Canadian Ophthalmological Society evidence-based clinical practice guidelines for the periodic eye examination in adults in Canada

Clinical Practice Guideline Expert Committee*

The foundation of sound eye care is the periodic eye examination. While this examination is the most common procedure performed by comprehensive ophthalmologists, there is considerable variation and no clear directive on appropriate screening intervals or recommended elements of the examination. Indeed, the elements of the examination have, in large part, been dictated by third-party insurers rather than by any evidence. With this in mind, the Canadian Ophthalmological Society (COS) guideline expert committee reviewed the relevant evidence to produce guidelines that are as evidence-based as possible and sensitive to the resources available in Canada.

The objective of this document is to provide guidance on the recommended frequency and necessary elements of comprehensive eye examinations for adults aged 19 to 64. The document also identifies patients who are considered at high risk of visual impairment. In these cases, the frequency of screening may be different and the content more targeted. The intended audience is any Canadian health care professional who refers or sees patients for a comprehensive oculovisual examination (e.g., ophthalmologists and other physicians, optometrists). The recommended frequencies of examination will also be of interest to the general public, as provincial health care plans typically only provide coverage for eye examinations for children up to age 18 years and adults over age 65. Canadians between ages 19 and 64 must therefore rely on private (third-party) insurance or out-of-pocket payment to see an eye specialist for routine vision screening. In the absence of Canadian data on the cost-to-benefit ratio of the recommended screening intervals, these guidelines do not attempt to comment on the financial impact of routine eye care. Nonetheless, it is hoped that these guidelines will help health care professionals and patients appropriately ration their health care spending budgets. These guidelines will be reviewed periodically by the COS clinical practice guideline expert committee and will be updated as necessary in the light of new evidence.

Clinical practice guidelines have evolved over the past decade, moving away from reliance on expert opinion to approaches that are more evidence-based. The goals have been not only to improve the quality of care but also to contain costs.[1] This progression has generated some confusion, however, with respect to the status of guidelines as "regulations" or standards of care. Although guidelines do not define the standard of care, they may inform a standard of care. Medically justified deviations from existing guidelines with deferment to clinical judgment can therefore be expected.[2,3]

Other concerns about guidelines have been expressed. First, clinical guidelines are primarily produced by professional organizations with a vested interest in continuing to provide intervention. Second, guidelines are often underwritten by pharmaceutical or medical device corporations. Both these factors, especially if they have not been explicitly acknowledged, may contribute to clinical guidelines being less than critical and poorly regarded by practicing physicians.[4]

The major shortcoming of any guideline that focuses on preventive recommendations is that therapeutic measures, rather than preventive measures, are typically insured by provincial health care plans or third-party insurers. Until clear evidence of cost-effectiveness of a preventive measure becomes available, such guidelines will continue to carry less weight than those addressing therapeutic options. In addition, because guidelines are generally produced by organizations with a vested financial interest in providing the recommended services, the cost of following a recommended guideline is often not included and the benefits or lack thereof are not adequately disseminated.[5]

*Canadian Ophthalmological Society Clinical Practice Guideline Expert Committee: Walter Delpero, MD, FRCSC, (chair), Ottawa, Ont., (Comprehensive ophthalmology/Cataract surgery); George Beiko, BM, BCh, FRCSC, St. Catharines, Ont. (Comprehensive Ophthalmology/Cataract/Refractive); Ronald Casey, MD, FRCSC, Edmonton, Alta., (Glaucoma); Anna Ells, MD, FRCSC, Calgary, Alta., (Pediatric/Retina); Peter Kertes, MD, FRCSC, Toronto, Ont., (Retina); Yvonne Molgat, MD, FRCSC, Quebec City, Que., (Oculoplastics); Tom Nagy, MD, MSc, FRCSC, Terrace, B.C., (Comprehensive ophthalmology)

Originally received Nov. 25, 2006. Revised Dec. 9, 2006
Accepted for publication Dec. 14, 2006

Français à la page 158

Also available online at http://www.eyesite.ca

Can J Ophthalmol 2007;42:39–45
doi:10.3129/can j ophthalmol.06-126e

METHODS

A MEDLINE in PubMed search of the English-language literature for the years 1990 to 2006 was conducted by using the following MeSH subject headings and key words: adult, disease progression, eye diseases, middle-aged, ophthalmology, optometry, preventive health services, vision disorders, visual function loss, vision screening, vision test. In addition, the Cochrane Library, the National Guideline Clearing House, and the United States Preventative Services Task Force databases were searched. Selected references were independently reviewed by at least two reviewers to ensure they were relevant and of acceptable methodological quality. Papers meeting Level 1 or Level 2 criteria as outlined in Box 1 were accepted for inclusion. Recommendations were formulated by incorporating the best available evidence. In the absence of evidence, recommendations were developed on the basis of the consensus of the expert committee. References used to support recommendations were assigned a level of evidence based on the criteria outlined in Box 1. Where possible, the content of this document was developed in accordance with the criteria specified by the Appraisal of Guidelines Research and Evaluation instrument[6] covering the six domains of scope and purpose, stakeholder involvement, rigor of development, clarity and presentation, applicability, and editorial independence. The final draft was reviewed by numerous independent external expert reviewers from across Canada.

FREQUENCY OF THE PERIODIC EYE EXAMINATION

The routine oculovisual assessment is, in reality, hardly routine. It can be employed for asymptomatic, symptomatic, or high-risk individuals. It may represent primary screening (e.g., to reduce the occurrence or incidence of disease, to encourage eye protection), secondary prevention (to reduce and control the consequences of existing disease such as diabetes mellitus [DM], glaucoma, high myopia), and tertiary prevention (e.g., to reduce the harm of a chronic disease, such as reducing intraocular pressure (IOP) in primary open-angle glaucoma, laser therapy for diabetic retinopathy).

There are good data that one eye examination before age 5 years is appropriate. Even in this age category, however, evidence suggests that more intensive screening than typically occurs is required to detect problems in visual acuity and reduce the incidence of amblyopia.[7,8]

There are very good data indicating that screening above 61 to 65 years of age will uncover pathology, because both the incidence and prevalence of ocular disease increase significantly in this age group.[9–12] Visual screening rates vary highly in terms of quality-of-life-years saved and cost effectiveness.[13] As well, in studies that controlled for confounders such as other illness, overall vision compromise was associated with some limitations in activities, such as night driving and risk of falls.[14,15] Nonetheless, screening asymptomatic older adults is not supported without reservation because a significant number of individuals do not experience improved vision quality after being identified.[16] On the other hand, identification can lead to access to financial resources, through disability pensions or social programs geared to the visually impaired, that may enhance quality of life despite poor visual status.

Box 1—Assessment of studies of prevalence and incidence of disease

Level 1:

- The study includes a population of at least 1000.
- The study describes the inclusion and exclusion criteria.
- The follow-up includes at least 66% of the initial identified population.
- The study discusses possible shortcomings or biases in the reporting.
- The study compares its outcome with previous high-quality reports.

Level 2: Meets 4 of the Level 1 criteria

Level 3: Meets 3 of the Level 1 criteria

Level 4: Meets 1 or 2 of the Level 1 criteria

PREVALENCE AND ETIOLOGY OF VISION LOSS

The prevalence of disease in the population under age 40 is low, suggesting there is limited benefit of a periodic eye examination in the asymptomatic low-risk patient in this age group. Accordingly, there is little evidence to support periodic eye examinations in asymptomatic low-risk patients from the time they leave secondary school to middle age.

A recent large study[17] of people aged 12 years to over 65 years found that the prevalence of visual impairment (defined as visual acuity <20/50) was as high as 10% for individuals younger than age 20 or older than age 60, and approximately 5% for those 20 to 59. Until age 60, visual impairment in the majority of individuals (85–90%) was due to uncorrected refractive errors. After 60, other ocular pathology accounted for at least 50% of impairment.

Large high-quality studies of screening for low vision typically include populations over age 40.[9,10,16] The uncorrected risk of impairment increased 1.8 times for

each decade starting at age 40. It was also positively correlated with lower education, lower socioeconomic status, and the non-ability to speak English.[17–19]

Other large studies in the United States, Australia, and Europe found the prevalence of vision impairment increased dramatically over the age of 60. Indeed, this prevalence tripled in these individuals.[20–22]

Incidence of visual impairment over time

Good data are available only for the population over age 40. Five-year incidence of impairment from any cause ranges from 0.1% per year for those under age 55 to more than 4.5% in the population over age 65. The seven-year incidence increases from 1% below age 55 to more than 5% for the over-60 age group. The rate of increase is 20% per year. Again, uncorrected refractive error is by far the largest single cause of visual impairment.[9–11,23] It tends to be greatest in the young (<30 years) and decrease with age; however, it remains the leading cause overall. Ocular pathologies also increase with age, with the vast majority being glaucoma, diabetic retinopathy, cataract, and age-related macular degeneration (AMD).[24,25]

A recent study showed that the majority of people identified with a decrease in visual acuity had noted it themselves before presentation for an ocular examination.[9] Less than 1% of the study population was unaware of this decrease in vision, suggesting that the prevalence of asymptomatic or unrecognized ocular disease remains very low. Therefore, frequent routine eye examinations of those with initial normal examination results will have a low yield and may not be cost effective.[9,17]

Patients at higher risk for visual impairment

Although the most frequent cause of decreased vision remains uncorrected refractive error,[17] glaucoma, diabetic retinopathy, macular degeneration, cataract, and high myopia are the most frequent pathological causes, but these vary with age and ethnicity. Patients with a predisposition to vision compromise include those who wear glasses or contact lenses, have diabetes, are of African descent, or have a strong family history of glaucoma, AMD, or retinal detachment.

Simple vision testing with current correction at distance and near has very good correlation with the presence of ocular disease. Somewhat more specific, but less sensitive, is the Amsler grid; the most nonspecific vision test is contrast sensitivity.[26] Other studies have found low-luminance, low-contrast vision testing to be a good predictor of future vision loss.[27]

Routine screening for asymptomatic retinal tears, holes, and lattice degeneration has not been supported. On the other hand, symptomatic patients and high-risk patients with previous retinal problems, surgery, trauma, posterior uveitis, diabetes and myopia, or myopia greater than –6.00 can benefit from such an examination.[28,29]

Diabetic retinopathy

Diabetic retinopathy remains the leading cause of visual impairment in the population younger than age 65.[30,31] This is especially true if a patient presents with concurrent proteinuria.

There is considerable consensus and evidence with respect to the frequency of screening in patients with diabetes.[30] Screening strategy should include, but not be restricted to, a dilated fundus examination with stereoscopic viewing. Seven-standard field fundus photography is considered the gold standard, but it has not achieved wide clinical acceptance except as a standardized form of documentation for telehealth screening and research purposes. Furthermore, such studies focused on screening for sight-threatening retinopathy. Clinically, most ophthalmologists would consider the gold standard (for a patient without sight-threatening retinopathy) to be careful examination of the retina through a dilated pupil. Screening intervals of 2 to 3 years for patients with type 1 diabetes with minimal or no retinopathy have been shown to be cost effective.[32] The Canadian Diabetes Association[30] recommends the following schedule: annual screening of type 1 diabetes patients, beginning 5 years after onset of diabetes in patients 15 years[33,34]; screening on diagnosis of type 2 diabetes and every 1 to 2 years thereafter as determined by the degree of retinopathy[35,36]; preconception screening in women with type 1 or type 2 diabetes who are planning a pregnancy; and in pregnant women with diabetes, screening during the 1st trimester, as needed during the pregnancy, and during the 1st year postpartum.[37,38]

Glaucoma

Primary open-angle glaucoma causes such insidious damage to the optic nerve and vision that few people have early awareness of the condition.[39] This is consistent with the finding that only half of patients are diagnosed in industrialized countries, a number that falls to 10% in developing nations.[40] It is an ideal disorder for screening because it is asymptomatic, typically progresses slowly, and can be effectively treated.[41]

Combined large prevalence studies found glaucoma-related vision compromise to be 3 times more prevalent in the African and Hispanic populations than in the white population.[42] In the white population, prevalence ranged from 0.2% in the under-40 age group to 4.3% for individuals in their 80s. As 93% of cases of glaucoma are

in individuals over age 55, there is an implied incidence of 0.11% per year in this age group. In all age groups, the greatest risk factor is raised IOP. If patients with ocular hypertension were included, the prevalence would double for this age group and population.[43] With these risk factors in mind, age followed by race and finally by family history are the major contributors to this disorder.

Screening with simple IOP testing and optic nerve examination will tend to underestimate the disease prevalence.[10] While automated visual field testing will typically reveal damage, it is usually at a more advanced stage than the ideal very early stage desirable for definite diagnosis. Frequency-doubling technology (FDT) has been shown to be more sensitive in demonstrating early damage to visual function, and assessment of the nerve fibre layer by means of optical coherence tomography, Heidelberg retina tomography, or GDx scanning laser imaging with variable corneal compensation is helpful in many cases.[41]

Age-related macular degeneration

In North America, AMD remains the single most common cause of legal blindness in individuals over the age of 65. Data support detection and intervention in individuals with high-risk findings such as soft/large drusen. Although treatment is not the mandate of this document, lifestyle changes have been shown to reduce progression. Intervention is best accomplished with

Box 2—Elements of the comprehensive eye examination*

History

- **Patient name, date of birth, gender, and, if appropriate, race**
- Contact information (address, home and work phone numbers)
- Insurer
- Occupation
- **Driving status**
- **Chief complaint, if any**
- Family doctor
- Date of most recent eye examination
- **Current medication and allergies (ocular and systemic)**
- **Ocular history**
- **Medical history**
- Smoking history
- **Medical and ocular family history**
- Directed review of systems

Ocular examination should include:

- **Current vision acuity status with correction at distance (each eye separately) and near (refractive correction documented)**

Vision without correction

- **Best corrected visual acuity with refraction documented**
- Muscle balance
- Pupillary reaction
- Gross visual fields to confrontation
- External examination
- **Slit-lamp examination** of lid, lid margins, conjunctiva, cornea, anterior chamber (clarity and depth), lens
- **Intraocular pressure determination**

Dilated examination (if adequate view of posterior pole not obtained)

- **Lens**
- **Biomicroscopic examination of optic nerve head**
- **Fovea**
- Peripheral retina (employing appropriate accessory lens or indirect examination of peripheral retina)

Discussion with patient should include:

- Discussion of findings with appropriate correction and mitigating strategy
- Counselling with respect to lifestyle changes and co-morbidities (e.g. smoking cessation, hypertension control, diet, antioxidants and zinc supplements, blood glucose control, lipid control)
- Follow-up recommendation

*Essential elements of the examination are in boldface.[9,26,28,49]

Box 3—Supplemental testing depending on initial findings

Appropriate ancillary tests should be used when screening identifies the possible presence of ocular disease. The following items have been included as tests that are not first-line screening tests, but they can be employed. This list is not exhaustive; other tests may be indicated by findings from screening. As technology evolves, other tests may become available. As well, self-screening or patient education play an important role in promoting patient awareness of visual impairment and the need to consult.

- Palpebral fissure measurement
- Levator function
- Lacrimal function (production, drainage)
- Exophthalmometry
- Colour vision screening
- Amsler grid
- Stereo acuity
- Corneal topography
- Central corneal thickness (pachymetry)
- Endothelial cell count
- Gonioscopy
- Automated visual field testing, frequency-doubling technology perimetry
- Heidelberg retina tomography, optical coherence tomography, GDx with variable corneal compensation
- Fundus photography, stereoscopic disc photography, drawing
- Angiography
- Electrophysiological testing (electroretinogram, electro-oculogram, visual evoked potential)
- Ocular or orbital ultrasound
- Radiographic testing
- Lab tests (including microbiology, blood work, biopsy)

RECOMMENDATIONS

1. *Screening intervals in the asymptomatic low-risk patient*

- Age 19–40 years: at least every 10 years [*Consensus*]
- Age 41–55 years: at least every 5 years [*Consensus*]
- Age 56–65 years: at least every 3 years [*Consensus*]
- Age > 65 years: at least every 2 years [*Level 1*[9]]

2. *Screening in symptomatic patients*

Any patient noting changes in visual acuity, visual field, colour vision, or physical changes to the eye should be assessed as soon as possible [*Consensus*].

3. *Screening intervals in high-risk patients*

Patients at higher risk of visual impairment (e.g., those with diabetes, cataract, macular degeneration, or glaucoma [and glaucoma suspects], and patients with a family history of these conditions) should be assessed more frequently and thoroughly.

- Age > 40 years: at least every 3 years [*Consensus*]
- Age > 50 years: at least every 2 years [*Consensus*]
- Age > 60 years: at least annually [*Consensus*]

cessation of smoking and control of hypertension. As well, antioxidants and zinc have been shown to reduce conversion to wet AMD, with associated decrease in vision, at a rate of approximately 25% over a 5-year period.[44–47]

Cataracts

Cataracts represent the second most common cause of correctable visual impairment after the correction of refractive error.[22,42] Advancing age remains the most common risk factor, with progression typically extending over a long period of time. Other common risk factors include DM, history of ocular trauma, and previous intraocular inflammation or surgery.

Other high-risk categories

Other high-risk patients include those with extreme refractive error, high hyperopia or myopia, previous ocular injury, systemic medication (such as hydroxychloroquine, tamoxifen), neurological or neurosurgical disorders, and possibly adults with mental retardation. Given the broad heterogeneity of the high-risk group, screening intervals will vary depending on the underlying cause of visual impairment.

Elements of a comprehensive eye examination

Much of the content of a comprehensive eye examination is dictated by the requirements of insurance providers and may not provide good screening value. For example, the value of funduscopy for hypertension screening outside of a hypertensive crisis was not supported in a recent systematic review.[48] In addition, a unique strategy employing an automated and very focused approach has been employed. Using an autorefractor, non-mydriatic fundus camera (for fundus and lens documentation), and FDT visual field for glaucoma screening have been shown to be very cost effective.[49] Box 2 outlines elements of the oculovisual examination, while Box 3 lists supplemental tests that may be appropriate for a more targeted oculovisual assessment.

Additional resources

Patient Information Sheet "When Should Adults See an Eye Doctor?"

This information sheet for patients is available on the *CJO* Web site at http://pubs.nrc-cnrc.gc.ca/cjo/cjo.html. It is linked to this article in the online contents of the February 2007 *CJO*.

Note to readers: These guidelines were developed using the best available evidence and are intended to inform patterns of clinical practice. Guidelines are not a replacement for clinical judgment. Ophthalmologists must consider the needs, preferences, values, and financial and personal circumstances of individual patients and work within the realities of their health care setting.

It is understood that there are disparities in human, financial, and health care resources in different regions of the country and that these factors may have an impact on physician and patient options and decisions. There is no expectation that these guidelines be applied in a research setting.

The COS clinical practice guideline expert committee members gratefully acknowledge the support and contributions of guideline editor Cynthia N. Lank, medical librarian Mona Frantzke, as well as the numerous external reviewers who provided feedback and insight on the document.

Funding for the development of these guidelines was provided by the Canadian Ophthalmological Society and by the following sponsors (in alphabetical order) in the form of unrestricted educational grants: AMO Canada Inc., Alcon Canada Inc., Allergan Canada Inc., Novartis Ophthalmics, Pfizer Canada Inc. Neither industry nor government were involved in the decision to publish guidelines, in the choice of guideline, or in any aspect of guideline development.

Members of the clinical practice guideline expert committee were volunteers and received no remuneration or honoraria for their time or work. The committee members made the following disclosure regarding their relationships to pharmaceutical and medical device manufacturers:

W.D.: No dualities of interest to disclose.

G.B.: Honoraria from Alcon Canada, Alcon USA, AMO Canada, AMO USA; Research support from Alcon Canada, Allergan Canada, AMO Canada, Pfizer Canada, Visiogen Inc. USA.

R.C.: Although I do not believe there to be a direct conflict of interest involved in the following affiliations, I disclosure the following past and present affiliations with ocular pharmaceutical companies that have medications used in the treatment of ocular illness that may be identified through a comprehensive ocular examination. Honoraria from Alcon Canada, Merck Frosst Canada, and Pfizer Canada for participation in meetings, advisory boards, and development of CME programs.

A.E.: No dualities of interest to disclose.

P.K.: No dualities of interest to disclose.

Y.M.: No dualities of interest to disclose.

T.N.: No dualities of interest to disclose.

References

1. Kane RL. Creating practice guidelines: the dangers of over-reliance on expert judgement. *J Law Med Ethics* 1995;23:62–4.
2. Schwartz PJ, Breithardt G, Howard AJ, Julian DG, Rehnqvist Ahlberg N. The legal implications of medical guidelines—a Task Force of the European Society of Cardiology. *Eur Heart J* 1999;20:1152–7.
3. College of Physicians and Surgeons of Ontario. Position Statement. The College's expectations on the use of clinical practice guidelines. *Dialogue* 2005;Nov/Dec:12–13.
4. Choudhry NK, Stelfox HT, Detsky AS. Relationships between authors of clinical practice guidelines and the pharmaceutical industry. *JAMA* 2002;287:612–7.
5. Picone G, Brown D, Sloan F. Do routine eye examinations improve vision? *Int J Health Care Finance Economics* 2004;4:43–63.
6. The AGREE Collaboration. Appraisal of Guidelines Research and Evaluation (AGREE) instrument. 2001. Available: www.agreecollaboration.org/instrument (accessed 2006 Dec 13).
7. U.S. Preventative Services Task Force. Screening for Visual Impairment in Children Younger than Age 5 Years: Recommendation Statement. May 2004. Agency for Healthcare Research and Quality, Rockville, MD. Available: http://www.ahrq.gov/clinic/3rduspstf/visionscr/vischrs.htm (accessed 2006 Dec 13).
8. Community Paediatrics Committee. Canadian Paediatric Society. Vision screening in infants, children and youth. *Paed Child Health* 1998;3:261–2. Reaffirmed 2005. Available: https://www.cps.ca/English/statements/CP/cp98-01.htm (accessed 2006 Dec 13).
9. Taylor HR, Vu HT, McCarty CA, Keeffe JE. The need for routine eye examinations. *Invest Ophthalmol Vis Sci* 2004;45: 239–42.
10. Foran S, Mitchell P, Wang JJ. Five-year change in visual acuity and incidence of visual impairment: the Blue Mountains Eye Study. *Ophthalmology* 2003;110:41–50.
11. Dimitrov PN, Mukesh BN, McCarty CA, Taylor HR. Five-year incidence of bilateral cause-specific visual impairment in the Melbourne Visual Impairment project. *Invest Ophthalmol Vis Sci* 2003;44:5075–81.
12. Klein R, Klein BEK, Lee KE. Changes in visual acuity in a population. The Beaver Eye Dam Study. *Ophthalmology* 1996;103:1169–78.
13. Coffield AB, Maciosek MV, McGinnis JM, Harris JR, Caldwell MB, Teutsh SM, et al. Priorities among recommended clinical preventive services. *Am J Prev Med* 2001;21: 10–19.
14. Klein BEK, Moss SE, Klein R, Cruickshanks KJ. Associations of visual function with physical outcomes and limitations 5 years later in an older population: the Beaver Dam Study. *Ophthalmology* 2003;110:644–50.
15. Patterson C. Screening for visual impairment in the elderly. In: Canadian Task Force on the Periodic Health Examination. *Canadian Guide to Clinical Preventative Health Care*. Ottawa: Health Canada;1994;932–42.
16. Smeeth L, Iliffe S. Effectiveness of screening older people for impaired vision in a community setting: systematic review of evidence from randomised controlled trials. *BMJ* 1998;316:660–3.
17. Vitale S, Cotch MF, Sperduto RD. Prevalence of visual impairment in the United States. *JAMA* 2006;295:2158–63.
18. Liou HL, McCarty CA, Jin CL, Taylor HR. Prevalence and predictors of undercorrected refractive errors in the Victorian population. *Am J Ophthalmol* 1999;127:590–6.
19. Macias EP, Lee DA, Oelrich FO. Refractive errors and visual acuity impairment among self-selected Hispanic, white and black adults examined by the UCLA Mobile Eye Clinic. *J Am Optom Assoc* 1999;70:724–34.
20. Attebo K, Mitchell P, Smith W. Visual acuity and the causes

of visual loss in Australia. The Blue Mountains Eye Study. *Ophthalmology* 1996;103:357–64.
21. Weih LM, VanNewkirk MR, McCarty CA, Taylor HR. Age-specific causes of bilateral visual impairment. *Arch Ophthlamol* 2000;108:264–9.
22. Klaver CC, Wolfs RC, Vingerling Jr, Hofman A, de Jong PT. Age-specific prevalence and causes of blindness and visual impairment in an older population: the Rotterdam Study. *Arch Ophthalmol* 1998;116:653–8.
23. Cedrone C, Culasso F, Cesareo M, Nucci See, Palma S, Mancino R, et al. Incidence of blindness and low vision in a sample population. The Priverno Eye Study, Italy. *Ophthalmology* 2003;110:584–8.
24. Kinge B, Midelfart A. Refractive changes among Norwegian university students: a 3-year longitudinal study. *Acta Ophthalmol Scand* 1999;77:302–5.
25. Lee KE, Klein BEK, Klein R, Wong TY. Changes in refraction over 10 years in an adult population: the Beaver Dam Eye Study. *Invest Ophthalmol Vis Sci* 2002;43:2566–71.
26. Ariyasu RG, Lee PP, Linton KP, LaBree LD, Azen SP, Siu AL. Sensitivity, specificity, and predictive values of screening tests for eye conditions in a clinic-based population. *Ophthalmology* 1996;103:1751–60.
27. Schneck ME, Haegerstrom-Portnoy G, Lott LA, Brabyn JA, Gildengorin G. Low contrast vision function predicts subsequent acuity loss in an aged population: the SKI study. *Vision Res* 2004;44:2317–25.
28. Batchelder TJ, Fireman B, Friedman GD, Mattas BR, Wong IG, Barrick ME, et al. The value of routine dilated pupil screening examination. *Arch Ophthalmol* 1997;115:1179–84.
29. Aylward GW. Screening for retinal detachment. *J Med Screen* 2001;8:116–8.
30. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2003 clinical practice guidelines for the prevention and management of diabetes in Canada. *Can J Diabetes*. 2003;27(suppl2):S76–S80.
31. Rahmani B, Tielsch J, Katz J, Gottsch J, Quigley H, Javitt J, et al. The cause-specific prevalence of visual impairment in an urban population: The Baltimore Eye Survey. *Ophthalmology* 1996;103:1721–4.
32. Younis N, Broadbent DM, Harding SP, Vora JP. Incidence of sight-threatening retinopathy in Type 1 diabetes in a systematic screening programme. *Diabet Med* 2003;20:758–65.
33. Klein R, Klein BEK, Moss SE, Davis MD, DeMets DL. The Wisconsin Epidemiologic Study of Diabetic Retinopathy. IX. Four-year incidence and progression of diabetic retinopathy when age at diagnosis is less than 30 years. *Arch Ophthalmol* 1989;107:237–43.
34. Klein R, Klein BEK, Moss SE, Davis MD, DeMets DL. The Wisconsin epidemiologic study of diabetic retinopathy. II. Prevalence and risk of diabetic retinopathy when age at diagnosis is less than 30 years. *Arch Ophthalmol* 1984;102:520–6.
35. Klein R, Klein BEK, Moss SE, Davis MD, DeMets DL. The Wisconsin Epidemiologic Study of Diabetic Retinopathy. X. Four-year incidence and progression of diabetic retinopathy when age at diagnosis is 30 years or more. *Arch Ophthalmol* 1989;107:244–9.
36. Klein R, Klein BEK, Moss SE, Davis MD, DeMets DL. The Wisconsin epidemiologic study of diabetic retinopathy. III. Prevalence and risk of diabetic retinopathy when age at diagnosis is 30 or more years. *Arch Ophthalmol* 1984;102:527–32.
37. Klein BEK, Moss SE, Klein R. Effect of pregnancy on progression of diabetic retinopathy. *Diabetes Care* 1990;13:34–40.
38. Diabetes Control and Complications Trial Research Group. Effect of pregnancy on microvascular complications in the Diabetes Control and Complications Trial. *Diabetes Care* 2000;23:1084–91.
39. Sponsel WE, Shoemaker J, Trigo Y, Mensch J, Rugwani R, Garrett B. Frequency of sustained glaucomatous-type visual field loss and associated optic nerve cupping in Beaver Dam, Wisconsin. *Clin Experiment Ophthalmol* 2001;29:352–8.
40. Wensor MD, McCarty CA, Stanislavsky YL, Livingstone PM, Taylor HR. The prevalence of glaucoma in the Melbourne Visual Impairment Project. *Ophthalmology* 1998;105:733–9.
41. Salmon JF. Screening for chronic glaucoma. *J Med Screen* 2006;13:1–3.
42. Congdon N, O'Colmain B, Klaver CC, Klein Are, Munoz B, Friedman DS, et al, for the Eye Disease Prevalence Research Group. Causes and prevalence of visual impairment among adults in the United States. *Arch Ophthalmol* 2004;122: 477–85.
43. Tuck MW. The age distribution of primary open angle glaucoma. *Ophthalmic Epidemiol* 1998;5:173–83.
44. Age-Related Eye Disease Study Research Group. A randomized placebo-controlled trial of high-dose supplementation with vitamins C and E, beta carotene, and zinc for age-related macular degeneration and vision loss: Age-Related Eye Disease Study report no. 8. *Arch Ophthalmol* 2001;119: 1417–36.
45. Age-Related Eye Disease Study Research Group. Risk factors associated with age-related macular degeneration. A case–control study in the age-related eye disease study: Age-Related Eye Disease Study Report Number 3. *Ophthalmology* 2000;107:2224–32.
46. VanNewkirk MR, Nanjan MB, Wang JJ, Mitchell P, Taylor HR, McCarty CA. The prevalence of age-related maculopathy: the visual impairment project. *Ophthalmology* 2000;107:1593–600.
47. VanNewkirk MR, Weih L, McCarty CA, et al. Cause-specific prevalence of bilateral visual impairment in Victoria, Australia: the Visual Impairment Project. *Ophthalmology* 2001;108:960–7.
48. Van den Born BJ, Hulsman CA, Hoekstra JB, Schlingemann RO, van Montfrans GA. Value of routine funduscopy in patients with hypertension: systematic review. *BMJ* 2005;331:73.
49. Ferraro JG, Mazzoni LL, Keeffe JE, Vu HT, Constantinou M, Tayor HR. Evaluation of an eye health program: the vision initiative. *Ophthalmic Epidemiol* 2006;13:127–35.

Key words: clinical practice guidelines, comprehensive eye examination, oculovisual assessment, oculovisual examination, periodic eye examination, vision screening