Chapter

Attention Deficit Hyperactivity Disorder (ADHD) and Other Neurocognitive Factors Contributing to Road Traffic Accidents (RTA)

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Abstract

Road traffic accidents (RTAs) are among the leading causes of mortality worldwide. RTAs are multifactorial in origin, but neurocognitive function of drivers contributes about 25% of the variance of most accidents. This chapter reviews the commonest disorders that contribute to RTA. They are attention deficit hyperactivity disorder (ADHD), specific learning disabilities (e.g., dyslexia), autism spectrum disorder (ASD) in adolescents and young adult drivers, and mild cognitive impairment (MCI) and dementia in older drivers. The features of these disorders and how they impair driving along with evidence-based treatments and interventions are discussed. Increasing awareness of these disorders, screening for them, and offering treatment when appropriate can contribute to reducing the disease burden related to RTA, which is currently the eighth leading cause of death across all ages globally. The lack of attention to these disorders within the road safety disciplines constitutes a significant public health problem which requires attention.

Keywords: neurocognitive factors, ADHD, learning disabilities (LD), dyslexia, autism spectrum disorder (ASD), mild cognitive impairment (MCI), dementia, road traffic accidents (RTAs)

1. Introduction

According to the World Health Organization (WHO), some 1.35 million people die and another 50 million people are injured or disabled from road traffic accidents (RTAs) annually across the globe. RTAs remain the eighth leading cause of death for people of all ages [1]. Unfortunately, the SDG target to halve road deaths by 2020 will not be achieved. The mortality rates in low-income countries are three times that of high-income countries. Though mortality from RTA has dropped by 50% over the last 16 years globally, the rate is far short of the SDG target. No low-income country has reduced its mortality rate from RTA since 2013. It is the leading cause of death between the ages of 5 and 29 years, globally [2].

While there are likely many factors contributing to these accidents in mortality and morbidity estimates, the relative contributions of individual driver neurocognitive characteristics are not fully understood or emphasized in road safety programs.

Neurocognitive difficulties resulting from conditions like attention deficit hyperactivity disorder (ADHD), specific learning disabilities, autism spectrum disorder and mild cognitive impairment, Alzheimer's disease, and other dementias, among other conditions, are likely to play a role in particular circumstances in road traffic accidents.

From a population health standpoint, these conditions have a fairly high prevalence among the driving public. The worldwide prevalence of ADHD is about 7%, Learning disabilities, such as dyslexia occur at about the rate of 7%, ASD at about 2% and dementia because it about 5–7% in most world regions in individuals over 60 years of age. In this chapter, a review of the current knowledge on the contribution of these individual driver factors to road traffic accidents is examined.

The WHO has developed road safety guidelines for member states, given the significant contributions of RTA to global disease burden. The pillars of focus are (1) road safety management, (2) safer roads and mobility, (3) safer vehicles, (4) safer road users, and (5) post-crash response. Interestingly, individual driver neurocognitive challenges are not directly addressed by this initiative. The WHO has focused on supporting member countries to enact legislation to manage excessive speeding, drunk driving, motorcycle helmet use, the use of seatbelts while driving, and child restraints, all of which are impacted by road user neurocognitive deficits. Compliance with these behavioral elements of road safety is affected by undiagnosed and untreated neurocognitive factors.

Since 2014, only 22% of member countries have amended their laws to fall in line with one or more of the key pillars, positively impacting about 14% of the world's population.

Driving is a complex cognitive-motor-perceptual-multi-tasking activity, and given the significant prevalence of disorders like ADHD, learning disabilities, ASD, and dementia, the core symptoms of these disorders are likely to contribute to road traffic accidents and are unlikely to be affected by the interventions outlined by the WHO. As a result, the standard of care requires physicians to notify their patients if their medical condition can potentially impair the operation of potentially dangerous equipment, such as motor vehicles. In fact, this is the law in most states [3]. Traditionally, neurocognitive functioning of drivers has not been considered a factor in evaluating road safety programs [2].

Individual driver factors reportedly comprise 25% of the variance of RTA [4].

In this chapter, the state of the literature in contributing to our understanding of the relationship between these disorders and driving is reviewed in the order below:

2. Attention deficit hyperactivity disorder (ADHD)

ADHD is one such individual-level factor, which has been extensively studied globally. Its core symptoms are inattention, distractibility, and impulsivity. It is mostly a genetic neurodevelopmental disorder beginning in childhood, which tends to be enduring and lifelong. Increasingly, emotional lability and difficulties with anger control have also been recognized as a common symptom [5, 6].

Other symptoms reflective of impaired executive functioning, including risk-taking behaviors such as difficulty in planning and setting priorities, make for an increased risk of accidents when someone with these symptoms is operating a motor vehicle. Evidence establishing driving risks has been obtained from self-report, informant report studies, simulation studies, on-road testing, and official driving records [7–9].

The literature over the past two decades suggest an association between ADHD and driving accidents in North America and other western countries [10, 11]. Barkley indicated that drivers themselves report inattention as the single most frequent reason for their car accidents [12]. Insurance data also suggests that ADHD drivers had 3.3 times more accident-related claims than controls [13]. Researchers have also presented findings suggesting that educational achievement is inversely related to road traffic driver accidents and injuries [14–16].

Identification of drivers with ADHD and their treatment has been correlated in some jurisdictions with reduced risk of RTAs and fatalities [14, 16–18]. Vaa in a meta-analysis in 2003 presented findings suggesting that individuals with ADHD had a 54% higher risk of being involved in an accident when compared with non-ADHD drivers [19]. However, in a later meta-analysis in 2014, Vaa et al. showed that comorbidity accounted for a large portion of the variability in ADHD-influenced accidents. They distinguished between intentional violations and driving errors. The former was more common in ADHD cormorbid with ODD and CD and the latter with ADHD occurring alone. Speeding was a common reason for driving errors in patients with ADHD alone [20]. This contradicted Barkley's 1993 finding of ADHD accounting for a fourfold increase in relation to RTA.

Chang et al., in a population-based prospective study in Norway, confirmed the increased risk of RTA in adults with ADHD and more importantly confirmed that with medication treatment, there was a 58% risk reduction for driving accidents in males [17]. There was no data on females reported in this study. Numerous studies have shown that treatment of ADHD with methylphenidate has been found to reduce collision and other traffic violation rates and also reduction in "angry and hectic driving" in drivers with ADHD [21–23].

Simulation studies have also addressed the comparative impairment caused by ADHD to that resulting from alcohol use in drivers. Subjects with ADHD had more difficulty maintaining constant speed than controls when tested with alcohol at 0.05% BAC relative to placebo. They also had a positive illusory bias which caused them to overestimate their abilities while driving and viewed themselves as less intoxicated than controls when tested with the same level of alcohol [24, 25]. These findings from simulation studies raise concerns about the additional risks posed by common comorbid conditions of ADHD, such as alcohol and substance abuse. It is established that individuals with untreated ADHD are more likely to have substance use disorders [26].

In an analysis of over 7000 severe pedestrian injuries and deaths, the New York City Department of Transportation in 2010, demonstrated the particular vulnerability of pedestrians in RTA. The results revealed that driver inattention accounted for 36% of the pedestrian-involved accidents. Drivers failing to yield to pedestrians, driver speed, and intoxication accounted for 27, 21, and 8%, respectively. Pedestrians were noted to be at fault in 20% of cases [1]. Importantly, most fatalities from accidents involve vulnerable populations like pedestrians, cyclists, and motorbike riders [1]. Inattention is a core ADHD symptom, and speeding was often a reflection of impulsivity, another core ADHD symptom. Additionally, drivers with ADHD seem to have more distractibility during low-stimulus driving such as found on interstate highways. They tend to be more fatigue-prone in these situations, from visual and task monitoring [27].

Individuals with ADHD are at significant risk of being involved in RTA due to the features of their condition. This reality is supported by many studies showing increased rates of motor vehicle accidents and impulsive-influenced driving behaviors compared with those without ADHD. Both pharmacologic and non-pharmacologic interventions can reduce these risks. The non-pharmacologic interventions include manual transmission vehicles, hazard perception training, and electronic motion alerts on vehicles [28, 29].

Treating physicians should consider the potential impact of a patient's ADHD symptoms on driving behaviors and possible related outcomes when developing a treatment plan for their patients. Significant psychoeducation is central to a positive outcome, resulting in improved treatment compliance.

3. Specific learning disabilities

Specific learning disabilities are also a source difficulty in driving for those afflicted. They are often comorbid with ADHD in about 30% of individuals with either disorder. Dyslexia is the commonest of the specific learning disabilities. It has been estimated that 7% of the population could be considered as dyslexic, a specific learning disorder impairing accurate or fluent word recognition despite adequate instruction and intelligence and intact sensory abilities [30].

Individuals with dyslexia have difficulty perceiving written words accurately in their environment. There are numerous kinds of dyslexia, including phonological dyslexia, which includes selective difficulty with nonword reading; surface dyslexia, which is selective difficulty with exception of word reading, and visual dyslexia, where words are frequently misread as another, particularly visually similar words. There is also lexical non-semantic reading, i.e., reading without comprehension and pure alexia where words can only be read letter by letter.

This suggests that the reading of road signs, for example, can be quite problematic for these individuals. Moving text messages that are now more frequently used as road signs would be more difficult for them.

They have shorter legibility distances because they have to make a greater cognitive effort to accurately decipher road signs. While trying to read road signs when driving, there is more gazing and poor speed control. They have a longer reading time and have to apply an increased cognitive effort.

These drivers are usually helped by the use of pictograms rather than written words or moving text messages that have become more popular. The use of pictograms in conjunction with the written word is helpful in reducing accidents in this population. Dyslexia is traditionally considered as a language-based disorder, and consequently, the processing of pictorial information would be theoretically preserved [30].

Other controlled studies show that even with pictorial signs, individuals with dyslexia are slower to decipher what they see [31]. Sigmundsson 2005 showed that dyslexic individuals had significantly slower responses than controls to signs shown to them in a simulator-based experiment [32].

Roca et al. confirmed this finding and suggest that pictorial information could be a potential countermeasure to reduce driving risk for dyslexic drivers but also cautioned that reliance on pictograms must be considered with care, because it was observed in their study that participants with dyslexia also showed increased cognitive effort when trying to identify the pictograms in the variable message signs (VMS) [33].

This is an area in which further research will be useful in clarifying the extent to which the processing of pictogram-based information can be more demanding for adult drivers with dyslexia than non-dyslexic control participants.

Specific learning disorders like dyslexia are often overlooked as deficits that are relevant in road safety because by definition, those afflicted have normal or superior cognitive and intellectual abilities. They have no outward signs of deficits.

4. Autism spectrum disorder

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition, which is associated with impairment of communication and social interaction, along with executive function deficits affecting working memory, motor coordination, attention, planning, mental flexibility, and visual perception [34, 35]. It has a worldwide prevalence of 0.6–2% [36] and is often comorbid with ADHD. They have great difficulty obtaining driver's licenses. When they do obtain licenses, they do so much later than their neurotypical counterparts. In most countries, gaining a driver's license represents increased independence and can lead to improved quality of life for individuals and their families [37].

A recent literature review by Lindsay [38] indicated that youth with ASD have face difficulties in obtaining a driver's license. They have difficulty with handling unexpected changes, sustaining attention for long drives, and merging into traffic and limited ability in reading facial expressions and gestures of other drivers. They also have issues with anxiety which manifest as poor driver confidence due to lower reaction time in changing situations. As a result, they avoid heavy traffic or highways or driving at night and have problems adhering to speed regulations and staying in their lanes.

These result in poor driving performance. They have an increased risk of accidents and have more driving hazards because they tend to delay in responding to social hazards requiring interaction with other road users. They are slow in perceiving and responding to social stimuli within the driving context [39]. Research shows that people on the autism spectrum are also at greater risk of being involved in motor vehicle accidents, which poses risks not only for them but also for other road users in the community [40].

They have atypical eye gaze patterns, e.g., they may be fixated on billboards or their speedometer when they are driving. They tend to have increased anxiety if other drivers deviate from road rules, and they focus on those events instead of managing their own vehicles.

They tend to have increased reaction times to changes in the driving environment and more tactical driving difficulties with more crashes, as they have poor situational awareness [41].

They require specific interventions to make them safer drivers. Useful strategies for teaching people with ASD to drive include direct communication, minimal verbal correction, encouraging coping mechanisms, breaking down tasks into smaller segments, and providing regular and consistent short-duration driving lessons. In many jurisdictions, there is an opportunity for clinicians and educators to advocate for further transportation-related training and supports for people with ASD [38]. They also require regular and consistent driving lessons over a longer period of time to achieve the level of skill required to acquire a license.

Many countries currently have no autism-specific licensing requirements for learner drivers, and there is a general lack of ASD-specific support and training packages for individuals, their families, and driving instructors [39]. At a minimum, it is important to identify treatable comorbid conditions like ADHD and anxiety in these individuals to assist in making them safer drivers.

5. Mild cognitive impairment and dementia

It is estimated (2016) that there are 5.4 million individuals in the United States with dementia. It is projected that by 2050 there will be 13.8 million people with dementia in the United States [42]. There is a public health concern that many with mild cognitive impairment and dementia continue to drive, in spite of the deficits associated with these conditions. These include memory impairment, poor decision-making, poor problem-solving skills, impaired insight and judgment, difficulties with hand-eye coordination, reduced reaction time, visual attention deficits, and decreased visual spatial abilities [43]. Clinicians are often wary of advising these patients to stop driving because of the negative impact this will have on their autonomy and on the doctor-patient relationship [44]. These concerns contribute to under-reporting of patients to the appropriate transportation authorities in jurisdictions with mandatory reporting requirements [45].

Recent cross-sectional study on women's health revealed at 60% of older women with a mean age of 84 years with mild cognitive impairment and 40% with dementia were still driving at the time of assessment [46].

Hird et al. [47] reported that patients with very mild Alzheimer's disease (CDR-0.5) and mild Alzheimer's disease (CDR-1.0) were more likely to fail on-road tests than healthy control drivers (CDR-0.0) with failure rates of 13.6, 33.3, and 1.6%, respectively.

Chee et al. [48] reported that there is still a great deal of work to be done in determining the absolute and relative risk of motor vehicle collisions or driving impairment in patients with mild cognitive impairment and Alzheimer's disease.

Screening instruments that are currently used to evaluate cognitive functioning are unable to distinguish between patients who should be referred to specialized driving centers for assessment. It is also difficult to accurately assess recommendations on caregiver's opinion of driving performance and fitness to drive in the elderly [49].

More on-road assessment studies in older adults with dementia are needed to enhance confidence in on-road assessment prediction to find common ground to define the severity of dementia.

Motor vehicle collision data may play a more important role in mild cognitive impairment and preclinical dementia, as these diagnoses become more commonplace among the elderly who continue to drive. A clinically useful evidence-based algorithm for predicting safe driving among patients with mild stages of dementia remains elusive [50, 51].

Clinically, driving behaviors such as problems identifying landmarks or signs, lost trips, not wearing a seatbelt, less freeway driving, and closer to home and daylight driving may all be red flags suggesting that an elderly person may have worsening cognitive function and probably should not be driving. Additionally, assessment of activities of daily living (ADLs) may be a predictor of one's ability to drive based on a broader assessment of functional capacity [52].

At earlier stages of cognitive decline, drivers are often less familiar with their personal limitations and may take more risks. Earlier assessment and interventions with driving ability have a greater potential to improve driving safety more effectively or, alternately, offer guidance on the timeliness of decisions regarding driving cessation, which are often difficult for healthcare providers, patients, and families alike.

There may also be a role for technology, e.g., instrumented vehicles, GPS tracking, and other data sensors which may provide interesting solutions to carefully study the longitudinal deterioration in driving ability of patients with dementia [53–55].

6. Summary

This review of common neurocognitive disorders that have an impact on driving raises questions about the application of the current state of knowledge to rules, regulations, and laws governing the operation of motor vehicles in most jurisdictions.

The paradox is that in many jurisdictions applicants for drivers' licenses have to declare whether they have epilepsy, which has a worldwide prevalence of 0.6% [56].

The disorders discussed in this chapter are much more prevalent and together are greater source of danger for drivers, both private and commercial and other road users.

Attention deficit hyperactivity disorder (ADHD), learning disabilities (LD), autism spectrum disorder (ASD), and dementia are all conditions for which simple validated screening tools are available. There is therefore a need to create capacity and knowledge within licensing and regulatory agencies, in collaboration with mental health professionals to ensure that individuals diagnosed with treatable conditions receive treatment for their own well-being and also for the safety of the public.

These conditions together with others that may not have been covered in this chapter constitute a significant public health concern and need to be addressed holistically within most jurisdictions to improve the safety of the driving public and pedestrians as well.

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