Driving and Neurological Disease

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Updated: Feb 27, 2007

Overview Of Medical Problems And Driving Fitness

Driving an automobile is an economic, social, and recreational necessity for most Americans. Driving occupies a central role in the lives of adults, especially older adults, who rely in an ever-growing way on a private automobile, now used for 88% of their transportation needs. For persons handicapped by medical problems, including advanced neurological disease, a conflict may arise between reasonable transportation opportunities for them and society's need to protect public safety.

Impact of automobile crashes

Accidents were the fourth leading cause of death in United States in 1999; motor vehicle accidents accounted for over half of these deaths. Automobile crashes in the United States in 1999 claimed the lives of 40,000 individuals and disabled 2.2 million, at least temporarily. They were the leading cause of death among persons younger than 30 years. Of 2549 children aged 14 years or younger who died in 1999 in car collisions, 60% were unrestrained.

For youths aged 15-24 years, accidents claimed nearly twice as many lives as the next leading cause of death. The US Department of Labor reported that workers were more likely to die in motor vehicle crashes than in other job-related incidents. According to the National Safety Council (NSC), the financial cost of highway crashes in 1999 was substantial—an estimated $192.2 billion, including $20.7 billion in medical expenses, $66.4 billion in lost wages and reduced productivity, and $45.8 billion in vehicle damage.

The highway statistics show a gradual small decline (1%) in the death toll from 1992 to 1999, and an overall decline of 50% per 100,000 since 1972 to 15 deaths per 100,000. This progress reflects contradictory trends, according to spokespeople for the NSC. Increases in seat belt use, improvements in automobile manufacturers' compliance with modern safety standards (including air bags), and reductions in drunken driving have improved highway statistics. Roadway improvements and enhanced emergency medical services also have helped.

With a strong economy, individuals in the United States are driving more miles and often at higher speeds. To continue and to accelerate this trend toward safer automobile travel, the NSC proposed actions on several key traffic-related issues—occupant protection, young driver safety, drunk driving, large truck safety, and pedestrian safety. For teenaged drivers, the NSC believes that the key is to gradually introduce young drivers to the responsibility of driving, allowing them to gain experience under low-risk conditions. Currently 25 states and the District of Columbia provide this kind of graduated driver licensing program.

Assessing impact of neurological disease on driving

Epidemiologists have been trying for decades to determine the extent to which medical diagnoses leads to increased car-crash risk. In fact, the functional limitations caused by the disease, rather than the mere presence of the disease, are key to stratifying driving risks in an individual driver.

Unfortunately, the degree of severity of the medical condition typically has not been considered in past research studies of driving; therefore, much of the data are inconsistent. Moreover, disease indices in early Parkinson disease (PD) and obstructive sleep apnea, among others, do not associate closely with driving test performance or state-reported collisions. Furthermore, methodological problems plague the driving literature of the last 40 years, in part because a common safety endpoint, car crashes, is such a rare, quixotic, and underreported event, adding to the confusion. Small sample size limits most of the studies. Driving exposure (miles driven annually) is ignored in most research. Frequently, the driving evaluators in road test studies are not blinded properly to the subject's condition.

None of the commonly studied medical conditions (eg, diabetes, heart disease, stroke, PD) has been associated consistently with a high vehicle crash rate in older drivers. Some epidemiologists report that a diagnosis of heart disease, cancer, stroke, hypertension, diabetes, asthma, arthritis, osteoporosis, or emphysema, by itself, does not increase one's risk of a state-reported automobile crash, according to some observational studies in rural areas. Others disagree, including those researchers cited by the National Highway Traffic Safety Administration (NHTSA), which reports to the US Congress.

According to a retrospective study of diabetic drivers older than 65 years in Alabama, for instance, car crash-related injury risk was 2.6 times higher than in the general population of older adults. It was even higher for those treated with insulin (OR = 5.8) or oral hypoglycemic agents (OR = 3.1), those having diabetes for more than 5 years (OR = 3.9), and those with both diabetes and coronary heart disease (OR = 8.0).

The ability to drive safely cannot be determined in a medical office, since factors such as judgment and risk-taking behaviors, so critical to operating an automobile, are difficult to assess in an examination room. Multidisciplinary neurological teams often are needed to reliably evaluate the driving ability of brain-injured patients. Physicians are not trained in this technical area as nationally certified driving instructors are.

Surveys of neurologists and geriatricians reveal that few have knowledge of driving laws and reporting responsibilities. However, the public views the physician as the best person to judge driving capacity; physicians are expected to play a part in the decision to stop driving in half their patients with Alzheimer disease (AD). Physicians may face liability exposure if they do not report to their state authorities and carefully counsel those drivers with certain uncontrolled neurological disorders, mainly epilepsy.

General and intuitive agreement holds that those severely affected by dementia, multiple sclerosis, or PD should not drive, but little consensus exists about those only mildly affected and when to screen them for a more complete professional on-road assessment. No single battery of test exists for this purpose, since the driving task, unlike other overlearned skills, is so complex. Nonetheless, a standardized approach is important, both to avoid unnecessary bias against well-functioning persons as well as to ensure safety of the driver and general public.

One proposed strategy in the medical office to screen drivers older than 80 years is to examine their feet for deformities, ask them to raise their arms above their shoulders, and draw a pentagon. If they cannot pass this examination, or if they report they walk less than a block each day, they probably should undergo formal testing, including an assessment of visual attention, termed the "useful field of view" (UFOV). Physicians may purchase the commercial software for UFOV testing and install it on a computer in the office. The examination, administered by a medical technician, takes 15 minutes to complete and costs the physician $7 per use. The test scores the individual on a 1-5 scale and is believed to predict 40% of accidents.

A diagnosis of dementia of the Alzheimer type (DAT) alone has not been an adequate predictor of driving ability. Drivers with DAT generally are safe during the first 2 years of their cognitive decline, but not after 3 years. Dubinsky et al (2000) reviewed literature on driving safety in DAT in a report to the Quality Standards Subcommittee of the American Academy of Neurology in an attempt to offer official guidelines to practitioners. Using the 5-point Clinical Dementia Rating (CDR) scale (Morris 1993), the report recommended that all individuals with mild dementia (ie, score of 1) categorically stop driving. (For more information on the CDR scale, see Table 1.)

These individuals experience a level of memory loss that interferes with daily life, suffer geographic disorientation, abandon more difficult daily chores, and need occasional prompting to perform personal care. They cannot function independently in social activities, though they may appear normal to casual inspection and do maintain good social judgment. The evidence supporting this cut point for driving prohibition was so convincing that the subcommittee offered this with the highest level of confidence as a "standard" guideline.

Individuals with "questionable" dementia, scoring 0.5 on the CDR, in view of the subcommittee, still might drive safely. They should receive counseling about increased and progressive risk of accidents and be encouraged to undergo formal road testing with reassessment of formal driving testing every 6 months, until they reach a CDR of 1. The evidence for this recommendation for those with questionable dementia was less secure and did not meet the level of a "standard" guideline. Tests of visual search tasks and visual tracking, apparent on the UFOV exam, best correlate with driving performance on road tests in persons with mild DAT.

Drivers with epilepsy who do not comply with medications or prescribed seizure-free intervals or who have had previous car crashes related to seizures are at an especially high risk. Inexperienced young male drivers, especially those who abuse alcohol or are sleep deprived, appear to be the riskiest of all motorists, so any patient with a neurological disorder with these characteristics must be counseled and educated deliberately. Physicians may choose to refer patients at risk to rehabilitative training programs and should acquaint themselves with local transportation alternatives to the private automobile.

Impact Of Youth, Gender, Alcohol, And Sleep Deficits On Driving Fitness

Only rarely are drivers with neurological problems the most risky. The most common health reason for denial of a driving license is epilepsy, although data show convincingly that persons with well-controlled seizure disorders pose no increased driving risk. Epilepsy appears to elevate automobile crash risk much less than alcohol intake or sleep disorders. Epilepsy accounts for less than 0.03% of traffic accidents; by contrast, sleep disorders account for 8 times this number and alcohol more than 100 times.

Excessive alcohol accounts for 40% of traffic accidents. Surprisingly, neither alcoholism nor sleep disorders commonly appear in the statistics for license revocations for medical reasons.

Age and sex

Most car collisions involve young drivers in excellent health, concluded those attending an international conference on driving safety in Vienna in 1977. The accident rates for drivers aged 16-19 years is 28 per million miles driven; this is 7 times the rate for drivers aged 40-65 years, almost 4 times the rate for those aged 65-80 years, and almost twice that for those aged 81-85 years. (In adults older than 85 years, the rate jumps to 85 accidents per million miles driven.) Simply being a male and younger than 25 years, as the automobile insurance companies know well, places a driver at a much higher risk of serious car crashes.

Men are 2-4 times more likely to crash than women, even when adjusted for the increased time men spend driving, though this difference begins to disappear later in life. In one of the best epidemiological studies of driving accidents, involving 6000 crashes in Wisconsin, Hansotia attributed excess risk in 1000 crashes to the driver being younger than 25 years, and in 1500 crashes to being male. Importantly for physicians, the excess risk attributable to epilepsy, the medical problem most commonly reported to licensing authorities, explained only 13 cases.

Alcohol abuse

Those who consume alcohol irresponsibly also face a much higher risk of driving accidents. Three drinks in 60 minutes for a man or in 90 minutes for a woman raise the blood alcohol level to 0.05% (0.01 mmol/L), a level at which the risk for crash doubles. In the United States, the vast majority of states specify 0.08% or 0.10% as the legal definition of impairment. Generally, two 45-mL (1.5 oz) drinks of spirits are thought to produce a blood level of 0.05%.

The cost of drink-related accidents has been estimated at $45 billion a year, with $70 billion lost in quality of life costs. In 1997, in the United States, just over 16,000 people were killed in crashes involving alcohol, nearly two fifths of all traffic deaths. Mothers Against Drunk Driving (MADD) estimates that about 800,000 Americans are injured in alcohol-related crashes every year, and that 3 of every 10 Americans will be involved in an alcohol-related traffic crash at some time in their lives.

Comparison of the impacts of alcohol and epilepsy, the medical condition most commonly reported to driving licensing authorities, reveals that of every 10,000 individuals killed in motor vehicle accidents, 4000 deaths are due to excess alcohol, 6 to natural causes, and only 1 to epilepsy. It is strange that all states in the United States carefully advise physicians to report to licensing authorities any driver with uncontrolled epilepsy, but none mandate reporting of drivers with alcoholism. Not surprisingly, very few physicians in practice ever do.

Certain other behaviors inflate accident rates as well. A history of a prior serious accident, especially when the driver was at fault, increases risk (and insurance premiums). The relative risk of a crash while driving a sports car is 1.3 and while talking on a cellular phone is estimated to be 4.3. As automakers bring more satellite-based telecommunications to drivers—email, traffic reports, navigational systems—temptation to "multitask" increases, further distracting motorists.

By comparison, relative risk from diabetes is similar to that of driving a sports car (1.3). For drivers with epilepsy, all ages combined, the relative risk is also 1.3 (*P*

The drowsy driver

The NHTSA estimates that 1-3% of US highway crashes and 4% of fatal motor vehicle crashes are caused by driver sleepiness. Few attempts have been made to assess the total costs of drowsy driving, although a recent report from the NHTSA estimated them at $12.4 billion a year. Rau reported that when impairments in performance caused by alcohol and sleep deprivation were compared directly, sustained wakefulness for 17 hours decreased performance about as much as a blood alcohol concentration of 0.05%, the legal limit for driving in several European countries.

Fatigue is the leading cause of long-haul truck crashes. Rates of drowsy driving crashes are highest among young people (especially men), shift workers, and people with untreated sleep conditions. NHTSA data show that males are 5 times more likely than females to be involved in drowsy driving crashes. In one study, male youths with the greatest extracurricular time commitments were most likely to report falling asleep at the wheel. The subgroup at greatest risk comprised the brightest, most energetic, and hardest-working teens.

Experimental evidence shows that sleeping less than 4 consolidated hours per night impairs performance on vigilance tasks. Individuals working rotating shifts lose 2-4 hours with each shift. People who restrict to 4-5 hours per night for 1 week need 2 full nights of sleep to recover vigilance, performance, and normal mood, according to one study. Although the relative risk for fall-asleep crashes has not been established, individuals who exhibit a sleep latency of less than 15 minutes on the maintenance of wakefulness test, a routine sleep lab study, categorically are too sleepy to drive a motor vehicle. Sleepiness and alcohol interact, with sleep restriction exacerbating the sedating effects of alcohol.

Sleep apnea

Teran-Santos et al reported a strong association between sleep apnea, as measured by the apnea-hypopnea index, and the risk of traffic accidents. As compared with those without sleep apnea, patients with an apnea-hypopnea index of 10 or higher had an odds ratio of 6.3 (95% confidence interval [CI] = 2.4-16.2) of having a traffic accident. In 1991, an expert panel of the Federal Highway Administration recommended that drivers with suspected or untreated sleep apnea "not be medically qualified for commercial motor vehicle operation until the diagnosis has been eliminated or adequately treated."

The Older Driver

Growing need to assess older drivers

Researchers forecast that by the year 2020, more than 15% of drivers will be older than 65 years. People aged 85 years and older have emerged recently as the fastest growing segment of our driving population. Meanwhile, the driving task itself has changed. Ever-growing traffic volumes, congestion, and novel highway features and vehicle technologies demand greater attention by drivers (NHTSA, 1998). The number of automobiles on the road has doubled in the past 30 years.

As a group, people older than 65 years nonetheless have fewer accidents that any other age group, largely because they drive fewer miles. Those older than 75 years are twice as likely as the average driver, per mile driven, to crash their cars, while those older than 85 are 2.5 times more likely, even without adjustment for miles driven. When they crash, elderly drivers are more likely to incur injury and death. The most common errors committed by older driver are failure to yield right-of-way, incorrect lane changes, and improper turning, particularly left hand turns, and turning from the wrong lane. They incur accidents in situations that require astute perception, problem-solving ability, immediate reactions, and agile decision making.

Most seniors are as capable of driving safely as their younger counterparts, and when they become aware that they have a problem they typically act responsibly by limiting or modifying their driving habits. Most alter their driving habits as they age, driving less at night. (Nighttime trips represent only 28% of all driving, but account for 62% of all pedestrian fatalities.) They avoid heavy traffic times and complicated roadways and limit their geographic area. They stop driving for 1 of 2 reasons, medical or financial, in equal measure. One community sample found that 75% had stopped by the age of 75-84 years, and 100% by 85 years. Older individuals hold on to driving as long as possible; 44% with a disability limiting personal care still drive. Generally, those who drive could still walk half a mile or do heavy household chores.

Many older individuals regard the loss of ability to drive to be as devastating as the loss of the ability to walk. It is perhaps not surprising that many older drivers with chronic medical and neurological problems ignore the restrictions placed on them by licensing authorities. The development of screening procedures for license renewal and regulatory control that are fair, accurate, and administratively cost-effective is important to policy planners.

Screening strategy in older drivers

Marottoli et al observed that community-dwelling older individuals who could not copy overlapping pentagons on the Folstein Mini-Mental Status Examination (MMSE) encountered significantly more driving problems (relative risk [RR] = 2.3, 95% CI = 1.5-5). This deficit combined with 2 other factors, multiple foot abnormalities and an inability to walk regularly more than a block, was demonstrated by the authors as a powerful predictor of poor driving competency. Of drivers with none of these 3 factors, 6% had had an adverse driving event during the previous year; 12% of drivers with 1 of these 3 factors had had adverse events, and 26% of those with 2 of the 3 factors had had such events. Finally, of drivers with all 3 factors, 47% had had adverse driving events within the previous year.

Functional deficits

Deformities of the feet as well as impairment of gait and balance predict car collisions. Elderly individuals who have fallen within the preceding 2 years are involved in more car collisions. Older drivers who indicate their feet or legs feel cold are at increased crash risk (OR = 1.82, CI = 1.17-2.82). In a study of community-dwelling elderly, toenail irregularities, calluses, bunions, hammer toes, and the inability to rise up onto one's toes were associated with self-reported involvement in automobile crashes, moving violations, or being stopped by police in the following year. This study also found that individuals who walked less than a block each day reported more automobile crashes, moving violations, or being stopped by police the following year (RR = 2.3, 95% CI = 1.3-4), linking mobility problems on foot and behind the wheel.

Older drivers with poor flexibility of arms, legs, and neck are at increased crash risk. In an epidemiologic study, Hu et al found that older women who could not extend their arms above shoulder height were more than twice as likely to crash their vehicles. In another study, limited neck range of motion was associated independently with adverse driving events (RR = 6.1, CI = 1.7-22).

Visual attention, the most robust risk factor

Age-related visual processing impairments, particularly the inability to divide attention, predict crashes. Older drivers with 40% or greater impairment in their UFOV—which stems from decline in visual sensory function, visual processing speed, and/or visual attentional skills—appear to be at an increased crash risk. The UFOV refers to the visual spatial area functionally available in a single glance (without head or eye movements) for a given visual task, such as target identification or localization, representing attentional processing at an early preattentive level. The UFOV test reveals deficits in the ability to process peripheral target information amidst visual distractions while simultaneously monitoring a central task.

Ball et al found that the UFOV is the best predictor of driving disability and collisions. Owsley et al also found that the UFOV was the best predictor of accident frequency in a sample of older adults (together accounting for 20% of the variance). Older adults who failed the UFOV task in this last study had 3-4 times more accidents overall and 15 times more intersection accidents than older adults who passed the UFOV task. Based on this success, NHTSA recommends that the UFOV protocol (or a related procedure validated on the same measurement construct) be incorporated as a diagnostic test of cognitive deficits, which predict driving impairments for license renewal applicants.

In a prospective study utilizing a structural equation model, only the UFOV directly predicted crash frequency. Measures of visual sensory function (eg, acuity, contrast sensitivity, glare sensitivity) were related only indirectly to crash frequency and were mediated by the UFOV. Goode et al found the UFOV more valuable in identifying the high-risk older driver than commonly used neuropsychological tests such as trail making, Wechsler Memory Scale subtest, and Rey-Osterreith complex figures. Using UFOV, the authors reported a ranking that successfully classified 85.4% as at either low or high risk of at-fault crashes, with a sensitivity of 86.3% and specificity of 84.3%.

Methodologic research hurdle - Appropriate driving research safety endpoints

Accident rates are not a good criterion for most studies on driving competency because they are rare, reducing the statistical power of the studies, and because accidents occur for many reasons, some of which do not reflect the action of the driver. Moreover, many driver errors never cause accidents. Further, the source of information used to identify crash-involved drivers is important. One study indicated only a moderate level of agreement between self-reported and state-recorded crash involvement (kappa = 0.45). In another study, of 33 drivers with evidence of a crash reported either by self or state, 20 were identified by self-report only, 9 by both self-report and state records, and 4 by state records only. Both sources appeared to complement each other, though the self-report data were more sensitive.

Not surprisingly, therefore, much of the existing research on medical and functional risk factors for crash involvement has been inconsistent. Finally, the great majority of studies examining driving fitness in individuals with neurological disease are compromised, being retrospective, small, uncontrolled, and of too brief a duration to detect changes in driving status. Moreover, the driving safety endpoints vary from fatal and nonfatal crashes and moving violation statistics to performance on standardized road and simulated driving tests.

Central Role Of Physician In Driving Fitness Assessment

Older drivers feel that a physician is in the best position to evaluate their driving. Many older individuals may need annual health examinations to maintain jobs driving school buses or company vehicles. Specialists, most frequently ophthalmologists, are asked for guidance. In this regard, neurologists should focus not only on their role in policing for public safety, detecting the patients who should not drive, but also enabling the patient with marginal skills to find remediation and other means for maintaining automobile mobility as long as possible.

Physicians can expect to be involved in half the cases of driving cessation among patients with dementia. They need knowledge of driving reporting laws, skills in identifying risky drivers, and skills in counseling patient and family on strategies for driving cessation. Where possible, they should know how to refer marginal drivers for driving training (see Appendix). Some must advise state authorities on policy issues.

King et al showed that the knowledge of doctors in reporting laws was weak. Cable found that more than 28% of all geriatricians do not know how to report patients with dementia who are potentially dangerous drivers. Eighty-six percent of these providers would contact state authorities despite objections from the patient, and 72.9% would contact authorities despite objections from the patient's family. One author encouraged neurologists to become involved to keep the process of regulation current with the dynamic changes in medical care and in transportation technology, such as air bags and roll bars.

How accurate are neurologists and their patients at assessing driving competency?

In a small study by Heikkila et al, neurologists treating patients with PD overestimated the patient's ability to drive compared with the driving ability evaluated by the structured on-road driving test and with results of driving-related laboratory tests. Disease indices in PD, as in other common neurological impairments, do not associate closely with driving test performance or state-reported crash statistics, at least not earlier in the disease when doubts and controversy are highest. Patients with PD, furthermore, were not capable of evaluating their own ability reliably. Brain-injured patients themselves and their spouses tend to overestimate driving ability. Evaluation of a patient's driving ability is very difficult to carry out without psychological and psychomotor tests and often ultimately a standardized traffic interactive on-road driving test.

Limitation of the neurologist's role

Accurate assessment of the impact of symptoms on functional abilities is not possible in an office or hospital setting, because such an assessment typically requires specialized equipment or actual driving observation, which goes beyond the scope of ordinary neurological care. Neurologists do not have special expertise in assessing patients' ability to drive; they should not be expected to make these assessments in the course of clinical practice. Multidisciplinary neurological teams often are needed to reliably evaluate the driving ability of brain-injured patients.

Neurologists will want to discuss with their patients those symptoms that may be serious enough to impair their driving ability substantially. Similarly, they should warn patients about the possible effects of prescribed medications on alertness and coordination, and about the possibility that such medications could magnify the effects of alcohol. Researchers have found that sedating antihistamines can impair driving ability even more than alcohol, even if the driver does not feel drowsy; self-reported drowsiness was actually a poor predictor of impairment among those taking diphenhydramine in one study. Some cases of physician liability in automobile collisions relate to prescribed medication.

Providers should warn patients clearly about drugs that could impair operation of machinery and automobiles and document this discussion clearly. Neurologists should not be required to report information on a patient's driving ability to state licensing authorities; providers should, however, know local legal requirements, as several states mandate this anyway. Nonetheless, when clear-cut evidence of substantial driving impairment is noted, reports to licensing authorities, made in good faith, should be accompanied by immunity from subsequent liability.

Important role of physician in screening

Physicians can expect to be involved in half the cases of driving cessation among patients with dementia. In keeping with this trend, the American Medical Association in 1999 adopted a new ethical guideline stating that it is "desirable and ethical" for physicians to notify a state licensing authority about patients who, because of a medical condition, may be unsafe drivers.

When the demented individual with little insight does not agree to a prohibition on driving, the neurologist may want to step forward with the patient and take the blame for the ban, taking the family caregiver "off the hook." The health care provider may wish to counsel family members to file down the ignition key, remove the car keys or automobile from the premises, disable the battery cable, or have the authorities confiscate the patient's driver's license.

When state authorities mandate physicians to report individuals with certain diagnoses, particularly epilepsy, the ability of these providers to treat the seizure may be hampered. A significant proportion of patients with epilepsy underreport their seizures, and may do so even more when they fear the policing authority of the provider. (See Seizure Disorders and Driving Fitness for further discussion of this and related points.)

Physicians need knowledge of driving reporting laws and skills in identifying risky drivers and counseling patient and family on strategies for driving cessation. Where possible, they should know how to refer marginal drivers for driving training. Some may advise state authorities on policy issues. According to one study by Perrson, most elderly persons stop driving when a threshold is reached after an accumulation of compensatory behaviors.

Few stop because of their doctor's advice, although all feel a physician is in the best position to evaluate driving. Nonetheless, one survey by King et al showed that doctors' knowledge in these areas is poor; the authors recommended that this subject receive more and mandatory attention in undergraduate and postgraduate medical education and that doctors should be updated regularly on new recommendations from the driving and licensing authorities.

Dementing Disorders And Driving Fitness

Increased dangers with demented drivers

Numerous class II studies have revealed increased driving accident rates in individuals with DAT of either questionable or mild severity. Friedland et al found that individuals with DAT were 7 times more likely to be involved in a motor vehicle accident than healthy age-matched controls, and that 58% of these individuals stopped driving only after having an accident.

Dubinsky et al found those with very mild or mild DAT to be 3 times more likely to crash; Drackman and Tuokko reported them twice as likely; whereas Trobe and Carr found them to be no more likely. The differences in these studies arose, in part, because the sample sizes were retrospective, underpowered, and followed samples not similarly impaired. Some authors relied on state automobile crash records and others on self-reports, further skewing the results. Moreover, the researchers did not consider driving exposure or number of miles driven, nor did they blind driving evaluators. No large prospective studies exist of actual on-road driving performance in demented drivers. Nonetheless, overall accident statistics to date show increased risk for those with very mild and mild DAT.

Functional cut point may define unsafe demented driver

Dubinsky et al (2000) reviewed literature on driving safety in DAT in a report to the Quality Standards Subcommittee of the American Academy of Neurology in an attempt to offer official guidelines to practitioners. The functional assessment tool was the CDR scale (Morris, 1993). The subcommittee recommended that all individuals with mild dementia categorically stop driving. Individuals so affected score 1 on the CDR scale (see Table 1). A CDR score of 0.5 roughly correlates with a score of 25 on the MMSE, whereas a CDR of 1 approximately matches an MMSE score of 19-24, though factors such as poor education also may depress MMSE score.

On-road performance testing

How well can the driving fitness of an individual with DAT be estimated with formal standardized on-road examinations? One class I study tried to answer this important question. In this study, 19% of subjects with CDR score of 0.5 (ie, very mild dementia) and 41% with CDR score of 1 (ie, mild dementia) were judged unsafe drivers on a road test. Only 3% of the healthy controls failed in the test. The relative risk for very mildly affected persons was 5.64 (95% CI = 4.4-31.3); for mildly affected it rose to 12 (95% CI = 9.1-62.1). In another study of driving performance in similarly impaired individuals with DAT, the CDR was not as powerful a predictor, accounting for only 9% of the variance in driving performance. In that study, 59% of individuals with mild DAT and 81% with very mild DAT passed the driving test.

Given that driving represents a highly automatized skill, it appears that some drivers with mild DAT preserve these relatively automatic tasks. Fitten found that individuals with mild DAT performed significantly worse on a road test than either healthy control subjects or diabetic control subjects. Specifically, the DAT group drove more slowly and made more errors (eg, driving into a street marked "do not enter"), particularly in the more complex stage of the driving assessment. Driving scores on the road assessment in this study were correlated with the number of collisions and moving violations during the preceding 2 years. Brashear found that of 37 patients with very mild or mild DAT, 21 could not successfully recognize 10 common traffic signs, a standard test used by state licensing authorities; the author estimated the relative risk of failing in this group was 5.5 (95% CI = 3.1-18.1).

Crash risks rise in third year of Alzheimer disease

Among persons with AD, the increase in crash risk develops toward the end of the third year and more than doubles in the fourth year. Patients who have had AD for more than 2 years should have their driving ability closely monitored if they are to continue driving, as overall risk to society during the first 2 years is well within the accepted range for other drivers. Throughout the first 3 years, the crash rate for AD patients is only slightly higher than that for drivers of all ages in the United States and remains well below that of young adults aged 16-24 years.

Optimum timing and type of screening for the cognitively impaired driver is still uncertain. Most recommend retesting every 6 months, although a clear-cut policy intended chiefly for primary care physicians is still lacking. Very mildly demented individuals, once approved for driving, should be encouraged to restrict their driving voluntarily to near-home and familiar environments. They should avoid high-risk situations (see Safe driving tips for those with memory problems). In 1996, the California Department of Motor Vehicles revised its policy to automatically revoke driver's licenses only of persons with moderate or advanced dementia, and to enable those with very mild dementia to demonstrate the capacity to drive through a re-examination process.

Poor driver insight into deficits

Drivers with dementia tend to overestimate performance abilities. They are less likely to report driving problems than cognitively unimpaired drivers, and their perception of their driving ability does not correspond either to that of their caregivers (as assessed by questionnaire) nor their actual driving performance. These drivers seldom stop driving on their own (22% of the time, versus 61% of the time in age-matched nondemented seniors who stopped); more commonly, they stopped after intervention by family (24%), family and patient jointly (13%), the family doctor (18%), or memory clinic (11%).

In another study, family caregivers reported long periods between the caregiver's perception that the patient should stop driving and actual cessation, up to 4 years in some cases, suggesting that patients with DAT do restrict several areas of their driving voluntarily. Almost half the patients found to be demented while undergoing first-time evaluations in a geriatric clinic were still driving; younger and male demented drivers were less likely to stop driving despite significant cognitive impairment. In another study, of the 38% of patients with AD who failed a road test for driving competency, all considered themselves to be safe drivers. Hunt and Gilley found that 61% of demented individuals had quit driving after 24 months of disease progression and 78% had stopped after 32 months.

MMSE helpful in initial screening

The MMSE was found to be a significant predictor of final on-road driving performance results, but not of crashes and traffic violations. Scores below 10 justify recommending immediate cessation of driving. In a study by Fitten, the Sternberg memory search, visual tracking, and MMSE scores were best correlated with driving scores relative to other cognitive measures, together accounting for 68% of the variance in drive scores.

Selected neuropsychological tests helpful in more advanced screening

General cognitive status is useful for identifying individuals "at risk" for unsafe driving. Drivers with mild dementia need focused cognitive testing to assess driving fitness. Only selected neuropsychological tests predict future crashes or traffic violations. The Boston naming test was the only significant predictor of driving ability, of the many psychometric measures in one study, perhaps because pattern recognition and the retrieval of information from semantic memory are both processes related to driving. Measures of selective visual attention and Boston naming performance accounted for 65% of driver road test performance variance in one study in a DAT population. The UFOV test already discussed reveals a deficit in patients with DAT, namely their inability to process peripheral target information amidst visual distracters while simultaneously monitoring a central task.

In a small study of 18 subjects with mild DAT, Scharre et al reported 4 measures of visual attention and visuospatial skills that differentiate individuals who are unsafe drivers. In their findings, deficits in choice reaction time, time to complete cancellation task, block design, and a 4-turn route-finding walking task in the hallway of the clinic all correlated significantly with poor road-test performance. Other studies have focused on measures of selective attention to differentiate unsafe drivers.

In a study of patients recovering from strokes, perceptual tests, such as the Motor-free Visual Perception test (MVPT) and Trail Making B test, were the most predictive of on-road performance. The positive predictive value for the 2 tests, when combined, was 86.1%; the negative predictive value was 58.3%. Those who scored poorly on both were 22 times more likely to fail on-road evaluation and were deemed not ready to undergo an on-road driving evaluation. Marottoli et al found that the Hooper Visual Organization test, which measures visuospatial ability, and the Number Cancellation test, which measures visual attention, predicted driving problems.

Caregivers often not good judges of driving

Caregiver perceptions of driving ability did not predict driving performance consistently in one small study. The question, "Would you feel safe with your grandchild riding along when your spouse is driving?" is not an accurate criterion standard, as these family caregivers were not accurate judges of driving abilities in their demented relatives.

Formal driving assessments

The conventional criteria used in North America for licensing new drivers are generally inappropriate for license removal in experienced drivers, particularly mildly demented drivers. This group of motorists is more likely to position themselves poorly on turns and drive overcautiously. A standardized road test may be the only appropriate means of determining driving competence in people diagnosed with very mild and mild DAT. Closed-course, off-road tests, while valuable in the preliminary assessment of a person's ability to track, steer, and brake a car, yield little useful information about actual driving behavior once the same motorist goes on road, as they allow no chance to observe interaction with other motorists. Even on-road tests face limitations, since the tester, giving one-step commands at various intersections, cannot assess a person's ability to navigate by a road map and otherwise find a route.

Testing in stationary training cars is not adequate for persons with central neurological disorders. Driving simulators have only limited roles in predicting the safety of demented drivers. They are useful in drivers recovering from strokes or traumatic brain injuries (TBIs), a prelude to formal on-road examinations. They also may highlight risks to drivers who do not easily acknowledge diminished capabilities when used as an educational tool in a rehabilitative program.

Fortunately, a systematic traffic-interactive road test for elderly drivers with a range of cognitive skills has been developed and its safety, reliability, and validity established. Researchers who developed this test have produced a performance-based road test that examines cognitive behaviors and provides an accurate and reliable functional assessment of driving ability.

Washington University road test

The Washington University Road Test (WURT) is a popular standardized on-road measure of driving performance commonly used in driving research in the elderly and cognitively impaired population. The WURT is a 45-minute in-traffic road test along a predetermined route. Subjects drive a standard car with dual brakes, usually at approximately the same time of the day in good road conditions. A driving instructor is seated in the front and an investigator is seated in the back of the car.

The test consists of 2 components -- a closed-course and an open-course test. The closed-course test is given in a large parking lot. Subjects are familiarized with the controls of the car and asked to perform various basic maneuvers, such as starting the car, driving forward, stopping, and making a left turn. Each of these behaviors is scored as either "pass" or "fail." The open-course test is conducted in traffic and assesses several typical driving skills such as maintaining speed, obeying traffic signs, signaling, turning, changing lanes, and negotiating intersections. Each skill is scored on a 2- or 3-point scale, thus yielding a total quantitative driving score ranging from 0-108 (ie, 108 is perfect performance). The test-retest reliability for the WURT is r = 0.76.

Can we rehabilitate drivers with mild dementia?

The Washington State Special Examination Program offers a customized licensing examination to individuals with mild dementia and chronic psychiatric conditions such as bipolar disorders. This examination includes an in-depth interview and an extended or specialized on-road drive test, typically conducted near the driver's residence. The most common outcome of the "special examination" is to impose driving restrictions (eg, time of day, area, equipment).

Salzberg and Moffat followed a small (n = 46) group of older individuals who underwent and passed this specialized examination but continued driving with restrictions. The author found that this group (over a period of 5 years before and after the examination) had nearly 60% lower collision and violation rates than older patients who did not undergo this special test. This brought their rate of collisions per 100 drivers per year from 12.4 to 4.6, approaching the rate for all drivers in the state (3.5 per year per 100 drivers). However, rate reduction still resulted in a crash and violation risk that was approximately 4 times that of the control group of older drivers.

Table 1. Clinical Dementia Rating

Categories	**Impairment**			
	0	**0.5**	**1**	**2**

Memory (major category)	No memory loss or slight inconsistent forgetfulness	Consistent slight forgetfulness, partial recollection of events, "benign" forgetfulness	Moderate memory loss; more marked for recent events; defect interferes with everyday activities	Severe memory loss; only highly learned material retained; new material rapidly lost
Secondary categories				
Orientation	Fully oriented	Fully oriented except for slight difficulty with time relationships	Moderate difficulty with time relationships; oriented for place at examination; may have geographic disorientation elsewhere	Severe difficulty with time relationships; usually disoriented to time, often to place
Judgment and problem solving	Solves everyday problems and handles business and financial affairs well; judgment good in relation to past performance	Slight impairment in solving problems, similarities, and differences	Moderate difficulties in handling problems, similarities, and differences; social judgment usually maintained	Severely impaired in handling problems, similarities, and differences; social judgment usually impaired
Community affairs	Independent function at usual level in job, shopping, and volunteer and social groups	Slight impairment in these activities	Unable to function independently at these activities although may still be engaged in some; appears normal to casual inspection	No pretense of independent function outside home. Appears well enough to be taken to function outside a family home
Home and Hobbies	Life at home, hobbies, and intellectual interests are well maintained	Life at home, hobbies, and intellectual interests slightly impaired	Mild but definite impairment if function at home, more difficult chores abandoned, more complicated hobbies and interests	Only simple chores preserved; very restricted interests, poorly maintained

			abandoned	
Personal care	Fully capable of self-care	Fully capable of self-care	Needs prompting	Requires assistance in dressing, hygiene, keeping of personal effects

Seizure Disorders And Driving Fitness

Impact of epilepsy on car crash rates

The relative risk for car crashes in persons with epilepsy varies according to the study, but seems to be about 1.3, making it similar to the risk posed by diabetes. When compared with the number of crashes due to other preventable causes, such as alcohol consumption, which alone accounts for 5-10% of automobile crashes in the United States, the impact of epilepsy on road safety seems small. The number of accidents in the population due to drivers with epilepsy is 1 per 10,000, though when they occur, they may be more serious. Approximately 10% of people with epilepsy drive illegally, often despite a physician's prohibition. Novak reported that over half of all those of driving age with epilepsy drive motor vehicles.

Which drivers with epilepsy are the safest?

In one of the oldest but best epidemiological studies in the literature, Waller determined that the riskiest drivers with epilepsy were those with "deviant attitudes." These individuals were the most noncompliant with their prescribed medications and were the most likely to drive illegally without a license. These persons were usually males younger than 25 years; unfortunately, the data in this group may have been contaminated by alcohol-related seizures.

Accident risk stratification must be individualized. Those with a prior car crash due to a seizure are worrisome and may require a longer seizure-free interval before resuming driving. Those persons with epilepsy who abuse alcohol are clearly at much higher risk. Those who do not comply with physician guidelines and state regulations, as mentioned above, are more dangerous on the highway. Those with structural brain lesions face increased risk, as do those with clusters of seizures despite long seizure-free intervals, though both risks are largely controllable with medication monitoring.

Those with seizures without loss of consciousness pose no increased risk. Those with an established pattern of exclusively nocturnal events, as well as those with consistent and prolonged auras, have much less risk. Patients with an isolated breakthrough seizure traceable to a medication problem or clear intercurrent illness are much safer drivers as well. Individuals with a history of only a single isolated seizure did not have an increased risk of crash in a study from England.

Patients with pseudoseizures should be treated as those with organic epilepsy, since they too have episodes of abrupt loss of control. Patients who are undergoing supervised medication changes should understand the need to minimize their driving as much as possible. Individuals with epilepsy who comply with driving regulations regarding seizure-free intervals, discussed below, pose no or little increased risk of accidents. Krauss et al found that the rate of accidents not related to seizures among drivers with epilepsy was actually lower than the general accident rate, suggesting that these motorists may be more cautious on the road.

In well-selected cases, epilepsy surgery can render about two thirds of patients seizure free, making driving a possibility, perhaps for the first time in their lives. Unfortunately, visual field defects, especially homonymous upper quadrant deficits, may complicate epilepsy surgery, particularly in the commonest form, temporal lobe surgery for hippocampal sclerosis. Most of these field defects are asymptomatic in everyday life, yet possibly hazardous at the wheel. Therefore, patients should be warned about possible postoperative visual field impairments and undergo Goldmann kinetic perimetry testing or similar tests.

International regulations differ markedly

Although the general trend is toward liberalization of driving standards for persons with epilepsy, considerable controversy still exists regarding the specific driving restrictions necessary for persons with seizures, the way in which such policies should be administered, and the role physicians should have in the process. The European Union Association on International Bureau for Epilepsy, at a meeting in 1996, recommended a mandatory period of 1 year seizure free before regaining driving rights. In 5 of the 10 provinces in Canada, physicians are required by law to report anyone with a medical condition that might impair driving.

For individuals with epilepsy in India, countries of the former USSR, Japan, Brazil, and Greece, to regain a private (noncommercial) driving license, they must have stopped their antiepileptic medication successfully for 2 years and been seizure free. In Sweden, the patient must be seizure free for only a year, but may remain on medications for this interval to regain a license. In several countries, including Canada, Germany, Austria, and Switzerland, the EEG findings must be normal before the license is regained.

Legislation and medical guidelines are based as much on empirical as on statistical data. The American Academy of Neurology, American Epilepsy Society, and Epilepsy Foundation of America drafted consensus statements on driver licensing and epilepsy based on a consensus workshop held in 1991. These groups agree that a seizure-free interval should be stated, and that 3 months, starting from the date of the seizure, is preferred. Both favorable and unfavorable modifiers could alter the interval. They also agree that "restricted licenses may be appropriate under certain circumstances in which such restrictions will allow driving with an acceptable risk of seizure occurrence."

They further state that physician and/or medical advisory board input should be obtained for individualized determination of the terms of each restricted license. Agreement among groups is unanimous that physicians should not be required to report their patients to licensing authorities; they should, however, advise patients about the medical risks involved, each state's driving requirements, self-reporting obligations, and their own recommendations about driving.

The patient should be responsible to self-report the condition initially to the state's licensing authority and to report recurrent seizures. However, the groups stated that if the physician believes that the patient has not self-reported and is endangering the public by driving, the physician should have the right to report the patient (with immunity). The participants of the consensus workshop determined that medical criteria for licensing are best handled in the form of medical guidelines or regulations.

Optimal, minimal, seizure-free interval before resuming driving

The optimal, minimal, seizure-free interval to minimize seizure-related crashes is still unknown. Good and replicated epidemiological data link length of seizure-free periods with risk of breakthrough events. Kuhland found that 87% of persons free of seizures at 1 year were still free of breakthrough events after 3 years. Drivers with well-controlled epilepsy, defined as being seizure-free for the preceding 12 months, pose no greater risk for car crashes than those with diabetes or heart disease, and probably no more than those in the general population. A US consensus statement approved in 1994 by the American Epilepsy Society and the American Academy of Neurology recommended a minimum seizure-free interval of only 3 months. Debate continues, and some predict this recommendation will be stretched to 6 months.

In the United States, the seizure-free interval mandated by regulatory authorities varies from 2 years to as little as 3 months. About half the states require a 1-year freedom from seizures, a few require 18 months, and the remainder require 3-6 months or do not stipulate any specific interval. Both the European and US panels recognized the role of the physician in considering mitigating factors, outlined above, that influence a person's capacity to drive safely.

Whatever the interval prescribed, however, the evidence is that these state-imposed restrictions are not effective in keeping at-risk motorists off the road. The percentage of drivers with epilepsy who report their condition to the governmental agencies is small, only about 10%. Seventy-five percent of patients underreport. Krauss et al pointed out that 54% of persons with epilepsy drove illegally without completing a sufficiently long seizure-free interval or did not report breakthrough seizures to their physicians in states with mandatory doctor-reporting requirements. Only 27-54% of motorists with epilepsy report their condition to the licensing authorities.

Currently 6 states in the United States and 5 provinces in Canada mandate that the physician report to the state anyone with epilepsy. Whether compulsory reporting laws achieve their purpose—increased traffic safety—is questionable. Policy makers are aware that many people with epilepsy do not comply with driving restrictions and do not report their epilepsy to their physicians. Most neurologists favor discretionary reporting.

A majority of neurologists surveyed in Canada admit to a lack of knowledge about local government regulations. When mandated by provincial regulations, 84% of physicians comply and report patients with a history of seizure disorder to licensing authorities; when not mandated, only 19% report such individuals. One legislative strategy for helping patients respect the seizure-free waiting period may be to free the health provider from all mandatory reporting duties to encourage more patient disclosure to the doctor.

Patient counseling and education critical

Given this breakdown of communication between patients and licensing authorities, physicians should educate patients about the importance of the seizure-free interval. Health providers must counsel their patients about the imperativeness and advantages of reporting the seizure disorder to the appropriate licensing authority. Patients should understand that this process not only improves public safety but also shields the driver from litigation should he or she have a seizure while driving, provided he or she has not been otherwise negligent. If patients do not report their disorder and do not obtain the physician statement, they may face civil liability and criminal prosecution in the event of an accident related to a seizure. Moreover, their insurance company may deny coverage for the accident, particularly where the facts show that the individual failed to take the prescribed antiepileptic medication appropriately.

For those patients who have controlled their seizures successfully, the physician may offer a statement to the licensing authority, usually on specified forms, confirming that the individual's seizures are controlled. With this statement, the physician asserts the opinion that, if licensed to drive, the person will not present an unreasonable risk to public safety. Generally, state medical review boards then review the driving application and physician statement and render a decision whether to grant the license. State laws protect the physician from liability for violating patient confidentiality for statements about driving risk presented to the state, provided the statement is made in good faith and with reasonable belief of its accuracy.

However, filling out the forms for the state authority is not enough. Providers may ask patients to sign in the medical record that they have received and understood counseling about driving risks and their obligations to report their disorder. Providers have an obligation to use reasonable care to protect potential victims and prevent harm to the public. Physicians who fail to counsel patients about driving risks from uncontrolled seizures, or who fail to document such counseling, may face future direct liability exposure, even to other individuals and third parties injured in seizure-related accidents.

Other Neurological Disorders And Driving Fitness

Ability of persons with stroke, PD, or TBI to drive safely cannot be determined as precisely as for individuals with epilepsy. General and intuitive agreement exists that those severely affected by these problems should not drive. No single battery of test exists to screen those only mildly or moderately impaired, though the UFOV, already discussed, comes close with cognitively impaired drivers. Nonetheless, a standardized approach is important, both to avoid unnecessary bias against the well-functioning person as well as to ensure the safety of the driver and the general public.

Parkinson disease

Driving ability is decreased greatly in patients with even mild to moderate PD. In a prospective study in a movement disorder clinic in Spain, of patients with largely stage II disease, 81% of patients with PD had stopped driving, usually because of the disease itself. The individuals complained particularly of difficulty managing pedals and assessing distances properly. Zesiewicz et al, using a driving simulation task in 39 individuals with moderately advanced PD (average Hoehn & Yahr score 2.10) found the subjects performed significantly worse than age-matched controls. Their scores on the United Parkinson Disease Rating Scale (UPDRS) correlated well with this performance (r = 0.477, *P P P* <.01).

Self-report of moving violations and collisions did not match the driving simulator achievements. According to one study, only 40% of patients with PD still drive 5 years after diagnosis. However, PD indices are not associated consistently with driving test performance. The author found no correlation between motor evaluations and driving ability.

Persons with mild PD experience problems with diminished visual contrast sensitivity, slower verbal learning, and slower set-shifting and executive tasks, all of which theoretically might affect driving. In moderately advanced disease, once patients begin to suffer motor freezing, they also perform poorly on dual tasks; when quizzed while walking, both their stride length and verbal fluency decline, reflecting frontal lobe compromise. While levodopa improves memory and verbal fluency, it worsens simultaneous visual and auditory reaction times. Trihexyphenidyl, another popular medication for PD, impairs attention, learning, and free recall. The small studies to date on the new deep brain surgeries suggest the operations do not harm overall measures of cognition and may boost attention.

Multiple sclerosis

In a small Norwegian study of 33 patients with multiple sclerosis who were examined medically, neuropsychologically and, in some cases, with an on-road driving test, 19 patients were allowed to drive and 14 were refused. Regression analysis showed that, when deciding for or against driving, cognitive and emotional deficits were given more weight than duration of illness and degree of neurologic deficit.

Stroke

Persons with a history of stroke, despite very heterogeneous deficits, as a group are at an increased driving-related risk owing to their decreased cognitive and psychomotor abilities. Thus driving ability should always be evaluated after stroke. All individuals in Great Britain who have suffered a transient ischemic attack (TIA) or stroke are banned from driving automatically for a minimum of 3 months after the event, given the high risk of recurrence. In a Norwegian study conducted in patients 4 months after the infarction, the finding of hemianopia excluded safe driving. Significant hemineglect and reduced speed of information processing were found to be the most discriminating variables when classifying those who performed well on road tests and who seemed safe to regain their driver's licenses. However, Schulte et al found that individuals with visual field defects, including those who suffered from homonymous hemianopia, performed as adequately as healthy individuals inrealisticdrivingscenarios.

These authors concluded that the perimetrically assessed visual field is of limited value for the prediction of driving safety, arguing that patients who have field defects should not be denied a driving license. Even though neglect was observed more frequently among those with right hemisphere-damaged (RHD) stroke than those with left hemisphere-damaged (LHD) stroke, the 2 hemisphere groups did not differ significantly in number of patients denied driving, 58% in the RHD group and 41% in LHD patients. When grouped together with individuals with PD, those recovering from strokes in one community sample had an adjusted odds ratio for having stopped driving of 2.90 (95% CI = 1.04-8.11).

In a large retrospective study of state driving records, Haselkorn could not find an increase in either motor vehicle crashes or moving citations in individuals in their first 12 months after a stroke. Nonetheless, driving ability always should be evaluated after stroke. Multidisciplinary neurological teams, including nationally certified driving instructors, are able to evaluate the driving ability of stroke patients reliably. The evaluation should include a road test, such as the Washington University model already described, which should be incorporated into the larger stroke rehabilitation program for these individuals.

Narcolepsy

Automobile crash risk is increased (not unexpectedly) among people with untreated sleep apnea syndrome (SAS) and narcolepsy. The proportion of crashes is higher for people with untreated narcolepsy than it is for people with untreated SAS. However, because the latter syndrome is more common than narcolepsy, the absolute number of crashes is higher for those with untreated SAS. As of March 1994, only 4 states in the United States (Maryland, North Carolina, Oregon, and Utah) had guidelines for narcolepsy, while 2 had guidelines for both narcolepsy and sleep apnea (California and Texas).

In Maine, guidelines had been proposed for sleep apnea. In contrast, almost all Canadian provinces have guidelines for both sleep apnea and narcolepsy, as does the United Kingdom. However, the nature of the regulations used in different states, Canadian provinces, and countries vary considerably. These variations are not based on scientific data. Currently, the impact of these regulations on crash rates or on the practice of sleep medicine has not been assessed.

Traumatic brain injuries

A retrospective study in Washington State reviewed the driving records of individuals with TBI and compared their records for motor vehicle crashes or moving violations for 4 years before and 1 year after the head injury, adjusted for age, sex, and prior driving record. The results did not support the hypothesis that individuals who have sustained a brain injury are at an increased risk of motor vehicle crashes. In a small survey of individuals with moderate TBI, only one third had undergone professional driving evaluation; most were currently active drivers, driving daily, more than 50 miles per week. Traditionally, most driving rehabilitation programs have focused on the operational level with emphasis on the handling of the vehicle and use of the controls and mirrors, rather than tactical and strategic skills where the deficits may lie for the drivers with TBI.

Traumatic spinal cord injuries

Expected functional transportation-related outcomes for individuals with traumatic spinal cord injuries, 1 year after injury, were published by the Consortium for Spinal Cord Medicine in 1999. These are summarized in Table 2.

Table 2. Expected functional transportation-related outcomes for individuals with traumatic spinal cord injuries, 1 year after injury

Spinal cord level	Expected functional outcome	Adaptive equipment
C1-3	Total assist	Attendant-operated van (eg, left, tie-downs) or accessible public transportation
C4	Total assist	Attendant-operated van (eg, left, tie-downs) or accessible public transportation
C5	Independent with highly specialized equipment, some assist with accessible public transportation; total assist for attendant-operated vehicle	Highly specialized modified van with lift

C6	Independent driving from wheelchair	Modified van with lift, sensitized hand controls, tie-downs
C7-8	Independent car if independent with transfer and wheelchair loading/unloading; independent driving, if independent with wheelchair unloading	Modified vehicle, transfer board
T1-9	Independent in car, including loading and unloading wheelchair	Hand controls
T10-11	Independent in car, including loading and unloading wheelchair	Hand controls
L2-S5	Independent in car, including loading and unloading wheelchair	Hand controls

Vestibular disease

The impact of vestibular disease on driving safety is not well described in the literature. Although no consensus of opinion exists on a method of reporting unfit-to-drive patients, according to a census of the American Neurotology Society, relative safety risks for patients with these disorders seemed low in comparison to other disorders. The society did not advocate mandatory reporting of patients with vestibular disorders.

Neurologic medications and drowsiness

Frucht et al reported sudden irresistible attacks of sleep, a side effect of the dopamine agonists (ie, pramipexole, ropinirole) used in the management of PD. Virtually all the medications used in the management of PD, epilepsy, neuropathic pain, and multiple sclerosis can induce drowsiness common in many car crashes. Long-acting benzodiazepines appear to increase car risks in older drivers.

Sensory impairments and driving

Visual acuity

For an unrestricted driver's license, NHTSA guidelines state that a driver must have 20/25 static near visual acuity in each eye (with correction less than 10 diopters), monocular visual fields of 120 degrees in each eye, and binocular visual fields of 70 degrees to the right and to the left in the horizontal meridian. Many common eye conditions require special consideration but lack set standards, including impairments of color vision and dark adaptation; heterophoria; stereopsis; monocular vision; refractive states; and telescopic lenses. Near static visual acuity less than 20/40 predicts self-reported adverse driving events among older drivers but correlates only weakly with traffic crashes and convictions. Far static visual acuity is relevant only when a vehicle is stopped or moving at a slow rate, such as at an intersection or in a parking lot.

Dynamic visual acuity (DVA), like static acuity, also declines with age, only more so. DVA reflects the ability to resolve the details of a moving target and therefore appears more crucial to driving tasks. However, studies do not bear out a correlation between DVA and crash rate for older drivers, so DVA has no practical significance for identifying at-risk drivers. Static contrast sensitivity tests measure both the response to sharply defined, black-on-white targets and those with grayer, less-distinct edges. Recent studies demonstrate that these tests are only slightly better at predicting driving test performance than static acuity, with a weak correlation ($r < 0.25$).

Individuals with moderately advanced cataracts (20/40 to 20/60) suffer more at-fault car crashes than individuals without cataracts (RR = 2.48, 95% CI = 1.0-6.14). Fortunately, visual impairment from cataracts is now correctable with surgery to 20/40 acuity or better in most cases. Neurologists will refer to eye specialists, who may counsel patients regarding the dangers associated with driving with cataracts and suggest driving restrictions (eg, at night/dusk, in reduced visibility conditions such as rain, fog) until surgery is performed. Glaucoma is one of the leading causes of blindness in the United States, affecting 2 of every 100 individuals older than 35 years. Glaucoma is associated with an increased car crash risk (RR = 1.7-5.2).

Hearing impairments

One population-based case-controlled study found no significant association between impaired hearing and motor vehicle collisions, but did note that individuals who used hearing aids while driving had about twice the risk of crashes as persons without hearing aids (adjusted RR = 2.1; 95% CI = 1.2-3.8).

Appendix

Patient education - Safe driving teaching points

Questions family members may address when observing older drivers

Is he/she alert to real or potential hazards, pedestrians, and traffic signals?

Can he/she see things from the side of the car as well as the front?

While driving, does he/she hear oncoming horns, cars, emergency vehicles?

Can he/she manage the steering wheel, pedals, and gear lever?

Does he/she make good decisions?

Does he/she respond quickly and appropriately to sudden situations?

Can he/she get to the proper destination?

Can he/she drive and carry on a conversation at the same time?

Safe driving tips for those with memory problems

Drive with a copilot whenever possible

Avoid unfamiliar routes

Avoid bad weather, heavy traffic, and drives for long distances

Keep the radio off

Role of the copilot with a demented driver

Ensure vehicle is properly maintained

Ensure driver has valid license

Ensure driver undergoes driving retest every 6 months

Enroll driver in remediation classes, where feasible

Do not distract with conversation during drives

Cue verbally in plenty of time for turns and other maneuvers

Track these driving tasks while in car - Signaling in time; using mirror appropriately; following at safe distance; maintaining proper speed; positioning in lane appropriately; changing lanes

Closely monitor these highest risk situations - Left turns against traffic; uncontrolled intersections (no stop signs or traffic lights); changing and poor road conditions

Resources for patients and families of demented and elderly drivers

The American Automobile Association Foundation offers a 16-page booklet, Drivers 55 Plus: Test Your Own Performance, for self-evaluations. Others may choose a formal driving evaluation.

The Association of Driver Educators for the Disabled maintains state listings of members trained to evaluate and train persons with disabilities (ADED, PO Box 49, Edgerton, WI 53534; (608) 884-8833).

Driving refresher courses are available through the American Association of Retired Persons (AARP). This organization offers an 8-hour training course in defensive driving developed specifically for older drivers (55 Alive/Mature Driving course). Individuals may contact 55 Alive/Mature Driving, AARP, 601 E Street NW, Washington, DC 20049; (202) 434-2277.

The National Safety Council and the American Automobile Association offer similar programs for adults of all ages. Participation in the class may bring an insurance discount. The National Safety Council produces videotapes that discuss such issues as in-car distractions, blind spots, right turn procedures, passing distance, windshield glare, backing, and parking.

For excellent patient education resources, visit eMedicine's Sleep Disorders Center. Also, see eMedicine's patient education article Narcolepsy.

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Keywords

aging, driving fitness, older drivers, neurological disorders, Alzheimer disease, senility, seizure disorders, dementing disorders, Mini-Mental State Examination, MMSE