

International vision requirements for driver licensing and disability pensions: using a milestone approach in characterization of progressive eye disease

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Objective: Low vision that causes forfeiture of driver's licenses and collection of disability pension benefits can lead to negative psychosocial and economic consequences. The purpose of this study was to review the requirements for holding a driver's license and rules for obtaining a disability pension due to low vision. Results highlight the possibility of using a milestone approach to describe progressive eye disease.

Methods: Government and research reports, websites, and journal articles were evaluated to review rules and requirements in Germany, Spain, Italy, France, the UK, and the US.

Results: Visual acuity limits are present in all driver's license regulations. In most countries, the visual acuity limit is 0.5. Visual field limits are included in some driver's license regulations. In Europe, binocular visual field requirements typically follow the European Union standard of $\geq 120^\circ$. In the US, the visual field requirements are typically between 110° and 140° . Some countries distinguish between being partially sighted and blind in the definition of legal blindness, and in others there is only one limit.

Conclusions: Loss of driving privileges could be used as a milestone to monitor progressive eye disease. Forfeiture could be standardized as a best-corrected visual acuity of <0.5 or visual field of $<120^\circ$, which is consistent in most countries. However, requirements to receive disability pensions were too variable to standardize as milestones in progressive eye disease. Implementation of the World Health Organization criteria for low vision and blindness would help to establish better comparability between countries.

Keywords: driver's license requirements, glaucoma, health outcomes, progressive eye disease

Introduction

Maintaining mobility outside the home is an essential part of independent and active living for the elderly. Driving is often the most convenient form of transportation, especially in places with limited or no public transportation services. It is the primary means of transportation among the elderly in the US^{1,2} and is becoming increasingly important in Europe.^{3,4} Visual cues provide the most crucial sensory information for safe driving performance.^{5,6} Although many factors contribute to safe driving, crash rates and driving-related injuries have been associated with deteriorating vision.^{5,7,8} Consequently, licensing authorities have instituted minimum vision requirements for maintaining driving privileges.

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The number of patients with visual impairments due to progressive eye diseases, such as glaucoma, is expected to rise in coming years as the population ages worldwide.^{8–10} Because glaucomatous damage progresses to visual impairment, many will fail to meet the vision requirements for legal fitness to drive and will be forced to relinquish their driver's license. Unfortunately, driving cessation can lead to profound negative psychosocial and economic consequences. For example, former drivers lose their mobility and independence, making it difficult to obtain essential services and daily goods, eg, doctors' appointments and groceries.¹¹ They also reduce the frequency of contact with relatives and friends as social opportunities become restricted.¹² Depressive symptoms are higher in former drivers, possibly as a result of these consequences.^{13–15} The economic consequences of losing driving privileges are not merely limited to the former driver. Drivers who lose their license must also rely on others for transportation, which may be costly in terms of a caregiver's time, and monetarily costly if the caregiver needs to make alternative work arrangements. As eye diseases progress to low vision and blindness, the former driver may no longer be able to participate fully in life and/or work activities, and disability pensions may be sought. Furthermore, people who lose the ability to drive are also more likely to require long-term care facilities,¹⁶ posing a personal and/or societal financial burden.

Fortunately, effective treatment can slow the rate of disease progression^{17,18} and potentially increase the length of time that a person is deemed fit to drive. For glaucoma, judgments about treatment effectiveness are typically based on intraocular pressure reduction. In recent years, researchers and clinicians have become increasingly concerned with slowing the progression of visual field loss,¹⁹ which may be as important as achieving target intraocular pressures. As a complement to visual field measurements, treatment effectiveness may also be considered in terms of postponing milestones, such as driver's license forfeiture and receipt of disability benefits. Measuring the rate of progression to defined milestones such as these would provide an important link between visual field measurements and patients' quality of life. However, the degree of consensus between countries regarding driver's license vision requirements and entitlement to disability pensions has not been clearly defined.

The purpose of the present study was to review the requirements for holding a driver's license and rules for obtaining a disability pension due to low vision. Results underscore the possibility of using these outcomes as milestones to describe progressive eye disease by relating disease severity

to disability. This review was conducted for five European Union countries and selected states within the US.

Methods

Research was conducted to identify driver's license rules and requirements for passenger cars and disability pensions due to low vision for six countries (Germany, Spain, Italy, France, the UK, and the US). For each of the six countries, the driver's license regulations were investigated with regard to visual standards. In the US, where the regulations are state-dependent, we focused on regulations from three arbitrarily chosen states (California, Iowa, and New York). In Europe, regulations in each country have been affected by minimum European Union standards. The European Union Member States have their individual driver's license requirements and guidelines, but the European Union regulations can potentially overrule these. Therefore, these European Union standards were also reported. Sources included government reports, research reports, government and nonprofit websites, and journal articles. Linguistic experts assisted with the review to include relevant nonEnglish documents. National findings and intercountry differences were reviewed, discussed, and verified with ophthalmology specialists from each country.

Results

Driver's license requirements

Visual acuity

The most important aspects of the driver's license requirements for passenger cars are summarized in Table 1 for the relevant European Union countries. The medical requirements for driver's licensing in European countries are affected by the minimum standard established by the European Union. Drivers of cars and motorcycles are required to have a binocular visual acuity of at least 0.5 (20/40 feet, 6/12 or 5/10 meters) with or without correction, and binocular visual field standards are limited to no less than 120°. ²⁰ For monocular vision, applicants must have a corrected or uncorrected visual acuity of at least 0.6 (approximately 20/30 feet, 6/9 meters). Also, medical authorities must certify that the condition has existed sufficiently long enough to allow adaptation and that the field of vision in the subject eye is normal. In cases where a progressive eye disease is detected or declared, driver's licenses may be issued or renewed provided that the applicant undergoes regular medical examinations. ²⁰ Exceptions can be made in cases duly justified by a favorable medical opinion and a positive practical test. At these

Table 1 Driver's license requirements in Europe

Country	Visual acuity	Visual field	Monocular vision	Other characteristics
EU	0.5 both eyes and with corrective lenses	No less than 120°	VA \geq 0.6 if monocular vision	Exceptions can be made by medical opinion
UK	Number plate test (\approx 6/10 to 6/15)*	At least 120° horizontally (no significant loss within central 20°)	Monocular vision if normal visual field	License must be revoked if standards not met (exceptions possible under EU standards)
Germany	Corrected VA not below 0.5 in the best eye, 0.2 in the worse eye	At least 120° horizontally (perfect within 30°)	If monocular or worse eye below 0.2: best eye at least 0.6 VA	
France	Binocular acuity not lower than 0.5	Horizontal: 60° right and left; vertical: 30° above and below	If monocular or worse eye below 0.1: best eye at least 0.6 VA	Night vision necessary; can be exceptions for restricted daytime licenses
Spain	Best-corrected VA of at least 0.5	Visual field has to be normal	Monocular vision not allowed; exceptions if at least 0.6 VA	Restrictions can be determined by medical experts
Italy	Best-corrected binocular VA at least 1	Normal field of vision (such as 120°)	Worse-seeing eye at least 0.2	Sufficient chromatic sense and nocturnal vision

Note: *0.4 to 0.6 in decimal fraction.

Abbreviations: VA, visual acuity; EU, European Union.

examinations, attention is paid to the state of visual function, recovery from glare, contrast sensitivity, and twilight vision.²¹ Driver's licenses are not issued if the medical examination shows any other eye condition that would compromise driving safety.²⁰

European countries generally follow the European Union driver's license requirements with a few exceptions. In the UK, visual acuity requirements are based on the number plate eye test in which the applicant must be able to read a registration mark fixed to a motor vehicle.^{22–24} The number plate test has been thought to convert to a Snellen acuity of between 6/15 and 6/10 (20/50–20/40 feet or 0.4–0.6 decimal).^{25,26} Monocular vision is allowed in the UK if there is a normal monocular visual field and no area of defect caused by pathology.^{22,27} Binocular visual acuity requirements for the remaining European Union countries are similar. France and Spain follow the European Union standard, in that both have a minimum binocular vision requirement of 0.5 (20/40 feet, 5/10 meters).^{28,29} However, in Italy, the best-corrected visual acuity must be at least 1.0 (10/10, 20/20 feet, 6/6 meters) for binocular vision, with a minimum of 0.2 (2/10, 20/100 feet, 6/30 meters) for the worse-seeing eye.³⁰ In Germany, applicants must also have a central visual acuity of at least 1.0 (0.7/0.7, 20/20 feet, 6/6 meters) with or without corrective means.³¹ Stricter standards are enforced for monocular vision in Germany and France, which require visual acuity of the better eye to be at least 0.6.³¹ In Spain and Italy, driving with monocular vision is normally not allowed.

The visual acuity requirements for holding a driver's license in the European Union are similar to those in the

US states (Table 2). In California, visual acuity of 20/40 (6/12 meters, 0.5 decimal) with or without correction is required.^{32,33} Visual acuity measurements are obtained for both eyes together and for each eye separately while both eyes remain open, as in normal driving.^{32,33} In New York and Iowa, a driver must also have 20/40 (6/12 meters, 0.5 decimal) vision in at least one eye with or without corrective lenses.^{34,35}

Visual field

The minimum visual field requirement in the UK is at least 120° horizontally (Table 1). Furthermore, there cannot be significant defects in the binocular field that encroach within 20° of fixation above or below the horizontal meridian.^{24,27} The same requirement is observed in Germany and France, but the central visual field up to 30° must be normal.^{28,31} For Spain and Italy, no diameter is given for visual field requirements. However, the field of vision, whether binocular or monocular, also has to be normal (eg, 120°).^{29,30} In the US, California does not have visual field requirements (Table 2). The standards are slightly more stringent for New York and Iowa compared with European Union countries. In New York, for individuals with corrected vision of less than 20/40 but no less than 20/70, the horizontal binocular field of vision must be no less than 140°.³⁶ In Iowa, the visual field requirement is also 140° or better.³⁴

Exemptions and restrictions

To drive in the UK, the applicant has to meet the visual standards. If the driver is unable to meet the standards, he or

Table 2 Driver's license requirements in the US

State	Visual acuity	Visual field	Monocular vision	Other characteristics
All states	Most states: 20/40 (one or both eyes)*	Some states: none; most states: 110° to 140°	20/40 to 20/100*** (20/40 in most states)	Most states allow for restrictive licenses
California	20/40 with or without corrective lenses	No visual field requirements	Tested for both eyes together and for each eye separately	A vision specialist can determine ability to drive
New York	20/40 vision in at least one eye with or without corrective lenses	If VA between 20/40 and 20/70*: 140° field of vision		A vision specialist can determine restrictions
Iowa	At least 20/40 vision in at least one eye, with or without corrective lenses	140° or better		20/40–20/50****: no headlights driving; 20/50 but at least 20/70: no driving over 35 mph

Notes: Decimal fraction equivalent: *20/40 = 0.5; **20/70 = 0.3; ***20/100 = 0.2; ****20/50 = 0.4.

Abbreviation: VA, visual acuity.

she must not drive and the license must be refused or revoked. However, the European Union regulations can override the UK standards, and the driver can apply to be considered as an exceptional case and granted an exemption.³⁷ In the UK, licenses are normally issued to be valid until the driver is aged 70 years, unless restricted to a shorter duration for medical reasons. There is no upper limit, but after the age of 70 years, renewal is necessary every three years.^{27,38}

In Germany, if the applicant does not pass the test, an eye medical investigation is required, and minimum requirements of this test must be fulfilled. Central visual acuity defects must be corrected as much as possible. Visual acuity must not fall below 0.5 in the best eye and 0.2 in the worse eye.³¹ Renewal is not determined by age, and there are no medical requirements for renewal.³⁸

For requirements in France, in case of severe vision loss of an eye, the driver will temporarily lose permission to drive. Also, night vision is required. Restricted licenses for daytime driving are given only if a specialist deems that the visual field is normal.²⁸ There are no age-related renewal procedures or medical requirements for renewal.³⁸ In the case of alterations of mesopic vision or glare, restrictions and limitations in Spain must be determined according to ophthalmologic criteria so that secure driving can be guaranteed. Driving with diplopia is not allowed. However, exemptions can be given in exceptional cases. People in Spain with monocular vision and a visual acuity of higher than 0.6 on the better-seeing eye can get permission to drive, provided they fulfill all other requirements and travel no faster than 100 km/hour.³⁹ In Spain the renewal cycles are 10 years for drivers younger than 45 years of age. For drivers between 45 and 70 years of age, the renewal cycles are five years. For drivers who are 70 years of age or older, renewal has to take place every other year.⁴⁰ In Italy, a medical/legal specialist and a general ophthalmologist examine the medical

certifications, ie, ophthalmic check reports and visual field examinations. Candidates must possess sufficient chromatic sense, adequate nocturnal vision, and binocular vision.⁴¹ The renewal cycle in Italy is 10 years until the age of 50 years. Between the ages of 50 and 70 years, the renewal cycle is five years, whereas after age 70 years the renewal cycle is accelerated to an interval of three years.⁴²

Driving requirements in the US are varied. In California, candidates who do not pass the vision examination may be referred to a vision specialist, who determines the ability to drive safely and may prescribe eye glasses or a stronger prescription (Table 2).^{32,33} Renewal takes place every five years regardless of the age of the driver. However, drivers who are 70 years of age or older will have to undergo a vision examination to get a renewal.⁴³ If the driver fails the vision test, a supplementary driving performance evaluation (driving test) can be given to determine whether the driver can compensate for the vision impairment. If this supplementary driving test is passed, the driver's license can be renewed with restrictions added to the license. Restrictions can include requirements for special mechanical devices to be placed on the vehicle, limiting when and where a person may drive (eg, no freeway driving, no nighttime driving), or requiring eye glasses or corrective contact lenses. In New York, if the vision test is not passed, further assessment must be made by a physician, ophthalmologist, or optometrist.³⁶ Renewal takes place every five years no matter what age the driver is. For a renewal process, the driver must prove that a visual acuity (eye) test has been passed within six months, or within one year as determined by a licensed health care professional.^{36,43}

In Iowa, if visual acuity is less than 20/40 but at least 20/50 (6/12–6/15 meters, 0.5–0.4), no driving is allowed when headlights are required. If visual acuity is less than 20/50 but at least 20/70, driving at speeds over 35 mph is not allowed, in addition to no driving when headlights are

required. Driving is not permitted for visual acuity less than 20/70. In respect of visual field requirements, left and right outside rearview mirrors are required if the field of vision is less than 140° but at least 115° for the single best eye (70° temporal and 45° nasal). For a field of vision less than 115°, driving is not permitted.³⁴ The normal renewal cycle in Iowa is five years, and for drivers who are 70 years of age or older it is two years.⁴³

Entitlement to disability pensions

The requirements for obtaining disability pensions due to low or no vision were found to be unique for each country. The most important aspects of disability pension qualifications have been summarized in Table 3 for the relevant European Union countries and US states. In the UK, people can claim a disability living allowance if they are certified blind (severely sight-impaired) or partially sighted (sight-impaired). Severely sight-impaired is defined as a visual acuity below 3/60 or 1/18 (20/400 feet) tested with the Snellen test, or with visual acuity better than 3/60 but below 6/60 (20/200 feet) with a very restricted visual field. A person can be certified blind (or severely sight-impaired) if he or she is unable to perform work for which eyesight is essential. Partially sighted (sight-impaired) corresponds to visual acuity from 3/60 to 6/60 (20/400 to 20/200 feet) with a full field or visual acuity up

to 6/24 (20/80 feet) with moderate contraction of the field, aphakia (lens removal), or opacities blocking vision in the eye itself, or with visual acuity of 6/18 (20/60 feet) or better if they have a gross visual field defect (of both eyes, such as hemianopia) or marked contraction of the visual field (eg, in retinitis pigmentosa or glaucoma). The visual acuity and visual field guidelines in the UK for partially sighted (sight-impaired) designations suggest that a person can be certified as such if he or she is substantially and permanently disabled by defective vision caused by congenital defect, illness, or injury.⁴⁴ Furthermore, a person is eligible to receive a disability living allowance only if he or she is below the age of 65 years, has severe sight problems for at least three months, and is expected to have severe sight problems for another six months.^{45,46} Other European Union countries have different requirements for receiving disability allowances. Germany requires legal blindness for receiving a disability allowance. A blind person is someone whose central best-corrected visual acuity is 1/50 (20/1000 feet, 6/300 meters) in the better eye.⁴⁷ For France, 50% of disability corresponds to visual acuity below 3/10 (approximately 20/66 feet, 6/20 meters) in both eyes or 50% of visual field loss according to the Esterman score (binocular field). Eighty percent of disability corresponds to visual acuity below 1/10 (20/200 feet, 6/60 meters) in both eyes, or 80% of visual field loss according to the Esterman score (binocular field). In France, complete blindness is defined by visual acuity corresponding to no light perception. Legal blindness is visual acuity $\leq 1/20$ (20/400 feet, 6/120 meters, 0.05 decimal) of one eye and visual acuity of the other eye below 1/20, with peripheral visual field deficiency when the visual field does not exceed 20° in the largest area.^{48,49}

In Spain, compensation for the blind relies heavily on ONCE (Spanish National Organization for the Blind). Membership conditions are a best-corrected visual acuity of 0.1 (1/10 on a Wecker scale) or lower, a visual field reduced to 10° or less, and Spanish citizenship.^{50,51} Between normal vision and blindness, there is a wide range of disabilities, eg, “visual disability”, “serious visual disability”, and “low vision”. In all three cases, visual acuity and visual field are used to obtain the degree of disability. Visual disability is defined as a person who has reduced or very reduced visual capacity (even though the person is using glasses) and there is no possibility for improvement with surgical treatment.⁵² People with disabilities can apply for the *Pensión no Contributiva por Invalidez* and *Pensión por Incapacidad Permanente*.^{53,54} In order to obtain any type of disability pension, it is necessary to pass an examination by specialized doctors. The application

Table 3 Eligibility for disability pension benefits

Country	Partially sighted	Blind
UK	VA of 3/60 to 6/60 with a full field, or 6/24 with field contraction, aphakia, or opacities blocking vision	VA of 3/60 or 1/18, or 6/30 to 3/60 with a very restricted visual field, or 6/18 or better with marked contraction of visual field
Germany		Central BCVA of 1/50 in the better eye
France	VA $< 3/10$ and $> 1/20$	Central vision $\leq 1/20$ of one eye, and VA of the fellow eye below 1/20, with peripheral visual field deficiency when the visual fields do not exceed 20° in the largest area
Spain	1/10 on a Wecker scale, visual field reduced to 10° or less	N/A
Italy	1/20 or lower for both eyes	Absolute blindness
US	BCVA of 20/200 in the better eye, or limitations in the fields of vision no greater than 20°	N/A

Abbreviations: VA, visual acuity; BCVA, best-corrected visual acuity; N/A, not applicable.

procedure is relatively complicated and involves a panel of specialized doctors who decide whether the candidate is sufficiently disabled for eligibility.

Pensions for the blind (*pensione ciechi civili*) in Italy apply only to people with complete blindness. The requirements also include Italian citizenship and residency, and the citizen must be older than 18 years. Requirements for the partially blind pension (*pensione per ciechi parziali*) include a visual acuity of 1/20 (20/400 feet, 6/120 meters) or lower for both eyes. The candidate can be a European Union citizen with an Italian residence or a nonEuropean Union citizen with a work permit in Italy.^{55,56}

In the US, people who are legally blind can obtain disability benefits. The requirements and definition for legal blindness are established in the Social Security Act, Section 216.⁵⁷ A person is considered legally blind if central visual acuity is 20/200 (6/60 meters, 0.1 decimal) or less in the better eye with the use of a correcting lens. An eye with a field of vision limitation, such that the widest diameter of the visual field subtends an angle of 20° or less, is considered to have a central visual acuity of 20/200 or less.^{57,58} A person may also receive disability benefits even if he or she is not considered legally blind, if the vision problems alone or combined with other health problems prevent the person from working. For social security disability benefits, a person must have worked long enough to have paid social security taxes. For supplemental security income payments based on disability and blindness, it is not necessary to have been employed, but income and resources must be below state-imposed limits.

Discussion

Progressive eye diseases such as glaucoma can negatively impact vision and driving. Maintaining mobility outside the home is a main priority of glaucoma patients and a major contributor to quality of life.^{59–61} Evaluating driver's license status and disability entitlements extends beyond typical quality of life assessments by highlighting the practical consequences of progressive eye disease.⁵⁹ These outcomes may be useful in assessing disease progression and efficacy of treatments.

Licensing authorities hold the primary responsibility for establishing the fitness of license holders.⁶² The most common visual requirements for driver's licensing are visual acuity and visual field. In most countries and jurisdictions, the visual acuity limit is 0.5 (20/40 feet, 6/12 meters). However, for monocular vision, the acuity limit is generally set higher. Monocular vision raises the visual acuity requirements in

the better-seeing eye to 0.6 in European countries, whereas in the US, it is maintained at 0.5 in some states and is increased in others. Visual field limits are present in some of the driver's license regulations and typically follow the European Union standard in European countries. The visual field limit is usually characterized by a radius or diameter, such as 60° or 120°. Variation in the US is somewhat greater. However, in states with visual field requirements, it is typically between 110° and 140°. Besides visual acuity and visual field, other characterizations of visual functions are sometimes present but are less well defined. Surprisingly, there is little focus on functional vision, such as actual driving performance. In some countries or jurisdictions, the field of vision has to be normal according to a competent medical authority. Measurement levels, defined by mean defect values, are not mentioned explicitly, despite the relevance to patients with eye disease. Most countries and states allow for exemptions or restricted licenses.

Although we had originally intended to use both driver's license forfeiture and entitlements to disability pension as milestones, our data show that disability pension requirements vary greatly from country to country, partly due to the multitude of rules and requirements that define legal blindness. For example, some countries distinguish between being partially sighted and blind, whereas in other countries, no such separation exists. As a result, disability pension entitlements cannot be standardized in a way that would be practical for use as a milestone or as a secondary endpoint in a clinical trial. In the absence of standardized national rules, one option would be to use the World Health Organization criteria for low vision and blindness to allow better comparability between countries in international trials. The World Health Organization defines low vision as "visual acuity of less than 6/18 but equal to or better than 3/60, or a corresponding visual field loss to less than 20°, in the better eye with the best possible correction". Blindness is defined as "visual acuity of less than 3/60, or a corresponding visual field loss to less than 10°, in the better eye with the best possible correction".⁶³

Milestone approach

Reductions in intraocular pressure and the rate of visual field progression are commonly used to assess the value of glaucoma treatments,⁶⁴ but these are not as complete in evaluating the impact of glaucoma on a patient's quality of life. Maintaining a driver's license is a performance-based measure and is not subject to the bias of self-reported questionnaires.^{61,65} Using health outcome measures

complements clinical measures and may help establish the effectiveness of competing treatments (Figures 1 and 2). For example, if a superior treatment can stop or delay the progression of an eye disease, the milestones can be postponed. This outcome can be reported as gained time with ability to drive. Treatment goals would include maintaining visual function above the legal driving standard so that glaucoma patients continue to drive for as long as it is safe to do so. Visual standards should be set to a binocular visual acuity of 0.5 or better and a visual field of 120° or better in the horizontal meridian.

There are a few limitations to the milestone approach. For clinical studies using driver's licensing as a secondary endpoint, it would be important to adjust for education, race, cognitive ability, and disease comorbidities,^{66,67} which influence driving ability independent of glaucoma status. Also, there is considerable heterogeneity for age-related driver's license renewal between countries, and older drivers often voluntarily reduce their driving frequency.^{68,69} Therefore, it may be more accurate to inquire about driving status, not just licensing. It is worth considering whether "driving a car" would be a better milestone rather than the administrative rules for maintaining a driver's license. Hence, the question would become "At what stage of the disease do patients stop driving cars, and for what reason?". A cross-sectional or a longitudinal study approach could be used. With cross-sectional data, the tendency to drive could be estimated as a function of relevant variables, such as disease progression, visual acuity, visual field, and other visual function parameters, sociodemographic and socioeconomic variables, and urbanization. The function could be estimated as a probability regression model, such as a logistic regression. If a longitudinal data set is available, either collected prospectively or retrospectively,

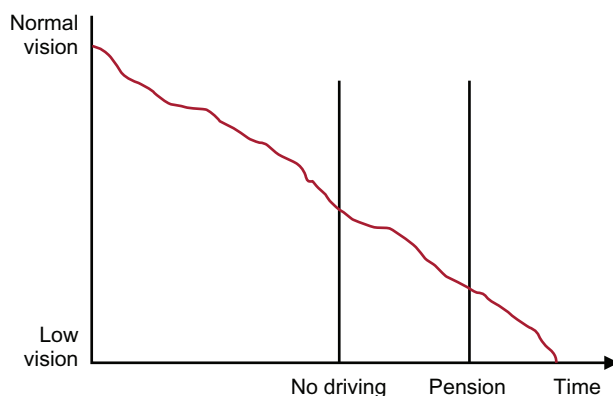


Figure 1 Example of how revocation of the driver's license and entitlement to disability pensions could be considered milestones. The downward-sloping line represents progression of visual impairment over time.

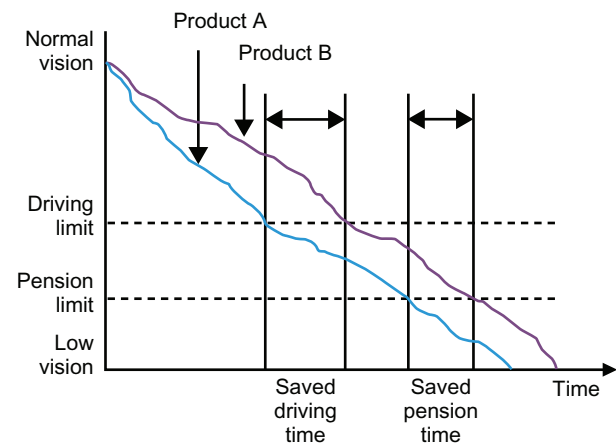


Figure 2 Driver's license forfeiture and entitlement to disability pensions can be used as endpoints in clinical trials. The results may be reported as time saved due to delaying milestones.

the statistical method of survival analysis can be carried out, whereby "survival" is defined as maintained ability to drive, and the "fatal" event is defined as giving up driving a car. Proportional hazard modeling could be used to estimate the effect of disease progression, visual acuity, visual field, other visual function parameters, sociodemographic and socioeconomic variables, and urbanization. Such a study would provide crucial data that would associate the endpoints used in clinical trials with the ability to drive a car. Information about driving behavior for eye patients can often be obtained from visual functioning questionnaires such as the National Eye Institute Visual Function Questionnaire. To study driving behavior in glaucoma patients, it might not be necessary to conduct new studies.

We acknowledge several limitations to our study. We focused on the comparison of driver's license regulations between only two states within the US and only five countries (those that account for more than half the population of Europe) out of 27 countries in the European Union. Moreover, we did not consider countries with more populations, such as India or China, where the relevant information is more difficult to gather.

Conclusion

The driver's license endpoint can be standardized as a best-corrected visual acuity of at least 0.5 and a visual field of at least 120°. This is consistent with the driver's license requirements in most countries and jurisdictions. Driver's license forfeiture, rather than entitlement to disability pensions, could be considered a milestone or secondary endpoint in the characterization of a progressive eye disease, such as open-angle glaucoma. Delaying these milestones is a useful

goal of therapeutic interventions, because it may decrease personal and societal burden and cost.

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References

- Foley DJ, Heimovitz HK, Guralnik JM, Brock DB. Driving life expectancy of persons aged 70 years and older in the United States. *Am J Public Health*. 2002;92(8):1284–1289.
- Jette AM, Branch LG. A ten-year follow-up of driving patterns among community-dwelling elderly. *Hum Factors*. 1992;34(1):25–31.
- Mollenkopf H, Marcellini F, Ruoppila I, et al. Outdoor mobility and social relationships of elderly people. *Arch Gerontol Geriatr*. 1997;24(3):295–310.
- Talbot A, Bruce I, Cunningham CJ, et al. Driving cessation in patients attending a memory clinic. *Age Ageing*. 2005;34(4):363–368.
- Colenbrander A, de Laey JJ. *Vision Requirements for Driving Safety*. San Francisco, CA: International Council of Ophthalmology; 2006.
- Hills BL. Vision, visibility, and perception in driving. *Perception*. 1980;9(2):183–216.
- Johnson CA, Keltner JL. Incidence of visual field loss in 20,000 eyes and its relationship to driving performance. *Arch Ophthalmol*. 1983;101(3):371–375.
- Owsley C, McGwin G Jr, Ball K. Vision impairment, eye disease, and injurious motor vehicle crashes in the elderly. *Ophthalmic Epidemiol*. 1998;5(2):101–113.
- Friedman DS, Wolfs RC, O'Colmain BJ, et al; Eye Diseases Prevalence Research Group. Prevalence of open-angle glaucoma among adults in the United States. *Arch Ophthalmol*. 2004;122(4):532–538.
- Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. *Br J Ophthalmol*. 2006;90(3):262–267.
- Fonda SJ, Wallace RB, Herzog AR. Changes in driving patterns and worsening depressive symptoms among older adults. *B Psychol Sci Soc Sci*. 2001;56(6):S343–S351.
- Mezuk B, Rebok GW. Social integration and social support among older adults following driving cessation. *J Gerontol B Psychol Sci Soc Sci*. 2008;63(5):S298–S303.
- Marottoli RA, Mendes de Leon CF, Glass TA, et al. Driving cessation and increased depressive symptoms: Prospective evidence from the New Haven EPESE. Established Populations for Epidemiologic Studies of the Elderly. *J Am Geriatr Soc*. 1997;45(2):202–206.
- Ragland DR, Satariano WA, MacLeod KE. Driving cessation and increased depressive symptoms. *J Gerontol A Biol Sci Med Sci*. 2005;60(3):399–403.
- Windsor TD, Anstey KJ, Butterworth P, et al. The role of perceived control in explaining depressive symptoms associated with driving cessation in a longitudinal study. *Gerontologist*. 2007;47(2):215–223.
- Freeman EE, Gange SJ, Muñoz B, West SK. Driving status and risk of entry into long-term care in older adults. *Am J Public Health*. 2006;96(7):1254–1259.
- The Advanced Glaucoma Intervention Study (AGIS): 7. The relationship between control of intraocular pressure and visual field deterioration. The AGIS Investigators. *Am J Ophthalmol*. 2000;130(4):429–440.
- Heijl A, Leske MC, Bengtsson B, et al; Early Manifest Glaucoma Trial Group. Reduction of intraocular pressure and glaucoma progression: Results from the Early Manifest Glaucoma Trial. *Arch Ophthalmol*. 2002;120(10):1268–1279.
- Chauhan BC, Garway-Heath DF, Goni FJ, et al. Practical recommendations for measuring rates of visual field change in glaucoma. *Br J Ophthalmol*. 2008;92(4):569–573.
- Council directive 91/439/EEC of 1991 Jul 29 on driving licences. Brussels, European Commission, 1991. Available at: http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=EN&numdoc=31991L0439&model=guichett. Accessed 2008 Apr 18.
- Commission Directive 2009/112/EC of 25 Aug 2009 amending Council Directive 91/439/EEC on driving licences, 2009. Available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:223:0026:0030:EN:PDF>. Accessed 2009 Oct.
- About medical standards for drivers. Swansea, Wales: Driver and Vehicle Licensing Agency, 2009. Available at: http://www.dvla.gov.uk/medical/about_dri_med.aspx. Accessed 2008 Apr 18.
- Motoring: Driver licensing. London, UK: Directgov. Available at: <http://www.direct.gov.uk/en/Motoring/DriverLicensing/index.htm>. Accessed 2009 Oct 8.
- Chisholm CM, Rauscher FG, Crabb DC, et al. Assessing visual fields for driving in patients with paracentral scotomata. *Br J Ophthalmol*. 2008;92(2):225–230.
- Keeffe JE, Jin CF, Weih LM, et al. Vision impairment and older drivers: Who's driving? *Br J Ophthalmol*. 2002;86(10):1118–1121.
- Charman WN. Vision and driving – a literature review and commentary. *Ophthalmic Physiol Opt*. 1997;17(5):371–391.
- Driver's Medical Group. For medical practitioners. At a glance. Guide to the current medical standards of fitness to drive. Swansea, Wales: Driver and Vehicle Licensing Agency; 2009.
- Ministère des transports de l'équipement du tourisme et de la mer. Arrêté du 21 Décembre 2005 fixant la liste des affections médicales incompatibles avec l'obtention ou le maintien du permis de conduire ou pouvant donner lieu à la délivrance de permis de conduire de durée de validité limitée. Journal officiel de la République Française 2005.
- Disposiciones generales, Anexo IV. Capacidad visual. Spain: Dirección General de Tráfico. Available at: http://www.dgt.es/portal/es/normas_legislacion/reglamento_trafico. Accessed 2008 Apr 18.
- Visual requirements for the guide to motor vehicles and the recent law of 2001 Apr 3 no. 138. Available at: <http://www.lautoscuola.it>. Accessed 2008 Apr 22.
- Anlagen zur Fahrerlaubnis-Verordnung: Anlage 6 (zu §§ 12, 48 Abs. 4 und 5). Deutschland GmbH: LexisNexis; 1998.
- Driver license and identification (ID) card information: Vision exam requirement. Sacramento, CA: California Department of Motor Vehicles; 2009. Available at: http://www.dmv.ca.gov/dl/dl_info.htm#VISION. Accessed 2008 Mar 19.
- California Department of Motor Vehicles. California Driver Handbook. Sacramento, CA: California Department of Motor Vehicles; 2008.
- Iowa Department of Transportation. Iowa Driver's Manual. Des Moines, IA: Iowa Department of Transportation; 2006.
- New York State Department of Motor Vehicles. Driver's Manual. Albany, NY: New York State Department of Motor Vehicles; 2008.
- New York State Department of Motor Vehicles. Available at: <http://www.nysdmv.com/index.htm>. Accessed 2008 Mar 25.
- Viswanathan AC. Personal correspondence, 2008.
- Assessing the fitness to drive. European Road Safety Observatory. 2007. Available at: http://www.erso.eu/knowledge/content/07_old/assessing_the_fitness_to_drive.htm. Accessed 2009 Oct.
- Reglamento Conductores. Anexo IV, Modificado por R.D. 1598 de 2004. Available at: <http://www.ascreme-galicia.org/reglamento-conductores/2-39-6-39.htm>. Accessed 2008 Apr 22.
- Noticias Jurídicas. Sección II Vigencia de permisos y licencias de conducción. Artículo 16, Vigencia. Available at: http://noticias.juridicas.com/base_datos/Admin/rd772-1997.t1.html#a13. Accessed 2008 Apr 18.

41. de Natale R. Personal correspondence, 2008.
42. Dipartimento di Prevenzione. Available at: http://prevenzione.ulss20.verona.it/pat_norm_requis.html. Accessed 2008 Apr 24.
43. Licensing renewal provision for older drivers. Arlington, VA: Insurance Institute for Highway Safety; 2009 Available at: <http://www.iihs.org/laws/olderdrivers.aspx>. Accessed 2009 Oct.
44. Registration of blindness/partially sighted. London, England: Department for Work and Pension. Available at: <http://www.dwp.gov.uk>. Accessed 2008 Mar 28.
45. Disability living allowance – eligibility. London: Directgov. Available at: http://www.direct.gov.uk/en/DisabledPeople/FinancialSupport/DG_10011816. Accessed 2009 Oct.
46. Action for blind people. Available at: <http://www.actionforblindpeople.org.uk>. Accessed 2008 Mar 28.
47. Kaltwasser, H. Personal correspondence with International Relations Officer Hans Kaltwasser, Deutscher Blinden und Sehbehindertenverband e.V., 2008.
48. Guide-Barème pour l'évaluation des déficiences et incapacités des personnes handicapées. Décret 93-1216. Available at: <http://admi.net/jo/SPSA9302269D.html>. Accessed 2008 Apr 18.
49. Décret 2007-1574. Available at: <http://www.legifrance.gouv.fr/affich-Texte.do?cidTexte=JORFTEXT000000823675&dateTexte=>. Accessed 2008 Apr 18.
50. ONCE. Available at: <http://www.once.es/acc/otras-webs/english/WhatsONCE>. Accessed 2008 Apr 22.
51. ONCE. Available at: <http://www.once.es>. Accessed 2008 Apr 22.
52. Itxaropena. Available at: <http://www.itxaropena.es/datos/descargas/archivo31/Gu%EDa.pdf>. Accessed 2008 Apr 22.
53. Discapnet. Available at: <http://www.discapnet.es/Discapnet/Castellano/Guias/Prestaciones/Prestacionessistema/NoContributivas/NoContributivas002.htm>. Accessed 2008 Apr 22.
54. Discapnet. Available at: <http://www.discapnet.es/Discapnet/Castellano/Guias/Prestaciones/Prestacionessistema/Contributivas/Contributivas005.htm>. Accessed 2008 Apr 22.
55. Triesteabile. Available at: <http://www.triesteabile.it/voglioinformarmi/previdenza/cieci/penciepar>. Accessed 2008 Apr 24.
56. Citta' di Torino. 44 del 1 marzo 2002 "Legge 28 dicembre 2001, n.448. Incremento delle pensioni in favore di soggetti disagiati" 2008 update of the law. Available at: <http://www.comune.torino.it/pass/php/4/abile.php?pag=501Circolare INPSn>. Accessed 2008 Apr 24.
57. Benefits for people with disabilities. Baltimore, MD: Social Security Administration; 2009. Available at: <http://www.ssa.gov/disability>. Accessed 2009 Oct.
58. Social Security. If you are blind or have low vision – how we can help. Baltimore, MD: Social Security Administration; 2009. Available at: <http://www.ssa.gov/pubs/10052.pdf>. Accessed 2009 Oct.
59. Aspinall PA, Johnson ZK, Azuara-Blanco A, et al. Evaluation of quality of life and priorities of patients with glaucoma. *Invest Ophthalmol Vis Sci*. 2008;49(5):1907–1915.
60. Mangione CM, Berry S, Spritzer K, et al. Identifying the content area for the 51-item National Eye Institute Visual Function Questionnaire: Results from focus groups with visually impaired persons. *Arch Ophthalmol*. 1998;116(2):227–233.
61. Ramulu P. Glaucoma and disability: Which tasks are affected, and at what stage of disease? *Curr Opin Ophthalmol*. 2009;20(2):92–98.
62. Bohensky M, Charlton J, Odell M, Keeffe J. Implications of vision testing for older driver licensing. *Traffic Inj Prev*. 2008;9(4):304–313.
63. WHO. Available at: <http://www.who.int/blindness>. Accessed 2008 Apr 18.
64. Rossetti L, Marchetti I, Orzalesi N, et al. Is proper methodology associated with the use of a clinically relevant outcome measure? The case of randomized clinical trials on medical treatment of open-angle glaucoma. *Online J Curr Clin Trials*. 1993;Doc No 100:6512.
65. Altangerel U, Spaeth GL, Steinmann WC. Assessment of function related to vision (AFREV). *Ophthalmic Epidemiol*. 2006;13(1):67–80.
66. Friedman DS, Freeman E, Munoz B, et al. Glaucoma and mobility performance: The Salisbury Eye Evaluation Project. *Ophthalmology*. 2007;114(12):2232–2237.
67. Ramulu PY, West SK, Munoz B, et al. Glaucoma and reading speed: The Salisbury Eye Evaluation project. *Arch Ophthalmol*. 2009;127(1):82–87.
68. Charlton JL, Oxley J, Fildes B, et al. Self-regulatory behaviours of older drivers. *Annu Proc Assoc Adv Automot Med*. 2003;47:181–194.
69. Owsley C, Stalvey B, Wells J, Sloane ME. Older drivers and cataract: Driving habits and crash risk. *J Gerontol A Biol Sci Med Sci*. 1999;54(4):M203–M211.

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