



# **Opinions of Expert Panel**

## **Parkinson's Disease, Multiple Sclerosis, and Commercial Motor Vehicle Driver Safety**

### **Medical Expert Panel Members**

Garson Caruso, MD, MPH

Jeffrey Dawson, ScD

John DeLuca, PhD, ABPP

Thomas Marcotte, PhD

Matthew Rizzo, MD

Presented to

**Federal Motor Carrier Safety Administration**

**September, 2009**

## Table of Contents

Introduction .....	1
Guideline Development Medical Expert Panel .....	1
Methodology.....	1
Brief Overview of Evidence Report Methodology .....	1
The Medical Expert Panel Meeting and Opinion Formulation .....	2
Opinions of Parkinson’s Disease and Multiple Sclerosis Medical Expert Panel.....	2
Opinion 1: Parkinson’s Disease and CMV Driver Certification.....	2
Opinion 2: Multiple Sclerosis and CMV Driver Certification .....	5
Opinion 3: Fitness to Drive Framework .....	7
References .....	10
APPENDIX A: Findings of Evidence Report.....	12
Identification of Evidence Bases .....	12
Grading the Strength of Evidence .....	12
Analytic Methods .....	13
Presentation of Findings .....	13
Evidence-Based Conclusions .....	13
Key Question 1: What criteria define when an individual with Parkinson’s disease (PD) should stop driving a CMV? .....	13
Key Question 2: What is the impact of pharmacotherapy for PD on driver safety? .....	14
Key Question 3: Are individuals with multiple sclerosis (MS) at an increased risk of motor vehicle crash? .....	15
Key Question 4: What factors associated with MS are predictive of an increased crash risk? .....	15
Key Question 5: How frequently should an individual with MS be assessed in order to monitor whether they remain safe to drive? .....	16
Key Question 6: What is the impact of pharmacotherapy for MS on driver safety? .....	16

## Introduction

The primary mission of the U.S. Department of Transportation's (DOT's) Federal Motor Carrier Safety Administration (FMCSA) is to reduce crashes, injuries and fatalities involving commercial motor vehicles (CMV), including large trucks and buses. One mechanism used to facilitate this effort is the updating of current, and the development of new, medical fitness standards and guidelines for medical examiners who are responsible for certifying drivers as fit for duty. FMCSA is committed to review and begin updating all of their current standards and guidelines by 2009.

This report serves the purpose of summarizing the considerations and opinions of a panel of five experts in the fields of Parkinson's disease (PD), multiple sclerosis (MS), and occupational medicine (henceforth termed the Medical Expert Panel) who examined FMCSA's current standards and guidelines for medical examiners pertaining to PD, MS, and CMV driver safety.

## Guideline Development Medical Expert Panel

Members of the Medical Expert Panel (MEP) charged with making opinions pertaining to whether the current standards and guidelines for PD and MS need to be updated are listed in Table 1.

**Table 1. Members of the Medical Expert Panel**

Name	Current Position
Garson Caruso, MD, MPH	Occupational Medicine Physician Private Practice Sebring, FL
Jeffrey Dawson, ScD	Professor Department of Biostatistics University of Iowa, College of Public Health
John DeLuca, PhD, ABPP	Vice President for Research Kessler Foundation Research Center West Orange, NJ
Thomas Marcotte, PhD	Associate Professor Department of Psychiatry University of California, San Diego
Matthew Rizzo, MD	Professor Department of Neurology University of Iowa, Carver College of Medicine

## Methodology

### Brief Overview of Evidence Report Methodology

The opinions contained in this report are based in part upon the interpretation and assimilation of information presented in a comprehensive systematic review of available literature, prepared by ECRI Institute and Manila, and presented to the Medical Expert Panel on May 28, 2009. This evidence report titled, "Parkinson's Disease, Multiple Sclerosis, and Commercial Motor Vehicle Driver Safety," was

developed following a systematic literature search for evidence accessible from several electronic databases. These databases included (but were not limited to) Medline, PubMed (pre Medline), EMBASE, PSYCHInfo, CINAHL, TRIS, and the Cochrane Library. Additional hand searches of the published literature (i.e., bibliographies of identified relevant articles), and “gray literature” resources (e.g., Web searches) were also performed. Data obtained from these searches were screened against a set of a priori inclusion criteria. The findings of this evidence report are summarized in the report’s executive summary that can be found in Appendix A.

## **The Medical Expert Panel Meeting and Opinion Formulation**

On May 28<sup>th</sup>, 2009, FMCSA, Manila Consulting, the ECRI Institute, and the five members of the PD and MS Medical Expert Panel convened a one-day meeting. The purpose of this meeting was several-fold:

- To review existing standards and guidelines for medical examiners pertaining to the certification and recertification of individuals with PD or MS as physically qualified to drive a CMV for the purposes of interstate commerce.
- To discuss the available evidence contained in the Evidence Report and other sources pertaining to the consequences to public safety associated with allowing individuals with PD or MS to drive a CMV.
- To provide expert opinion regarding changes to the existing FMCSA guidelines which are deemed necessary following the critical assessment of the available evidence.

This document reflects a summary of the one day meeting.

## **Opinions of Parkinson’s Disease and Multiple Sclerosis Medical Expert Panel**

It is the opinion of the MEP that current standards and guidance to those who certify drivers as physically qualified to drive a CMV for the purposes of interstate commerce are inadequate. Consequently, the MEP made several suggestions for improvement. Each suggestion was based on their current understanding of available information. Below we present the MEP opinions and provide justification for each.

### **Opinion 1: Parkinson’s Disease and CMV Driver Certification**

**It is the opinion of the MEP that a diagnosis of PD precludes an individual from obtaining unconditional certification to drive a CMV for the purposes of interstate commerce.**

**A diagnosis of PD, however, should not exclude all individuals with the disorder from driving a CMV; certification may be possible in some instances. An individual with a diagnosis of PD may be considered for certification to drive a CMV if that individual meets the following criteria, based upon an evaluation by a qualified specialist(s) (e.g., neurologist, movement disorders specialist, neuropsychologist, as appropriate depending upon the signs and symptoms of the individual being evaluated):**

- Shows mild symptoms only, as indicated by a Hoehn and Yahr Stage 1 or less and a high score (90% or higher) on the Schwab and England Activities of Daily Living Scale;
- Tolerates medications well, without cognitive, motor, or other side effects that might affect driving;
- Shows no significant fluctuations in motor response or “on-off” effects (i.e., sudden fluctuations in disability involving rapid and abrupt alterations between periods of good mobility and periods of hypokinesia, tremor, and dyskinesia);
- Demonstrates satisfactory functioning on a battery of tests assessing key cognitive functions important for safely driving a motor vehicle (e.g., processing speed, attention, perception, memory, executive functions, and emotion). Satisfactory functioning should be defined as performing within or above the normal range using test norms that adjust for relevant factors, such as age and education;
- Shows no evidence of a mood disorder or satisfactory control of an existing mood disorder (see psychiatric disorders MEP report)<sup>1</sup>;
- Provides written documentation of the specialist’s report at the time of the CMV medical evaluation.
  - The medical examiner form should be updated by adding a place to indicate that the applicant has been referred to a specialist who has documented the individual’s condition relevant to safely operating a motor vehicle.

An individual with PD who meets the criteria for certification above should be reevaluated on a semi-annual basis by their neurologist or other qualified specialist, and obtain an annual neuropsychological evaluation.

The choice of a qualified specialist should be based on the judgment of the medical examiner in the context of the complexity of the examinee’s case (with consideration of such factors as illness severity, symptomatology, duration, stability over time, and interventions such as medications required for management) and the available resources, with general preference given to more highly trained and experienced consultants.

**Justification:**

PD is a neurological disorder that is chronic, progressive, neurodegenerative, and associated with a loss of dopaminergic nigrostriatal neurons. Symptoms include tremors of the hands, arms, legs or jaw; a distinctive gait; muscle stiffness of the limbs and trunk; unusual slowness of movement (bradykinesia); stooped posture and postural instability; falling or jerking uncontrollably; impaired balance and coordination; rigidity; and dementia. All of these symptoms have the potential to adversely affect driving ability.

As indicated in the evidence report, there is preliminary evidence that cognitive and/or motor impairments associated with PD may result in increased crash risk. Meindorfner et al. (2005) conducted a survey study evaluating outcomes of sudden onset of sleepiness and driving behavior and found that

disease severity, sleepiness, and driving exposure were significantly associated with crash. Another study compared crash rates of patients with PD by Hoehn and Yahr (H&Y) Stage to the crash rate of health controls (Dubinsky et al., 1991). They found that subgroups of patients with H&Y Stages 2 and 3 showed a significantly increased crash risk compared to control individuals without PD. No evidence of increased crash risk was found among patients in H&Y Stage 1. A third study evaluated outcomes in driving patterns among individuals with PD and found that individuals with movement restriction had a significantly increased crash risk compared to individuals without movement restriction (Adler et al., 2000).

An additional 12 studies evaluated outcomes that are indirectly associated with crash risk among non-CMV drivers with PD (Devos et al., 2007; Heikkila et al., 1998; Hobson et al., 2002; Singh et al., 2007; Stolwyk et al., 2006; Stolwyk et al., 2005; Uc et al., 2007; Uc et al., 2006a; Uc et al., 2006b; Wood et al., 2005; Worringham, 2005; Zesiewicz et al., 2002). These studies identified certain risk factors that predicted falling asleep while driving, driving test failure, or decreased performance of specific driving tasks among individuals with PD. These risk factors and associated outcomes are presented in Table 2.

**Table 2. Predictors of Indirect Outcomes of Crash Risk**

Indirect Outcomes	Significant Predictors
Falling asleep while driving	Epworth Sleepiness Scale Inappropriate Sleep Composite Score
Driving fitness	Disease duration Contrast sensitivity Cognitive function Motor function
Driving suitability	Disease stage Car test score Reaction time to brake
On-road testing performance	Visual processing speed and attention Non-verbal memory Familiarity Ability to switch attention between competing tasks Levodopa dosage Age Perception
Simulator testing performance	H&Y stage Trail Making Test- substest A and B Symbol Digit Modalities Test Judgment of Line Orientation Test Brixton Test Weschler Adult Intelligence Scale-III of visual attention measurement Block Design Age Mini Mental Status Exam

However, there is also preliminary evidence that a subset of individuals without such impairments may be able to operate motor vehicles safely. For example, two of the studies included in the evidence report found no evidence of increased crash risk (actual and simulator crashes) among patients in H&Y Stage 1 compared to control individuals without PD (Dubinsky et al., 1991; Zesiewicz et al., 2002).

Therefore, the MEP believes that individuals with PD, who are not experiencing symptoms severe enough to adversely affect driving, should be permitted to drive. This evaluation of symptoms should be conducted by a qualified specialist (e.g., neurologist, movement disorders specialist, neuropsychologist, as appropriate) and should assess for disease associated symptoms which may adversely affect driving ability (following the criteria listed above).

An individual with PD meets the criteria listed above and receives certification, should be reevaluated on a semi-annual basis by their neurologist and receive a neuropsychological evaluation, annually. These time frames are based on clinical experience regarding the natural progression of the disease.

## **Opinion 2: Multiple Sclerosis and CMV Driver Certification**

**It is the opinion of the MEP that a diagnosis of MS precludes an individual from obtaining unconditional certification to drive a CMV for purposes of interstate commerce.**

**A diagnosis of MS, however, should not exclude all individuals with the disorder from driving a CMV; certification may be possible in some instances. An individual with a diagnosis of MS may be considered for certification to drive a CMV if that individual meets the following criteria, based upon an evaluation by a qualified specialist(s) (e.g., neurologist, MS specialist, neuropsychologist, ophthalmologist, occupational therapist, as appropriate depending upon the signs and symptoms of the individual being evaluated):**

- **Shows no signs of relapse or progression;**
- **Tolerates medications well, without cognitive, motor, or other side effects that might affect driving;**
- **Has satisfactory vision including acuity, fields, and ocular alignment (see vision MEP report)<sup>2</sup>;**
- **Demonstrates satisfactory cognitive functioning based upon a standardized neuropsychological test battery assessing key domains important for safely driving a motor vehicle (e.g., processing speed, executive functioning, attention, perception, memory and emotion). Satisfactory functioning should be defined as performing within or above the normal range using test norms that adjust for relevant factors, such as age and education;**
- **Shows no evidence of a mood disorder or satisfactory control of an existing mood disorder (see psychiatric disorders MEP report)<sup>1</sup>;**
- **Shows satisfactory motor function and mobility (see musculoskeletal MEP report)<sup>3</sup>;**
- **Has no history of excessive fatigability or periodic fluctuations of motor performance, as in relation to heat, physical and emotional stress, and infections.**

- **Provides written documentation of the specialist’s report at the time of their medical examination.**
  - **The medical examiner form should be updated by adding a place to indicate that the applicant has been referred to a specialist who has assessed the individual’s condition relevant to safely operating a motor vehicle.**

**An individual with MS who meets the criteria for certification above, should be reevaluated on a semi-annual basis by a neurologist or other qualified specialist, and obtain an annual neuropsychological evaluation.**

**The choice of a qualified specialist should be based on the judgment of the medical examiner in the context of the complexity of the examinee’s case (with consideration of such factors as illness severity, symptomatology, duration, stability over time, and interventions such as medications required for management) and the available resources, with general preference given to more highly trained and experienced consultants.**

**Justification:**

MS is a chronic progressive neurological disorder resulting in the inflammation and damage to myelin and other cells within the central nervous system. MS can affect many areas of the brain, optic nerve, or spinal cord and can cause a wide range of neurological symptoms. The disorder may frequently manifest in varying degrees of paresis and spasticity, visual blurring, sensory disturbances, diplopia, ataxia, fatigue, vertigo, paroxysmal attacks, cognitive dysfunction, and mood—any of which may impair driving. Cognitive impairment alone occurs in about half of all individuals diagnosed with MS and has been shown to affect attention and visual perceptual skills, information processing speed, and executive function (Hirtz et al., 2007; National Multiple Sclerosis Society, 2005).

As indicated in the evidence report, there is preliminary evidence that cognitive and/or motor impairments associated with MS may result in increased crash risk. Two cohort studies have been conducted evaluating outcomes directly associated with crash risk among non-CMV drivers with MS (Lings, 2002; Schultheis et al., 2002). In one of these studies, a subgroup of MS patients with cognitive impairment showed significantly increased crash risk compared to control individuals without MS, whereas a subgroup of MS patients without cognitive impairment did not show significantly increased crash risk compared to controls.

The degree to which individuals with MS experience symptoms, however, is highly variable. Disease progression is often characterized by periods of partial and sometimes complete recovery. Therefore, the MEP believes that individuals with MS, who are not experiencing symptoms severe enough to adversely affect driving, should be permitted to drive. This evaluation of symptoms should be conducted by a qualified specialist (e.g., neurologist, MS specialist, neuropsychologist, ophthalmologist, occupational therapist, as appropriate) and should assess for disease associated symptoms which may adversely affect driving ability (following the criteria listed above).

If an individual with MS meets the criteria listed above and receives certification, they should be reevaluated on a semi-annual basis by their neurologist and receive a neuropsychological evaluation, annually. These time frames are based on clinical experience regarding the natural progression of the disease.

### **Opinion 3: Fitness to Drive Framework**

**The MEP strongly believes that FMCSA should adopt a general framework for determining fitness to drive a CMV that relies upon a “functional” evaluation of multiple domains (cognitive, motor, perceptual, psychiatric) that are important for safe driving. Such a framework could be applied across many diseases/conditions, including conditions that have rarely been studied with respect to CMV driving.**

**It is envisioned that this framework would serve as a functional “screen” which would comprise elements of cognitive, psychomotor, and psychiatric function. It would be designed to screen for both primary effects of illness (e.g., cognitive dysfunction) and effects of medications (e.g., sedation) and illness-medication interactions. Examples include:**

- **Cognitive: processing speed, attention, perception, memory, executive functions, and emotion;**
- **Psychomotor: heel-to-toe walking, rapid alternating movement, and measures of perseveration for psychomotor function;**
- **Psychiatric: Patient Health Questionnaire (PHQ) or PHQ-2 for depression, among others**

**The screen would be administered by the medical examiner, based on the obtained medical and psychological history, and used as an additional guide for referral. Two key elements of this approach are validity of each element of screening and practicality. In the former context, the screen would need to comprise validated testing measures and not be easily defeatable by examinees. In the latter context, the evaluation would need to be easily teachable to medical examiners (e.g., through the National Registry process) and relatively quickly and effectively administered during the certification examination.**

**The MEP suggest revisiting evidence reports on other conditions (e.g., stroke, diabetes, TBI, etc.) and pooling these data to examine the predictive value of various factors (e.g., cognitive, motor, medication, etc.) in determining ability to drive safely and crash risk.**

#### **Justification:**

Many individuals have diseases/conditions that have never been studied in relation to driving, including CMV operation. Medical providers are often called upon to make judgments on whether or not these individuals remain fit to drive. A general framework that focuses on a “functional” evaluation of the multiple domains required for safe driving (cognitive, motor, perceptual, psychiatric) would be useful to

practitioners, because it could be applied across many diseases/conditions, including those that have rarely if ever been studied with respect to CMV driving.

One approach for establishing this framework would be to revisit the final evidence reports based on disease/condition and examine the commonalities, particularly with regard to the functional domains necessary for safe driving. When possible, we also suggest that the data related to functional domains be pooled across multiple diseases and meta-analyses conducted to examine the predictive value of various factors in determining the ability to drive safely and risk for crash.

It would be useful to develop a brief cognitive screening tool for use in the CMV driver medical exam, to identify drivers who may need more detailed assessment by a neuropsychologist. Driver self-report of cognitive abilities alone is not sufficient for this purpose.

---

<sup>1</sup> The Psychiatric MEP provided the following opinions regarding individuals with mood disorders: 'All individuals with a history of [mood disorders] should undergo additional medical and psychiatric evaluation to further assess functional ability before being considered qualified to drive a CMV. Such individuals must demonstrate that they are likely to be able to perform their normal duties by undergoing a thorough evaluation of physical and mental function by a qualified psychiatrist.' The Psychiatric MEP also proposed that the two question version of the Patient Health Questionnaire (PHQ) be added to the medical examination questionnaire to assist medical examiners in screening for depression. If the PHQ-2 is positive for a possible significant depressive disorder, it is proposed that the medical examiner refer the patient to a psychiatrist to conduct an interview for major depression, including suicidal ideation and/or attempt.

<sup>2</sup> The vision MEP upheld FMCSA's current standards and guidelines for visual disorders with the exception of visual field loss. The MEP recommended that the standard should be restated and the minimal field possibly modified. They stated that the current standard of 70 degrees *may be* adequate; whether this needs a modification, and what that modification should be, has yet to be determined. They also stated that the method(s) of visual field testing should be clarified. The confrontational test may be considered acceptable except in situations where the examinee has a history of visual disorders. Specifically:

- If the examinee has a history of visual disorders such as glaucoma, another test must be used to determine visual field loss.
- If the examinee fails the confrontational test, another test must be used to determine visual field loss.
- Which test to determine visual field loss for individuals who fail the confrontational test or have a history of visual disorders has not been determined by the MEP.

<sup>3</sup> The musculoskeletal MEP expressed the opinion that the current FMCSA standards for musculoskeletal disorders are too general and should be altered. With regards to functional tests of capacity/fitness for duty testing, the MEP recommended that FMCSA utilize trained driving testers to perform functional capacity examinations of CMV drivers under the premise that there must be a minimum level of musculoskeletal disorder capability required to safely operate a CMV. Specifically, the MEP made the following recommendations:

- A functional capacity evaluation would be required of any individual with an episodic and/or potentially progressive musculoskeletal disorder who had required evaluation and/or treatment by a physician/health care provider for their particular disorder in the prior 12 months.
- This functional examination of musculoskeletal capacity should take place every two years, regardless of type or severity of impairment.
  - If there is a significant confounding medical problem, exacerbation, progression, or new symptoms that require evaluation and/or treatment, re-examination may need to be done sooner.
- A thorough assessment, including a functional driving test and testing of ability to perform pre-trip and en route vehicular safety checks, dictated by the type of impairment, should be performed by trained driving testers to determine whether the individual in question should be allowed to operate a commercial CMV.
  - The tests would not need to be administered by a medical examiner. Instead, they may be administered by a physician or others as approved by the FMCSA.
  - The tests need to be sensitive and specific to the disorder.

- 
- It should be required that individuals who undergo the assessment do so in the CMV they intend to operate, using whatever adaptive equipment required to operate said CMV.
  - If the examination is comprehensive (includes 100% of all safety skills), and the individual passes the examination using their adaptive equipment, in the vehicle they intend to operate, then that individual has satisfied the requirements.
  - A restriction should be instituted requiring the individual to use their adaptive equipment when operating a CMV. This restriction would operate in much the same way as the requirement for private motor vehicle operators to wear corrective lenses while driving to address visual disorders such as myopia.

Given that a functional capacity test to determine whether an individual is physically qualified to operate a CMV does not currently exist, the musculoskeletal MEP provided additional recommendations regarding the development of a functional screening protocol (see full Opinions Report for further details).

Finally the musculoskeletal MEP recommended that an individual with a musculoskeletal disorder should be allowed to drive provided they pass the functional capacity testing. Further, they stated that the CMV operator with an episodic and/or progressive condition and/or impairment should be responsible for identifying an exacerbation and disease residuals and planning their driving accordingly.

## References

- Adler G, Rottunda S, Bauer M, Kuskowski M. The older driver with Parkinson's disease. *J Gerontol Soc Work* 2000;34(2):39-49.
- Devos H, Vandenberghe W, Nieuwboer A, Tant M, Baten G, De Weerd W. Predictors of fitness to drive in people with Parkinson disease. *Neurology* 2007 Oct 2;69(14):1434-41.
- Dubinsky RM, Gray C, Husted D, Busenbark K, Vetere-Overfield B, Wiltfong D, Parrish D, Koller WC. Driving in Parkinson's disease. *Neurology* 1991 Apr;41(4):517-20.
- Heikkila VM, Turkka J, Korpelainen J, Kallanranta T, Summala H. Decreased driving ability in people with Parkinson's disease. *J Neurol Neurosurg Psychiatry* 1998 Mar;64(3):325-30.
- Hirtz D, Thurman DJ, Gwinn-Hardy K, Mohamed M, Chaudhuri AR, Zalutsky R. How common are the 'common' neurologic disorders. *Neurology* 2007 Jan 30;68(5):326-37.
- Hobson DE, Lang AE, Martin WR, Razmy A, Rivest J, Fleming J. Excessive daytime sleepiness and sudden-onset sleep in Parkinson disease: a survey by the Canadian Movement Disorders Group. *JAMA* 2002 Jan 23-30;287(4):455-63.
- Lings S. Driving accident frequency increased in patients with multiple sclerosis. *Acta Neurol Scand* 2002;105(3):169-73.
- Meindorfner C, Korner Y, Moller JC, Stiasny-Kolster K, Oertel WH, Kruger HP. Driving in Parkinson's disease: mobility, accidents, and sudden onset of sleep at the wheel. *Mov Disord* 2005 Jul;20(7):832-42.
- National Multiple Sclerosis Society. National MS Society information sourcebook: epidemiology. New York (NY): National Multiple Sclerosis Society; 2005 Oct. 3 p. Also available: <http://www.nationalmssociety.org/docs/HOM/epidemiology.pdf>.
- Schultheis MT, Garay E, Millis SR, Deluca J. Motor vehicle crashes and violations among drivers with multiple sclerosis. *Arch Phys Med Rehabil* 2002 Aug;83(8):1175-8.
- Singh R, Pentland B, Hunter J, Provan F. Parkinson's disease and driving ability. *J Neurol Neurosurg Psychiatry* 2007 Apr;78(4):363-6.
- Stolwyk RJ, Charlton JL, Triggs TJ, Iansek R, Bradshaw JL. Neuropsychological function and driving ability in people with Parkinson's disease. *J Clin Exp Neuropsychol* 2006 Aug;28(6):898-913.
- Stolwyk RJ, Triggs TJ, Charlton JL, Iansek R, Bradshaw JL. Impact of internal versus external cueing on driving performance in people with Parkinson's disease. *Mov Disord* 2005 Jul;20(7):846-57.
- Uc EY, Rizzo M, Anderson SW, Sparks JD, Rodnitzky RL, Dawson JD. Impaired navigation in drivers with Parkinson's disease. *Brain* 2007 Sep;130(Pt 9):2433-40.

Uc EY, Rizzo M, Anderson SW, Sparks JD, Rodnitzky RL, Dawson JD. Driving with distraction in Parkinson disease. *Neurology* 2006a Nov 28;67(10):1774-80.

Uc EY, Rizzo M, Anderson SW, Sparks J, Rodnitzky RL, Dawson JD. Impaired visual search in drivers with Parkinson's disease. *Ann Neurol* 2006b Oct;60(4):407-13.

Wood JM, Worringham C, Kerr G, Mallon K, Silburn P. Quantitative assessment of driving performance in Parkinson's disease [erratum appears in *J Neurol Neurosurg Psychiatry*. 2005 Mar;76(3):458]. *J Neurol Neurosurg Psychiatry* 2005 Feb;76(2):176-80.

Worringham CJ, Wood JM, Kerr GK, Silburn PA. Predictors of driving assessment outcome in Parkinson's disease. *Mov Disord* 2006 Feb;21(2):230-5.

Zesiewicz TA, Cimino CR, Malek AR, Gardner N, Leaverton PL, Dunne PB, Hauser RA. Driving safety in Parkinson's disease. *Neurology* 2002 Dec 10;59(11):1787-8.

## APPENDIX A: Findings of Evidence Report

This appendix summarizes the findings of the Evidence Report titled, “Parkinson’s Disease, Multiple Sclerosis, and Commercial Motor Vehicle Safety.” The purpose of this evidence report was to address several key questions posed by Federal Motor Carrier Safety Administration. Each of these key questions was developed by FMCSA such that the answers to these questions provided information that the Agency believed would be useful in updating their current medical examination guidelines. The six key questions addressed in the evidence report were:

Key Question 1: What are the criteria that define when an individual with Parkinson’s disease (PD) should stop driving a CMV?

Key Question 2: What is the impact of pharmacotherapy for PD on driver safety?

Key Question 3: Are individuals with multiple sclerosis (MS) at an increased risk for a motor vehicle crash?

Key Question 4: What factors associated with MS are predictive of an increased crash risk?

Key Question 5: How frequently should individuals with MS be assessed in order to monitor whether they remain safe to drive?

Key Question 6: What is the impact of pharmacotherapy for MS on driver safety?

### Identification of Evidence Bases

Separate evidence bases for each of the key questions addressed by the evidence report were identified using a process consisting of a comprehensive search of the literature, examination of abstracts of identified studies in order to determine which articles would be retrieved, and the selection of the actual articles that would be included in each evidence base.

A total of seven electronic databases (MEDLINE, PubMed (preMEDLINE), EMBASE, PSYCH Info, CINAHL, TRIS, the Cochrane library) were searched through April 23, 2008. In addition, we examined the reference lists of all obtained articles with the aim of identifying relevant articles not identified by our electronic searches. Hand searches of the “gray literature” were also performed. Admission of an article into an evidence base was determined by formal retrieval and inclusion criteria that were determined *a priori*.

### Grading the Strength of Evidence

Our assessment of the quality of the evidence took into account not only the quality of the individual studies that compose the evidence base for each key question; we also considered the interplay between the quality, quantity, robustness, and consistency of the overall body of evidence.

## Analytic Methods

The set of analytic techniques used in the evidence report was extensive. Random-effects meta-analyses were used to pool data from different studies. Differences in the findings of studies (heterogeneity) were identified using the Q-statistic and  $I^2$ . Sensitivity analyses, aimed at testing the robustness of our findings, included the use of cumulative random-effects meta-analysis.

## Presentation of Findings

In presenting our findings, we made a clear distinction between qualitative and quantitative conclusions and we assigned a separate “strength of evidence” rating to each conclusion format. The strength of evidence ratings assigned to these different types of conclusion are defined in Table 3.

**Table 3. Strength of Evidence Ratings for Qualitative and Quantitative Conclusions**

Strength of Evidence	Interpretation
<b>Qualitative Conclusion</b>	
Strong	Evidence supporting the qualitative conclusion is convincing. It is highly unlikely that new evidence will lead to a change in this conclusion.
Moderate	Evidence supporting the qualitative conclusion is somewhat convincing. There is a small chance that new evidence will overturn or strengthen our conclusion. ECRI Institute recommends regular monitoring of the relevant literature for moderate-strength conclusions.
Minimally acceptable	Although some evidence exists to support the qualitative conclusion, this evidence is tentative and perishable. There is a reasonable chance that new evidence will either overturn or strengthen our conclusions. ECRI Institute recommends frequent monitoring of the relevant literature.
Insufficient	Although some evidence exists, the evidence is insufficient to warrant drawing an evidence-based conclusion. ECRI Institute recommends frequent monitoring of the relevant literature.
<b>Quantitative Conclusion (Stability of Effect Size Estimate)</b>	
High	The estimate of treatment effect in the conclusion is stable. It is highly unlikely that the magnitude of this estimate will change substantially as a result of the publication of new evidence.
Moderate	The estimate of treatment effect the conclusion is somewhat stable. There is a small chance that the magnitude of this estimate will change substantially as a result of the publication of new evidence. ECRI Institute recommends regular monitoring of the relevant literature.
Low	The estimate of treatment effect included in the conclusion is likely to be unstable. There is a reasonable chance that the magnitude of this estimate will change substantially as a result of the publication of new evidence. ECRI Institute recommends frequent monitoring of the relevant literature.
Unstable	Estimates of the treatment effect are too unstable to allow a quantitative conclusion to be drawn at this time. ECRI Institute recommends frequent monitoring of the relevant literature.

## Evidence-Based Conclusions

### Key Question 1: What criteria define when an individual with Parkinson’s disease (PD) should stop driving a CMV?

**The evidence is insufficient to determine with precision what risk factors or combination of risk factors truly defines when an individual with PD should stop driving. However, potential risk factors include movement restriction/decreased motor function, stage of PD, duration of PD, decreased cognitive function, and sudden onset of sleepiness (Strength of Evidence: Minimally Acceptable).**

*Direct Evidence – Crash Studies: Three studies in non-CMV driver populations provided direct evidence to address this question. One low-quality case-control study found that subgroups of patients with Hoehn*

and Yahr (H&Y) stages 2 and 3 showed a significantly increased crash risk compared to control individuals without PD ( $p = 0.001$ ,  $p = 0.008$ ). No evidence of increased crash risk was found among patients in H&Y Stage 1. A low-quality cohort study evaluating outcomes in driving patterns among individuals with PD found that individuals with movement restriction had a significantly increased crash risk compared to individuals without movement restriction ( $p = 0.034$ ). One low-quality survey study evaluating outcomes of sudden onset of sleepiness and driving behavior found that disease severity, sleepiness, and driving exposure showed a significant association with crash prediction. However, these findings need to be replicated before a definitive conclusion can be reached. Limitations of the evidence supporting this conclusion are the small size of the evidence base (three studies) and overall low quality.

Indirect Evidence – Studies of Driving Tests and Driving Simulation: Six cohort studies (four moderate-quality, two low-quality) evaluated outcomes indirectly associated with crash risk among non-CMV drivers with PD. One study showed a significant association of Epworth Sleepiness Scale scores and Inappropriate Sleep Composite Scores with risk of falling asleep while driving ( $p < 0.001$ ). Two studies' multivariate assessment of driving fitness showed a significant difference in factors (disease duration, contrast sensitivity, cognitive function, and motor function) associated with PD individuals who failed a driving assessment compared to individuals passing a driving assessment. However, predicting which individuals will pass or fail a driving assessment is not the same as predicting which individuals who pass a driving assessment will have an increased crash risk. Whether the variables identified in these two studies can predict which patients with PD who pass a driving assessment are at increased risk of crash remains to be determined. Another study identified disease stage, car test score, and reaction time to brake as predictors of driving suitability using stepwise discriminant analysis. Of the remaining two studies, one assessed stage of PD related to driving simulator crash and showed a significant increase in simulator crash correlated with increasing H& Y stage ( $p = 0.006$ ). The other study identified various neuropsychological measures as variables correlating with performance measures on a driving simulator. However, the possibility exists that some of these variables might not have remained significantly correlated with driving performance had a multivariate analysis been performed. The findings of the four studies that used multivariate assessment or discriminant function analysis for predicting driving performance should be given greater consideration than the studies that did not, as these studies attempt to isolate the true predictability of the associated risk factors evaluated within the studies.

We were not able to assess the crash risk for PD among CMV drivers. The lack of studies enrolling CMV drivers with PD precludes one from determining whether CMV drivers with this condition are at an increased risk for a motor vehicle crash.

### **Key Question 2: What is the impact of pharmacotherapy for PD on driver safety?**

**Evidence suggests that somnolence (sleepiness) associated with pharmacotherapy in individuals with PD may affect driver safety. (Strength of Evidence: Minimally Acceptable) Whether measures of somnolence among individuals with PD taking pharmacotherapy can predict actual crash risk cannot be determined from currently available evidence.**

*Direct Evidence – Crash Studies:* No included studies provided direct evidence of crash risk with noncommercial drivers.

*Indirect Evidence – Studies of Driving Performance:* The three included studies (ranging from low to high quality) evaluated an indirect outcome (sleepiness) which may be associated with driver safety. The combined data from two randomized controlled trials found that individuals with PD given treatment tend to be at an increased risk of somnolence compared to those given placebo ( $p = 0.002$ ).

We were not able to assess the impact of pharmacotherapy for PD on driver safety among CMV drivers. The paucity of data from studies enrolling CMV drivers treated with PD pharmacotherapy precludes one from determining whether CMV drivers with this type of condition are at an increased risk for a motor vehicle crash.

### **Key Question 3: Are individuals with multiple sclerosis (MS) at an increased risk of motor vehicle crash?**

**Currently available evidence is insufficient to determine whether crash risk is increased among individuals with MS. However, the possibility that crash risk is increased among a subgroup of individuals with MS and an additional impairment cannot be ruled out.**

*Direct Evidence – Crash Studies:* Two moderate-quality cohort studies evaluated outcomes directly associated with crash risk among non-CMV drivers with MS. Although the summary effect size in both studies suggested increased crash risk among drivers with MS, the findings did not reach statistical significance in either study. However, in one of these studies a subgroup of MS patients with cognitive impairment showed significantly increased crash risk compared to control individuals without MS, whereas a subgroup of MS patients without cognitive impairment did not show significantly increased crash risk compared to controls. The individuals in this study had minimal or no physical limitations, so they were not in a severe stage of MS. This finding suggests that cognitive impairment caused by MS may be a more important predictor of crash risk than simply having MS. However, this finding needs to be replicated before a definitive conclusion can be reached. Limitation of the evidence supporting the conclusion includes small sample size (one study) and moderate quality.

*Indirect Evidence:* No included studies provided indirect evidence of crash risk with non-CMV drivers.

We were not able to assess the crash risk for MS among CMV drivers. The lack of studies enrolling CMV drivers with MS precludes one from determining whether CMV drivers with this condition are at an increased risk for a motor vehicle crash.

### **Key Question 4: What factors associated with MS are predictive of an increased crash risk?**

**The available evidence is insufficient to determine which factors may be predictive of increased crash risk among individuals with MS. However, the possibility that crash risk is increased among subgroups of individuals with MS and cognitive impairment cannot be ruled out.**

*Direct Evidence – Crash Study: One moderate-quality cohort study evaluated outcomes directly associated with crash risk among non-CMV drivers with MS. The individuals in this study had minimal or no physical limitations. A subgroup of MS patients with cognitive impairment showed significantly increased crash risk ( $p = 0.012$ ) compared to control individuals without MS, whereas a subgroup of MS patients without cognitive impairment did not show significantly increased crash risk compared to control ( $p = 0.887$ ). The results suggest that cognitive impairment caused by MS may be an important predictor of crash risk. However, this finding needs to be replicated before a definitive conclusion can be reached. Limitations of the evidence include small sample size (one study) and moderate study quality.*

*Indirect Evidence – Road Test and Driving Simulator Studies: Two moderate-quality cohort studies evaluated outcomes that may be indirectly associated with crash risk among non-CMV drivers with MS. One study found that MS drivers who failed a road test scored significantly worse ( $p < 0.05$ ) on 6 out of 23 cognitive tests compared to MS drivers who passed a road test. This study included patients with a wide spectrum of disease severity, ranging from independent mobility to wheelchair dependence. In the other study, assessment of Useful Field of Vision (UFOV) performance related to driving showed that a subgroup of MS patients with cognitive impairment had a significant increase in estimated crash risk ( $p < 0.01$ ) compared to control individuals without MS, whereas a subgroup of MS patients without cognitive impairment did not show a significant increase in estimated crash risk compared to the control group. Assessment of neurocognitive driving performance within the same study showed a significant increase in latency time scores for MS patients with cognitive impairment compared to MS patients without cognitive impairment and healthy controls. The errors subcategory did not show a significant difference among these three groups. The patients in this study had minimal or no physical limitations. Whether these findings have any relationship with actual crash risk remains uncertain. Limitations of this evidence include small sample size (two studies) and moderate study quality.*

*We were not able to assess the crash risk for MS among CMV drivers. The lack of studies enrolling CMV drivers with MS precludes one from determining whether CMV drivers with this condition are at an increased risk for a motor vehicle crash.*

#### **Key Question 5: How frequently should an individual with MS be assessed in order to monitor whether they remain safe to drive?**

**No evidence was identified regarding assessment time interval for monitoring driver safety in patients with MS. Therefore, no evidence-based conclusion is possible at the present time.**

*Our searches identified no potentially relevant articles that addressed this question.*

#### **Key Question 6: What is the impact of pharmacotherapy for MS on driver safety?**

**No evidence was identified concerning the relationship between MS pharmacotherapy and driver safety outcomes. Therefore, no evidence-based conclusion is possible at the present time.**

*Our searches identified no potentially relevant articles that addressed this question.*