patients with the acquired immunodeficiency syndrome treated with either foscarnet or ganciclovir for cytomegalovirus retinitis. *New Engl J Med.* 1992; 326:213-220.

[61] Gallant, JE, Moore, RD, Richman, DD, Keruly, J, Chaisson, RE, & the Zidovudine Epidemioloogy Study Group. Incidence and natural history of cytomegalovirus disease in patients with advanced human immunodeficiency virus disease treated with zidovudine. *J Infect Dis*. 1992;166: 1223-1227.

[62] American Optometric Association. (n.d.) Retrieved August 4, 2004 from http://www.aoanet.org/eweb/DynamicPage.aspx?site=AOAstage&WebCode=CauseLowVision

[63] Kraus JF, and MacArthur DL. Epidemiologic aspects of brain injury. *Neurol Clin*. 1996; 14:435-450.

[64] Moscato BS, Trevisian M & Willer B. The prevalence of traumatic brain injury and co-occurring disabilities in a national household survey of adults. *J Neuropsychiatry*. 1994;6:134-142.

[65] United States Eye Injury Registry (2000). Eye trauma: Epidemiology and prevention. Retrieved July 5, 2004, from http://www.useironline.org//Prevention.htm.

[66] Leonard, Robin. Statistics on vision impairment: A resource manual. Arlene R. Gordon Research Institute of Lighthouse International. 2002. Retrieved July 6, 2004 from http://www.lighthouse.org/researchstats.pdf. (These estimates are from Prevent Blindness America [National Society to Prevent Blindness, 1980]).

[67] Chiang, YP, Bassi, LJ, & Javitt, JC. Federal budgetary costs of blindness. *Milbank Quarterly*, 1992;70 (2):319-340.

[68] Adams, PF, Hendershot, GE, & Marano, MA. Current estimates from the National Health Interview Survey, 1996. National Center for Health Statistics. Vital Health Statistics. 1999;10 (200).

[69] McNeil, JM. Americans with Disabilities: 1991-92. Current Population Reports, (Report No. P70-33). 1993. Washington, DC: U.S. Government Printing Office.

[70] 1997 Survey of Income and Program Participation (SIPP). See: http://www.bls.census.gov/sipp/

[71] National Eye Institute. Report of the visual impairment and its rehabilitation panel. Retrieved October 18, 2004 from http://www.nei.nih.gov/resources/strategicplans/neiplan/frm_impairment.asp

[72] National Society to Prevent Blindness, 1980.

[73] Hack, M, Klein, NK, & Taylor, GH. Long-term developmental outcomes of low birth weight infants. In Richard E. Behrman *The Future of Children: Low Birth Weight*. 1995. Los Altos, CA: Center for the Future of Children, The David and Lucille Packard Foundation.

[74] Thylefors, B, Négrel, AD, Pararajasegaram, R, & Dadzie, KY. Global data on blindness. Bulletin of the World Health Organization. 1995;73:115-121.

[75] National Eye Institute (n.d.). National plan for eye and vision research. Retrieved on July 30, 2004 from http://www.nei.nih.gov/strategicplanning/np_low.asp.

[76] American Diabetes Association (n.d.). Diabetes statistics for African Americans. Retrieved July 7, 2004, from http://www.diabetes.org/diabetes-statistics/african-americans.jsp.

[77] Tielsch, JM, Sommer, A, Witt, K, Katz, J, & Royall, RM. Blindness and visual impairment in an American urban population: The Baltimore Eye Survey. *Arch Ophthalmol-Chic*. 1990;108: 286-90.

[78] American Diabetes Association (n.d.). Diabetes statistics for Latinos. Retrieved July 7, 2004, from http://www.diabetes.org/diabetes-statistics/latinos.jsp.

[79] Rodriguez, J. Causes of blindness and visual impairment in a population-based Sample of U.S. Hispanics. *Ophthalmology*. 2002;109:737-743.

[80] Health Canada (n.d.) First Nations and Inuit Health Branch. Aboriginal Diabetes Initiative. Retrieved on July 30, 2004 from http://www.hc-sc.gc.ca/fnihb/cp/adi/introduction.htm.

[81] Health Canada. (1999). Diabetes in Canada. From http://www.hc-sc.gc.ca/pphb-dgspsp/publicat/dic-dac99/d12_e.html#2

[82] World Health Organization. International Statistical Classification of Diseases and Related Health Problems 1989 Revision*.* 1992.

[83] Fraser, K, Cole, R.G., Faye, E., et. al Optometric clinical practice guideline. Care of the patient with low vision. Reference guide for clinicians prepared by the American Optometric Association Consensus Panel on Care of the Patient with Low Vision. 1997. St. Louis, Missouri.

[84] Borsting E. Overview of visual and visual processing development. In: Scheiman M, Rouse MW, ed. Optometric Management of Learning Related Vision Problems. St. Louis, Mo: CV Mosby; 1994:35-68.

[85] Virtanen P, Laatikainen L. Low vision aids in age-related macular degeneration*. Curr Opin Ophthalmol.* 1993;4:33-5.

[86] Margrain TH. Minimising the impact of visual impairment. *BMJ*.1999;318:1504.

[87] Leat SJ, Fryer A, Rumney NJ. Outcome of low vision aid provision—the effectiveness of a low vision clinic. *Opt Vis Sci*. 1994;71:199-206.

[88] Bischoff P. Long-term results of low vision rehabilitation in age-related macular degeneration. *Doc Ophthalmology*. 1995;89:305-11.

[89] Soong GP, Lovie-Kitchin JE, Brown B. Does mobility performance of visually impaired adults improve immediately after orientation and mobility training? *Opt Vis Sci*. 2001;78:657-666.

[90] Burton G & McGowan J. Contact and posture in nonvisual judgment of gap crossability. *Ecol Psychol*. 1997;9:323-354.

[91] Clark-Carter BD, Heyes AD, & Howarth CI. The efficiency and walking speed of visually impaired people. *Ergonomics*. 1986;29:1575-1581.

[92] Cassel C, Besdine R, & Siegel L. Restructuring medicare for the next century: what will beneficiaries really need? *Health Affair.* 1999;18:118-131.

[93] Soroka M & Newcomb R. Vision care for the nation's elderly: a plea for policy direction. *J Health Polit Polic*. 1981;6:73-83.

[94] Greenblatt S. Physicians and chronic impairment: A study of ophthalmologists' interactions with visually impaired and blind patients. *Soc Sci Med.* 1988;26:393-399.

[95] Pankow L & Luchins D. Geriatric low vision referrals by ophthalmologists in a senior health center. *JVIB*. 1998;92:748-753.

[96] CNIB Core Services. Retrieved October 20, 2004 from http://www.cnib.ca/eng/index.htm

[97] Jackson ML. (n.d.). Electronic applications in ophthalmology and vision rehabilitation. Dept. of Ophtalmology, Vancouver Island Health Authority, Victoria, BC.

