Eye Disease in Medical Practice

What You Should Know and Why You Should Know It

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KEYWORDS

• Eye disease • Medical practice • Vision Screening • Vision loss

KEY POINTS

- Incidence of cataract, diabetic retinopathy, macular degeneration, and glaucoma will significantly increase by 2050.
- Visual impairment can increase morbidity and mortality in nonocular disease.
- There are different patterns of vision loss in cataract, diabetic retinopathy, age-related macular degeneration, and glaucoma.
- Internists and medical subspecialists play an important role in prevention, detection, and early treatment of eye disease.
- Awareness of screening guidelines for eye disease as well as a basic ocular history and simple penlight examination can decrease incidence of vision loss and its impact.
- Visual impairment places a significant financial burden on society.

The doctor of the future will give no medicines, but will interest his patients in the care of the human frame, in diet, and in the causes and prevention of disease.[1]
—Thomas Edison

INTRODUCTION

Physicians passionately pursue the prevention and treatment of disease in their patients. They cultivate productive habits, combat pain, discourage dangerous activities, provide empathy, and initiate medical and surgical treatments when indicated. In this series of vision articles, the reader will learn the vast array of visual disorders along with their impact on both individuals and society. The articles also

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detail how visual impairment (VI) can be prevented in most patients with early detection and treatment.

Ophthalmologists devote most of their time confronting the so-called big 4 eye diseases: cataract, diabetic retinopathy, age-related macular degeneration (ARMD), and glaucoma. Prevention, diet, early detection, and medical or surgical intervention play a role in each of these diseases.[2] With regard to prevention, smoking cessation can reduce the risk of vision loss from macular degeneration. Glycemic control dramatically decreases the incidence of diabetic retinopathy. Dietary modification and specific vitamin supplements can decrease the rate of progression of macular degeneration. Identifying and early screening of those at risk for glaucoma can significantly decrease rates of glaucomatous vision loss. In addition, advances in medical and surgical treatment of these diseases have led to improved visual outcomes.

This article informs primary care providers (PCPs) and medical subspecialists on the importance of patients' visual health. It shares information on the prevalence of eye disease globally and in the United States. It addresses the costs to society and morbidity of VI. It emphasizes the profound role medical providers have in prevention and early detection of blinding conditions in their patient populations. It discusses eye diagnoses readily made in the primary care office to avoid emergency room expenses. Lastly, it reviews ophthalmic manifestations of systemic diseases.

PREVALENCE OF VISUAL IMPAIRMENT AND EYE DISEASE

In the United States, the aging population contributes to the predicted increase in both VI and blindness, with a doubling of both parameters expected between 2015 and 2050. Six population-based studies used in the 2016 analysis by Varma and colleagues[3] included the Beaver Dam Eye Study (non-Hispanic white populations), Baltimore Eye Survey and Salisbury Eye Evaluation Study (white and African American), Proyecto VER and Los Angeles Latino eye Study (LALES; Latino/Hispanic populations), and Chinese American Eye Study (CHES; Asian American) to describe the growing scope of visual disability. The number of people with VI in the United States was estimated to be 3.22 million in 2015, and is expected to increase to 4.79 million in 2030, and to 6.95 million in 2050.[3]

With regard to prevalence and estimated increases in the big 4 eye diseases that were mentioned earlier (cataract, diabetic retinopathy, glaucoma, and macular degeneration), it is clear that health providers will encounter ever-surging numbers of patients with potentially disabling conditions. In all 4 disorders, public health specialists anticipate a doubling of affected individuals[4] (**Table 1**). Certain ethnicities will be affected to a greater extent compared with the general population. For example, Hispanic people are predicted to have a 6-fold increase in ARMD, a disease often mistakenly assumed to afflict primarily white people. The investigators report a 3-fold increase in Hispanic people with diabetic retinopathy.[5]

COST OF VISUAL IMPAIRMENT IN THE UNITED STATES

The National Opinion Research Center Research Center (NORC) reported the cost of eye disorders and vision loss in the United States in 2013 as $139 billion, with $65

Table 1
Prevalence projections of the big 4 visual disorders

Condition	Individuals (Millions) 2010	Individuals 2050	Increase (%)
Cataract	24.4	50	105
Diabetic retinopathy	7.7	14.6	89
Glaucoma	2.7	6.3	133
Macular degeneration	2.1	5.4	157

billion in direct medical costs. Employed individuals lost $48 billion in productivity because of VI. Long-term care of patients with VI accounts for $20 billion.[6] What is the scope of $1 billion? Spending at a rate of $1 million per month, it would take 83 years to spend a billion dollars, and, therefore, 11,537 years to spend $139 billion.

A recent analysis of Medicare data from April 2015 to 2018, by Morse and colleagues,[7] matched about 6165 individuals with normal vision to 6056 with vision loss, revealing that the latter had a 22% readmission rate, 12% higher costs, and a 4% longer hospital stay compared with controls. Similar findings were discovered in commercial health insurance patients. National extrapolation shows $500 million in additional costs for the severe VI group annually.[7]

VISUAL IMPAIRMENT: SEEING THROUGH PATIENTS' EYES

Although escalating numbers raise alarm, medical providers consider the implications of these statistics. What does it mean for patients when clinicians say that the big 4 are increasing? The Social Security Administration defines blindness as vision less than 20/200 in the better eye or blindness as a visual field of less than 20° in the better eye for at least 12 months. The implication for patients is that they cannot drive to their appointments or read medication labels. Subtle, as well as not so subtle, disruptions of activities of daily independent living occur with VI. Patients must self-advocate and call attention to the problems. They need to find means to address these deficits; however, they often suffer silently.

Each of the diseases mentioned earlier has a different type of vision loss and vision impairment. Cataracts can cause a generalized blurring of vision with or without glare, glaucoma typically begins with peripheral vision loss, macular degeneration affects

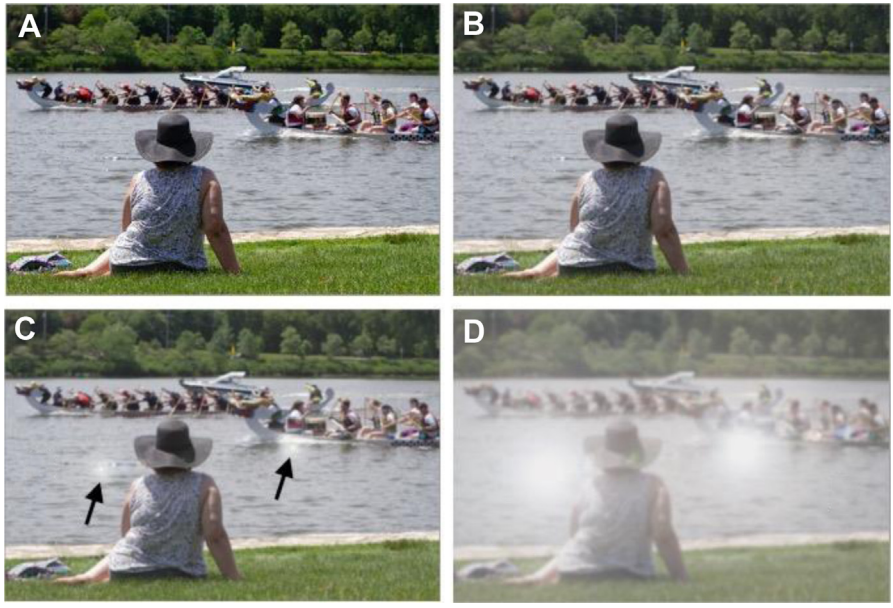

Fig. 1. Eye disease simulations: cataract. (*A*) Vision with a clear lens. (*B*) Mild cataract. There is a generalized mild blurriness, often described as seeing through a film. There are various types of cataract, but one of the most common is the age-related nuclear cataract, which typically slowly causes blurred vision over a period of many years. (*C*) Moderate cataract. Details on faces are no longer visible and there is the beginning of glare with reflected sunlight (*arrows*). At night, halos around light may develop. (*D*) Severe cataract. Diffuse blurred vision with glare obscuring people and objects.

the central vision, and diabetic retinopathy can cause various different patterns of vision loss. Figs. 1–4 are simulations of what patients with vision loss can experience in these different diseases.

Fig. 2. Eye disease simulation: diabetic retinopathy. (*A*) Normal vision with no retinal disease. (*B*) Diabetic retinopathy simulation. Diabetic eye disease can be asymptomatic or have several patterns of vision loss; for example, patchy vision loss caused by intraretinal hemorrhage, central vision loss caused by macular edema, or sudden diffuse loss caused by vitreous hemorrhage. This photograph simulates patchy vision loss caused by types of diabetic eye retinopathy, including retinal hemorrhage or ischemia.

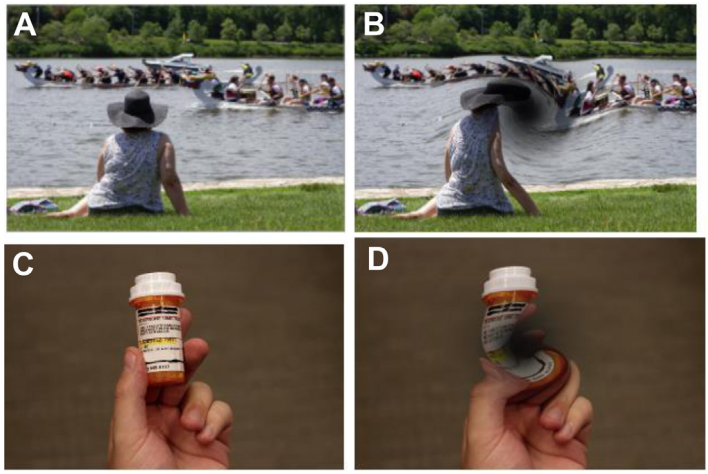

Fig. 3. Eye disease simulation: macular degeneration. (*A*) Normal distance vision. (*B*) Macular degeneration: distance vision simulation with loss of central vision and central distortion. (*C*) Normal near vision. (*D*) Macular degeneration: near-vision simulation with loss of central vision and distortions affecting reading. These distortions may be gradual or have abrupt onset.

Fig. 4. Eye disease simulation: glaucoma. (*A*) Normal distance vision. (*B*) Glaucoma can cause various types of vision loss, but it typically involves the painless, progressive, irreversible loss of peripheral vision simulated here, which, if left untreated, will also progress to central vision loss. The most common type of glaucoma is open angle glaucoma. It is sometimes referred to as the silent thief of sight because many patients do not notice any symptoms until late in the disease course.

VISUAL IMPAIRMENT AND RISKS TO PATIENTS' QUALITY OF LIFE AND NONOCULAR DISEASE

It is not surprising that vison loss contributes to undesirable health outcomes. Several observational studies and health surveys reach this conclusion. Medicare database analysis from 2014 done by Hamedani and colleagues[8] showed that, after adjustment for relevant comorbidities, VI is associated with hip fracture (adjusted odds ratio [AOR], 2.54), depression (AOR 3.99), anxiety (AOR 2.93), and dementia (AOR 3.91). Other investigators have provided further evidence of the relationship between VI and psychiatric/neurologic compromise. Using a powerful longitudinal study format of a Korean national sample with 1,025,340 subjects, published by a group from Hallym University College of Medicine, both the low-vision and blind subgroups had increased risk of depression. These results held after adjustment for age, sex, income, geographic factors, hypertension, diabetes, and dyslipidemia.[9] Cross-sectional analysis of 2 large datasets, the National Health and Nutrition Examination Survey (NHANES, 1999–2002) and the National Health and Aging Trends Study (NHATA 2011–2015), found decreased cognition testing parameters in study patients with low vision controlling for demographics, socioeconomic status, education level, household income, general health conditions, hearing impairment, and physical limitations.[10] VI brings risk to patients on several fronts. The effects of prevention and early detection of eye disease, as shown by the studies discussed earlier, affects the severity of nonocular diseases as well.

ROLE OF INTERNISTS AND MEDICAL SUBSPECIALISTS IN PREVENTION OF VISUAL IMPAIRMENT AND BLINDNESS

Despite the fact that VI reduces quality of life and affects nonocular disease, providers are encouraged to know that vision loss is preventable in most patients. PCPs and medical subspecialists play a vital role in prevention of vision loss. In the case of diabetic eye disease, for example, the Diabetes Control and Complications Trial (DCCT) concluded that, in type 1 diabetes, a 10% reduction in hemoglobin A_{1c} level (eg, from 10% to 9% or from 8% to 7.2%) reduced the risk of retinopathy progression by 43%.[11] Greater than 70% of respondents in the National Eye Health Education Program (NEHEP) 2005 Public Knowledge, Attitudes, and Practices Survey thought that loss

of their eyesight would have the greatest impact on daily life; however, less than 11% knew that early diabetic retinopathy and glaucoma lacked symptoms.[12] Providers can channel patients' concern for loss of vision into productive conversations to motivate patients in a range of areas, including glycemic control, smoking cessation, healthy diet, medication compliance, and screening guideline compliance. Patients benefit when their providers gather relevant ocular history, use simple examination techniques such as direct observation or penlight examination, and include appropriate eye-screening recommendations into patients' care plans.

Here are some simple steps that internists or medical subspecialists can incorporate into their daily practice that can dramatically decrease vision loss and its impact on their patients.

History

Ask appropriate visually-directed questions. The question, "Can you see well?" will not bring out the same information as, "Are you struggling with small print or seeing road signs at night?" Take interest in eye-drop instructions and eye vitamins on patient medication lists. PCPs are frequently asked by patients to fill glaucoma drops along with other systemic medications with 90 day/3 refills. Knowledge that a typical patient with glaucoma is seen 2 to 4 times per year by an ophthalmologist should prompt PCPs to inquire when the patient last presented to an eye doctor. This conversation identifies patients with glaucoma who repeatedly request their PCPs refill their drops, and are lost to follow-up, while glaucoma, the silent thief of sight, causes further irreversible vision loss.

PCPs often ask patients about risk prevention, such as wearing seatbelts or a bicycle helmet. If a patient's profession is high risk for eye trauma, ask whether the patient routinely wears safety glasses. The National Institute for Occupational Safety and Health (NIOSH) reports that every day about 2000 US workers sustain job-related eye injuries that require medical treatment. Safety experts and eye doctors believe proper eye protection lessens the severity or prevents 90% of these eye injuries.[13]

Examination

PCPs can detect eye disease or ocular manifestations of systemic disease without fancy slit lamps and cumbersome direct ophthalmoscopes. Careful direct observation (droopy eyelid, red eye, exophthalmos, and so forth) can detect many conditions (**Table 2**).

Table 2
Examples of ocular diseases that can be diagnosed by penlight examination

Observation	Condition Suspected
Corneal arcus in patients <50 y old or with xanthelasma	Hypercholesterolemia
White corneal opacity with red eye	Corneal ulcer
Loss of iris detail	Hyphema
Exophthalmos	Thyroid-related eye disease
Prominent diffuse eye vascularization	Cavernous-carotid fistula
Anisocoria	Subarachnoid hemorrhage
Restricted eye movement	Vascular muscle palsy, thyroid-related eye disease, myasthenia gravis
Eyelid mass with loss of eyelashes	Basal, squamous, or sebaceous cell carcinoma

Is there a focal white spot on the cornea in a contact lens wearer that is consistent with a corneal ulcer? Is there limited view to see the iris in a patient who took a tennis ball to the face? Lack of iris detail suggests blood in the front of the eye, called hyphema, with potential associated conditions such as increased eye pressure. Does the provider notice a restriction of eye movement in gaze positions in a vasculopathic patient with new-onset double vision?

An observation of a white ring in the peripheral cornea can be extremely important (Fig. 5). This ring is called corneal arcus. It is very common in patients more than 65 years of age and is typically not associated with any other systemic disease. However, if this is seen in patients younger than 55 years, this can be the only sign on physical examination of a patient with hyperlipidemia.

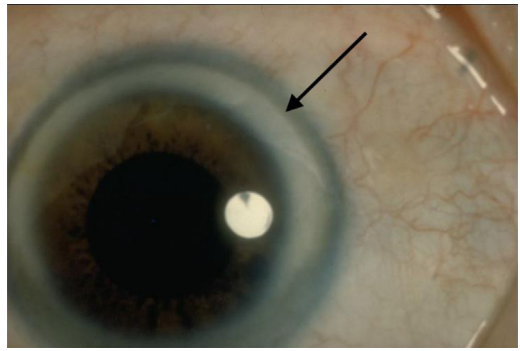

Fig. 5. Corneal arcus is a white ring in the peripheral cornea (*arrow*). This ring can be seen in younger patients with hyperlipidemia, or more commonly in patients older than 65 years. Used with permission, © 2021 American Academy of Ophthalmology.

Without regularly performing direct ophthalmoscopy, it is unlikely that a non–eye care provider will develop sufficient skill to make meaningful observations. In our opinion, it is much more valuable for PCPs to remind patients about the importance of regular screening eye examinations by an eye care provider. Nonmydriatic fundus cameras are becoming increasingly available and affordable. They may become ubiquitous in primary care or medical subspecialty offices in the near future. These cameras, combined with cloud-based or artificial intelligence–based services to review and read images, may soon greatly enhance successful eye disease screening.

A surprising number of eye problems find their way directly to the emergency department (ED). Many PCPs can easily triage with penlight and treat in the standard office. In a study of 12 million ED visits for ocular issues from 2006 to 2011, 44% were considered nonemergent. Of these, 4 million visits were for conjunctivitis, subconjunctival hemorrhage in the absence of trauma, and styes. Forty-one percent of the ED visits in the study were classified as emergent, and included corneal abrasion and foreign body.[14]

Follow-up Care Plan: Ocular Screening Examinations and Risk Assessment

Screening eye examinations

In the absence of eye disease or systemic disease requiring eye screening, the American Academy of Ophthalmology (AAO) 2016 Preferred Practice Patterns recommends comprehensive eye examinations for patients without risk factors or other ocular disease based on age.[15] Recommendations on the frequency of dilated eye

examinations for patients with no eye disease or need for corrective lenses vary by age. People less than 40 years old should have one every 5 to 10 years, between 40 and 54 years old every 2 to 4 years, 55 to 64 years old every 1 to 3 years, and annually for those 65 years of age and older. Although optometrists and ophthalmologists are capable of performing screening or surveillance eye examinations, as medical doctors, ophthalmologists have greater familiarity with systemic diseases and are equipped to provide necessary medical and surgical treatments.

Patients with diabetes require eye screening based on the type and duration of their disease. Type 1 patients need examinations within 5 years of diagnosis and yearly thereafter. Type 2 patients need referral at the time of initial diagnosis and yearly thereafter. Some guidelines allow for a diabetic eye examination every 2 years if the prior examination was normal.[16] Pregnant women with type 1 or 2 diabetes need examinations before conception and then again early in first trimester. Adherence to diabetic eye screening is arguably the most effective way to prevent VI and blindness in adults less than 65 years of age.

Patients who are at risk of other eye diseases (eg, African Americans and Hispanic people for glaucoma or patients with a strong family history of glaucoma) may need more frequent screening, perhaps every 1 to 2 years for those age 40 years and older.

Patients taking certain medications, such as hydroxychloroquine or ethambutol, require screening for ocular toxicity.

Smoking cessation

A repetitious and multifaceted approach is often necessary to convince patients to quit smoking. Smoking cessation decreases the incidence of cardiovascular disease and cancer in addition to many other diseases, including eye disease. Nonsmokers decrease their risk of vision loss and blindness associated with macular degeneration and glaucoma. Armed with this information, medical providers have another approach to discussing smoking cessation with their patients.

Driving

PCPs must consider several criteria in their discussions about driving privileges with concerned patients and their families. PCPs realize that driving safety and patient well-being are more than seatbelt use. Older patients carry higher risk of serious injury in even minor car accidents with air bag deployment. However, loss of driving privileges can dramatically affect independence in some patients. Some of the driving criteria are objective. These criteria include the presence of medical conditions (frequent seizures) or use of medications contraindicated with driving. Other parameters are more difficult to quantify, such as declining cognitive or motor skills. Knowledge of the state's vision requirements and the role of the PCP in the conversation helps wise decisions to be made.

Visual requirements vary state by state, with most states requiring the best-corrected vision to be 20/40 or better in 1 eye for night driving. In some states, the threshold is not as stringent. The best-corrected vision can be 20/70 or better if other criteria are met, such as the worse eye being better than 20/200. Some states have a minimum peripheral visual field requirement, whereas others do not. If a patient fails the state's vision screen in the licensure process, then most states refer that patient for a formal eye examination. The eye doctor provides specific information, such as uncorrected and best-corrected visual acuity, peripheral vision measurements, and ocular condition stability. Fortunately, the results of the eye examination are reported as either pass or fail. Meeting the vision requirements does not necessarily indicate that the patient should drive, but failure to meet the standards may help the patient

accept the decision not to drive. Failure on the vision component may assist the primary provider when resentful patients disagree over equivocal cognitive and motor skill evaluations.

PRESENTING SIGNS/SYMPTOMS OF SYSTEMIC DISEASE WITH OCULAR FINDINGS

Ocular disorders accompany systemic diseases. The AAO published a useful guide in 2009 on the topic of ocular manifestations of systemic disease, which the authors encourage readers to review.[17] The fascinating scope of this topic is beyond the limits

Table 3
Systemic disease with eye manifestations

Category	Example of Condition	Systemic Signs/ Symptoms	Ocular Signs/Symptoms
Congenital	Neurofibromatosis	Skin macules	Iris lesions (Lisch nodules), optic nerve glioma
	Marfan syndrome	Cardiac disease	High refractive error, dislocated lens
Traumatic	Shaken baby syndrome	Multiple fractures in different stages of healing	Vitreous, preretinal, intraretinal hemorrhage
Vascular	Embolic disease	Carotid bruit, heart murmur	Retina emboli (Hollenhorst plaque), painless monocular vision loss
	Hyperviscosity syndrome	Abnormal complete blood count parameters	Intraretinal hemorrhages, optic disc congestion
Neoplastic	Metastatic carcinoma	Mammogram/ computed tomography abnormality based on primary source	Choroidal masses with or without vision loss
Autoimmune	Collagen vascular disorders	Laboratory antibody abnormalities	Dry eye, uveitis, corneal melts
	System lupus erythematous	Neurologic, kidney, cardiac malfunctions	Above findings, plus retinal vasculitis
	Sarcoidosis	Multisystem computed tomography chest lymphadenopathy	Uveitis, lacrimal gland enlargement, optic disc infiltration
Idiopathic	Intracranial hypertension	Headache	Papilledema, visual field defects
	Multiple sclerosis	MRI abnormalities	Painful vison loss
Infectious	Acquired immunodeficiency syndrome	Laboratory value abnormalities, CD4, and so forth	Red conjunctival mass (Kaposi sarcoma), Retina disorder: cotton wool spots, retinitis with hemorrhagic white necrotic patches
		Pneumonia	

of this article, but a representative sample of ocular findings in certain systemic diseases is presented (Table 3).

SUMMARY

Eye disease and vision impairment have a significant impact on patients and society. In addition to the limitations in vision, VI negatively affects morbidity and mortality of nonocular disease. Internists and medical subspecialists play a vital role in the prevention, detection, and treatment of eye disease, which adds significantly to patients' quality of life. Primary providers are called on to take ocular history, perform penlight examinations, recognize screening guidelines, and to incorporate these elements into patient care plans. Most VI is preventable, and a collaborative approach with patients, internists, medical subspecialists, and eye care providers is essential in preserving vision.

CLINICS CARE POINTS

- Glycemic control reduces the risk of visual impairment in patients with insulin dependent diabetes such that a 10% deduction in HgA1C reduces risk of retinopathy progression by 43%.
- Type 1 diabetics should have dilated eye exams within 5 years of diagnosis and yearly thereafter. Type 2 diabetics need referral for fundus exam at diagnosis and yearly thereafter.
- Smoking cessation reduces the risk of vision loss from macular degeneration.
- Visual impairment erodes quality of life with increased morbidity and mortality in association with non-ocular diseases.
- Asking visually-directed questions regarding activities of daily living such as the utilization protective eyewear for those with high-risk professions or hobbies improve outcomes for our patients.
- Current recommendations for eye exams for patients without eye disease are every 1-3 years for ages 55-64 and annually for patients over 65.

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