Driving and Neurologic Disorders

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Automobile driving is an indispensable activity of daily life. Driving in the United States equates to independence, freedom, and, in most cases, economic livelihood. Yet vehicular crashes injure millions of people in the United States each year at a cost of more than $250 billion, resulting in 40,000 annual deaths.[1] Many medical, neurologic, and psychiatric disorders can impair the ability to drive. In particular, conditions such as Alzheimer disease (AD), Parkinson disease (PD), illicit drug use, multiple sclerosis (MS), cerebrovascular disease, sleep disorders, and epilepsy may impair an individual to the point of affecting the safe operation of a motor vehicle. Therefore, the issue of driving is significant for patients, physicians, and the public. Two common questions regarding driving typically arise during a neurologic consultation: When should driving be curtailed? When should a physician report an individual to a public driving authority to terminate their driving privileges? Driving is both a personal and public health issue mired in regulatory and legal language; therefore, it is essential to understand the variables that have an impact on driving.

THE NEUROLOGY OF DRIVING Driving is a deceptively complex task. To effectively drive an automobile, a number of neurologic systems must be intact. These include higher cognitive functioning, vision, motor control, intact coordination, and an ability to maintain attention. Any functional impairment in any of these domains can potentially lead to unsafe driving. Table 1 summarizes examples of common neurologic impairment and paroxysmal conditions that can affect safe driving. Any patient with a neurologic condition containing an impairment listed in table 1 should alert the neurologist that driving should be addressed with the patient during the consultation. The presence of either a neurologic deficit or paroxysmal condition does not automatically exclude driving. It is the degree of deficit, frequency, and type of events that determines fitness for driving.

Of the various neurologic systems involved in driving, cognitive function merits particular attention. Driving requires a number of essential cognitive activities for safe and successful vehicle operation. These cognitive activities include the following:

- Perception and attention to stimulus evidence through sensory input and interpretation of a situation on the road
- Formulation of a plan based on the particular driving situation and how to handle it based on previous memory experiences
- Execution of an action such as applying a brake, steering control, or accelerator
- Monitoring the outcome of a behavior as feedback for subsequent actions

The risk of driving error increases when there is any deficit in the ability to process these various tasks[2] (table 2). Therefore, pathology that affects attention, perception, executive and motor function, and awareness of cognition and behavioral performance may lead to driving errors resulting in a crash. Additionally, individuals with problems in these domains are less likely to be aware of their deficits and

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errors and self-monitor resulting in the inability to perform appropriate corrective actions.

Establishing fair and accurate performance criteria to predict ability to drive in patients with various neurologic conditions may reduce the risk of motor vehicle crashes and protect others from arbitrary and possibly unfair licensing revocation. Although a clinician is likely able to identify obviously impaired drivers, a clinician's assessment alone may not be accurate enough to determine driving competency in drivers marginally affected by neurologic disorders. For example, a patient with mild cognitive impairment (MCI) as defined by a Clinical Dementia Rating (CDR) score of 0.5 may or may not perform well on driving tasks. The same is true of paroxysmal conditions like epilepsy. The type and degree of cognitive and visual motor impairment are better predictors of driving skills than age or medical diagnoses.

The signs and symptoms of many neurologic conditions with unique neuropathological findings often demonstrate considerable overlap. Thus, a discussion of driving and neurologic disorders is best served by operating on a practical framework that clinicians are likely to encounter while patients are being actively evaluated for a final diagnosis. Neurologic diseases can be broadly classified into those associated with fixed deficits (i.e., neurodegenerative and stroke) or paroxysmal disorders (i.e., epilepsy and sleep disorders). This division of neurologic disorders allows the clinician to extrapolate applicable information to help counsel the individual patient regardless of the underlying neurologic process. Because epilepsy and dementia are explicitly cited by legal statutes (all 50 states for epilepsy; 2 states for dementia) (table 3), these 2 conditions serve as representative examples.

Table 1 **Neurologic impairments and paroxysmal disorders that may affect safe driving**

Neurologic impairment that may affect safe driving	Conditions associated with loss of awareness with potential to affect safe driving
Cognitive impairment	Epilepsy
Executive dysfunction	Excessive daytime sleepiness/sleep disorder
Memory impairment	Acute hypoglycemia
Inability to multitask	Syncope
Severe ataxia/balance dysfunction	Arrhythmia
Motor control impairment	Dysautonomia
Generalized	
Bradykinesia	
Severe weakness	
Vision impairment	
Visual processing abnormalities	
Hemianopsia or visual field deficits	
Toxicity	
Alcohol	
Prescription medications	

FIXED DEFICIT DISORDERS: AD AD is one of the most common forms of dementia with increased prevalence with older age. Because AD leads to cognitive impairment, which affects executive function, and memory, driving is a major issue. A survey of patients with AD showed a mean of 0.09 reported crashes per year per person, compared with 0.040 in age-matched controls over the same time period.[3] The average number of crashes per year in patients with AD increased dramatically after the first 3 years from symptom onset, consistent with other reports showing a sharp decline in driving abilities 3 years after AD onset.

An American Academy of Neurology (AAN) review panel found that drivers with MCI or very mild AD and a CDR score of 0.5 have impairment similar to drivers 16–20 years of age or those driving under the influence of alcohol at a blood alcohol concentration of less than 0.08%.[8] The panel recommended reassessing dementia severity in driving fitness every 6 months in patients with very mild AD, but suspending driving for patients with mild AD and CDR score of 1 because of a history of increased crashes and poor driving performance.[4] However, this recommendation may be unduly restrictive because in some ways it is a one-size-fits-all approach.

Recently, the AAN released a practice parameter update entitled "Evaluation and management of driving risk in dementia: Report of the Quality Standards Subcommittee of the American Academy of Neurology."[5] The parameter was helpful in that it coalesced a number of risk factors into a proposed evaluation algorithm (figure).[5] Yet the parameter is far from being the final word on the topic. There was no evidence to support or refute the use of cognitive tests in making driving determinations, which is problematic as they are used to track progression of these conditions. Patients scoring at a higher risk may agree to surrender driving privileges. Patients who insist on continued driving may require an as-

Table 2 **Cognitive impairments and impact on driving**

Impairment	Impact on driving
Abnormal visual perception and attention	May not perceive, attend, or interpret a stimulus (i.e., signs on the road, obstacles, pedestrians, other vehicles)
Executive dysfunction	Cannot plan or execute an immediate response or correction to road conditions such as applying a brake, taking the foot off of the accelerator, steering correction
Abnormal memory	Cannot recall how to handle specific driving scenarios, unable to get to a specific location
Motor dysfunction	Unable to control, steer, apply brakes, or move foot off of the accelerator

sessment by trained clinicians who conduct driving evaluations and retraining of patients with impairments (commonly poststroke or traumatic brain injury). The Association for Driver Rehabilitation Specialists, a professional organization of clinicians working in the field of driver education and training, information referral source, and specialized transportation equipment for disabled persons, may serve as a potential resource for neurologists looking for help in assessing individual patients. Referral to a health professional involved in driving assessments may help provide objective information needed to make difficult decisions. Patients who continue to drive despite progressive neurologic deficits should be reassessed every 6 months.

There is also considerable ongoing research utilizing driving simulation to accurately identify at-risk drivers and is based on simulator performance. These studies have not been validated to assess whether simulation tasks are predictive of increased crash rates. Moreover, these simulators are not readily available for widespread clinical use. However, they may prove to be the future for helping clinicians to decide which patients should stop driving.

Regarding other neurologic conditions with fixed deficits, there is considerable ongoing research but no practice parameters or guidelines on when to restrict driving for common conditions including MS, PD, stroke, and others. Nevertheless, the principles used to make decisions regarding driving and AD are applicable to these conditions as well.

Table 3 **State driving laws**

US states with laws pertaining to neurologic disability and driving	States requiring physicians to report persons with a neurologic disability that may impair driving	States requiring physicians to report persons with dementia
All states	California	California
	Delaware	Oregon
	Nevada	
	New Jersey	
	Oregon	
	Pennsylvania	

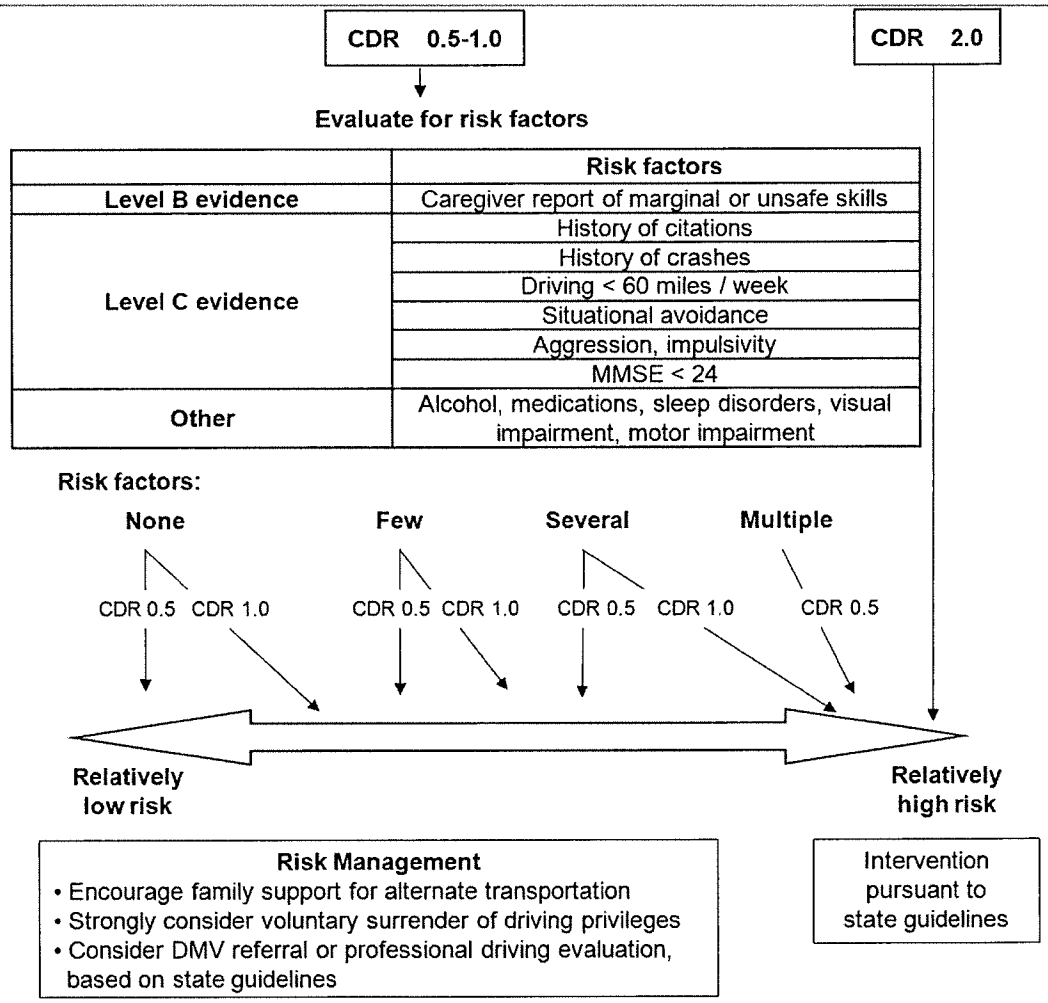
PAROXYSMAL CONDITIONS: EPILEPSY The ability to legally operate a motor vehicle has been shown to be very important for the person with a paroxysmal disorder such as epilepsy or syncope.[6] Driving has an impact on the quality of life for these patients. As opposed to other neurologic conditions, all states within the United States have laws that specifically address the ability to operate a motor vehicle for the person with epilepsy. However, among the various states, there is considerable legal variability as to the degree of seizure freedom one must exhibit in order to drive, with seizure-free intervals (SFI) ranging from 3 months to up to 1 year. Recommendations by the Epilepsy Foundation of America, American Academy of Neurology, and the International League Against Epilepsy have suggested standardized criteria be used when establishing laws that govern seizures and driving. Driving laws remain states' rights and not a federal issue, accounting for the heterogeneous approach to policy.[7,8]

The intent of laws governing the person with epilepsy (PWE) who drives is to ensure the public safety foremost with the secondary duty of protecting the individual driver. The optimal SFI that would allow the person with epilepsy to drive while at the same time ensuring public safety is not certain. Little difference in epilepsy-related crash rates has been found when comparing a reduction in the SFI from 12 to 3 months in Arizona.[9] The overall death rate attributable to motor vehicle crashes related to a seizure has also been shown not to be dependent on the length of the SFI.[9]

Web sites from the American Medical Association and the Epilepsy Foundation of America are important resources listing current state laws regarding driving and epilepsy.[7,8] These references compile information about local laws to help guide and counsel the PWE about relevant restrictions on driving. Several states have reporting requirements, where the individual practitioner must notify the driving authorities when a person has the diagnosis of epilepsy or other paroxysmal conditions as listed in table 3. Unfortunately, this places the reporting requirements on the practitioner providing care for the PWE, potentially interfering with optimal care, as the PWE may withhold vital information regarding recurrence and frequency of seizures in an effort to maintain driving privileges.

When comparing the various crash rates to other medical conditions that could affect driving, epilepsy has been shown to present the same relative risk as many other medical conditions. Many other medical conditions do not have specific restrictions against

Figure **An evidence-based algorithm to help clinicians decide when a patient with cognitive impairment should not drive**



CDR = Clinical Dementia Rating; DMV = Department of Motor Vehicles; MMSE = Mini-Mental State Examination. Reprinted with permission from Iverson D, Gronseth G, Reger M, et al. Practice parameter update: evaluation and management of driving risk in dementia. Neurology 2010;74:1316-1324.[5]

driving despite similar or higher risk of causing a crash. Paroxysmal disorders that are often not explicitly cited in driving laws include narcolepsy, syncope, and excessive daytime sleepiness. The PWE may have similar defined risk, but it should be noted that laws specifically mention seizures and therefore by nature will be more restrictive to keeping PWE off the road when compared to people with other medical conditions. The potential consequences of driving illegally are considerable, ranging from death and self-injury of the driver or a person at large to potential civil or criminal litigation. If a PWE knowingly drives illegally and causes a crash with injury to another due to a seizure, criminal prosecution is possible.

There are limited specific exceptions in some locales allowing PWE continue to drive despite still having seizures; these vary by state. Epilepsy advocacy groups have suggested specific exemptions be incorporated into driving regulations for PWE, such as 1) an established pattern of exclusively nocturnal seizures; 2) seizures with a consistent aura of sufficient length to allow the operator to safely stop the vehicle; and 3) breakthrough seizures due to nonrecurrent events (illness or medication change, where typically a shorter SFI is suggested). Not all states have these exemptions.

Most individuals are covered under noncommercial license laws. However, if an individual has the requirement to chauffeur or operate a motor vehicle carrying passengers, or drives a commercial vehicle (both interstate and interstate), commercial driving laws apply. Similarly, a person driving large commercial trucks across state lines must follow federal laws regulated by the US Department of Transportation.[7] Commercial driving laws are typically more restrictive in that PWE and other applicable neurologic

conditions cannot hold a commercial license. Additionally, the use of epilepsy medications, even when used for other medical conditions, will often restrict a commercial license.

COUNSELING A NEUROLOGY PATIENT REGARDING DRIVING Most health care practitioners have little or no training in medico-legal issues although counseling on these issues typically is done by practitioners. Driving with any health condition has legal implications. The discussion with the patient should be frank and honest, and known facts reviewed using many of the points previously discussed.[10] The practitioner may be conflicted in a situation where he or she suspects the individual is driving against advice. Many, but not all, states allow the practitioner to report such situations to driving authorities with immunity, to ensure public safety, specifically when reported in good faith. Practitioners can remind the driver that he or she is not immune from civil and possibly criminal prosecution if illegal driving continues. Additionally, it is important to inform the patient that auto insurance may not apply if it is determined that the person is driving illegally.

Using these discussion points provides the patient and practitioner with the basis for appropriate decisions. Nevertheless, discussions on driving are often quite challenging, even adversarial, as the patient sees such restrictions as a loss of personal freedom. As with many decisions regarding health care, the health care provider should be an advocate, which sometimes means no driving. The provider should commit to a relationship with the patient and advise him or her based on the individual facts and circumstances of the case. The discussion requires that the health provider understand local and possibly federal driving laws. Oftentimes, when the facts are explained, the patient generally follows a prudent course of action. Framing the discussion on a personal level and reminding the individual of the consequences of causing injury or death to another driver, bystander, passenger, or themselves often helps the patient to arrive at an appropriate decision.

REPORTING PATIENTS TO GOVERNMENT AUTHORITIES What should the role of the practitioner be in the contentious issue of reporting unsafe drivers to a public health authority? Currently there are 6 states that have mandatory reporting laws of any unsafe driver for any pathology that can impair driving function (table 3).[7,8] These 6 states include California, Oregon, Nevada, New Jersey, Delaware, and Pennsylvania. Moreover, California and Oregon have specific reporting laws for dementia to government authorities. The AAN addressed the issue of mandatory physician reporting of medical conditions that may affect driving competence in 2007.[11] In their official statement, the AAN supports the optional reporting of individuals with medical conditions that may affect one's ability to drive safely, especially in cases where public safety has already been compromised or it is clear that the person no longer has the skills needed to drive safely. Further details on the AAN position can be found in reference[11]. However, there are several concerns that need to be addressed regarding reporting, particularly involving trust between physician and patient. In states where mandatory reporting is not required, there is little protection for the physician who chooses to report out of concerns for public safety. Perhaps anonymous reporting or legal protection of the reporting physician could help the situation as concerns over the potential for litigation likely leads to underreporting to authorities.

Driving and Neurological Disorders

- *Motor vehicle accidents are a major cause of injury, mortality, and financial damage.*
- *Many neurologic conditions impair driving capability.*
- *Degree of deficit, frequency, and type of events determine driving fitness.*
- *Reporting drivers: Know the laws in your state.*
- *AAN has Practice Parameters for driving in patients with dementia.*

DISCUSSION The decision to drive or not depends on the individual facts of the case. There are no easy answers as to exactly when driving should be terminated. Neurologists would be well-served by understanding applicable driving laws and factors that affect driving, clearly documenting telephone conversations and consultations when driving is discussed, and periodically revisiting the topic to maximize safety and improve quality of life.

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