The Safety of Driving a Commercial Motor Vehicle After a Stroke

Meheroz H. Rabadi, MD, MRCPI; Abiodun Akinwuntan, PhD; Philip Gorelick, MD, MPH, FACP

Background and Purpose—Current guidelines for commercial motor vehicle (CMV) drivers to return to driving after a TIA or stroke were last reviewed in 1988. Updated recommendations are presented based on recent evidence.

Methods—A 3-member medical expert panel chosen by the U.S. Department of Transportation’s Federal Motor Carrier Safety Administration used findings of systematic literature review up to January 2008 to provide updated recommendations for return to driving for CMV drivers after TIA or stroke.

Results—Evidence from the systematic review showed that TIA patients are at increased risk for stroke, and stroke patients are at increased risk for motor vehicle crash. Although no studies provide direct evidence of predictability of crash risk of CMV drivers using outcomes of neuropsychological assessments, there is evidence that certain neuropsychological tests can identify on-road driving performance after stroke.

Conclusions—The medical expert panel recommended driving cessation for 1 year after a TIA or stroke, and return to driving a CMV should be allowed only after successful completion of a comprehensive neurological evaluation, neuropsychological assessments, and on-road testing. (Stroke. 2010;41:2991-2996.)

Key Words: commercial motor vehicle ■ driving ■ guidelines ■ stroke

The primary mission of the U.S. Department of Transportation’s Federal Motor Carrier Safety Administration is to reduce crashes, injuries, and fatalities involving commercial motor vehicles (CMV), including large trucks and buses. One mechanism to facilitate this effort is to update current standards and guidelines and to develop new medical fitness standards and guidelines for medical examiners who are responsible for certifying drivers as fit for duty.

This report summarizes updated recommendations of a panel of 3 experts in the field of stroke medicine (henceforth termed the medical expert panel) based on an extensive review of current literature.1 Until this time, Federal Motor Carrier Safety Administration’s physical qualification standards and guidelines for medical examiners to determine fitness to drive after stroke and TIA were last formulated in 1988 and (available at http://www.fmcsa.dot.gov/factssearch/research-technology/publications/medreports.htm). Other countries have similar guidelines that are used in determining medical fitness to drive, such as the Canadian Medical Association Drivers Guide, 7th edition.2

Materials and Methods
The Federal Motor Carrier Safety Administration asked the panel to address 3 key questions: among individuals who have experienced a TIA, what is the risk of experiencing a future stroke?; are individuals who have experienced a stroke at an increased risk for a motor vehicle crash (ie, crash risk)?; and can neuropsychological testing of individuals who have experienced a stroke predict crash risk?

A comprehensive systematic literature search was commissioned by Federal Motor Carrier Safety Administration and conducted by Emergency Care Research Institution (J. T. Reston, M. Noble) and Manila Consulting Group (J. Williams, S. J. Tregear) before being reviewed by the medical expert panel. The systematic search accessed several electronic databases, including MEDLINE, PubMed (PreMEDLINE), EMBASE, PsycINFO, CINAHL, TRIS, and the Cochrane Library (through January 10, 2008). The main search terms used in this analysis are presented in the Appendix (available at http://stroke.ahajournals.org), and the search strategy is summarized in Figure 1. Abstracts of identified studies were retrieved and “gray literature” was manually searched. All documents were screened against a set of general and key question-specific inclusion criteria that were determined a priori. General inclusion criteria were that articles must: (1) have been published in the English language; (2) be a full-length publication (abstracts and letters to the editor were excluded); (3) have included ≥10 subjects per group with enrolled subjects aged 18 years or older; and (4) be the most complete version and the primary reference to avoid double-counting of individuals if the same study was reported in multiple publications.

Other criteria that were specific to the 3 questions included studies that: (1) were limited to individuals with TIA or minor stroke only (no reversible ischemic neurological deficits); (2) determined the risk of stroke associated with TIA or the prevalence of TIA in subjects who had a stroke; (3) included a comparison group of comparable

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From the Department of Neurology (M.H.R.), Oklahoma University, Oklahoma City, Ok, and Department of Neurology and Neuro-rehabilitation, Oklahoma City VA Medical Center, Oklahoma City, Ok; Departments of Physical Therapy, Neurology, and Graduate Studies (A.A.), Medical College of Georgia, Augusta, Ga; Department of Neurology and Rehabilitation (P.G.), University of Illinois at Chicago, Chicago, Ill.

The opinions of the authors expressed herein do not necessarily state or reflect those of the United States Government.

The online-only Data Supplement is available at http://stroke.ahajournals.org/cgi/content/full/STROKEAHA.110.587196/DC1.

Correspondence to Meheroz H. Rabadi, Veterans Affairs Medical Center, 921 NE 13th Street, Oklahoma City, OK. E-mail rabadimh@gmail.com

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Experiencing a Future Stroke? Experienced a TIA, What Is the Risk of 

Question 1: Among Individuals Who Have Experienced a TIA, What Is the Risk of Experiencing a Future Stroke?

The search strategy identified 375, 89, and 20 articles for questions 1, 2, and 3, respectively. Of these only 13, 6, and 12 articles fulfilled the study criteria and therefore formed the evidence base of this report for questions 1, 2, and 3. The revised version of the Newcastle-Ottawa Quality Assessment Scale for these studies showed that they were of moderate to low quality with limited generalizability to the stroke population.

Results: Findings of Evidence Report

The systematic literature search took into account the quality of the individual studies for each key question the interplay between the quality, quantity (effect size), robustness, and consistency of the overall body of evidence. Provisions to perform meta-analysis, heterogeneity testing, and sensitivity analysis were made a priori. However, given the paucity of the data identified by our searches, these analyses were not performed. The strengths of evidence ratings assigned to the different types of conclusions are defined in Table 1.

Table 1. Strength of Evidence Ratings for Qualitative and Quantitative Conclusions

<table>
<thead>
<tr>
<th>Strength of Evidence</th>
<th>Qualitative Conclusion</th>
<th>Interpretation</th>
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<tbody>
<tr>
<td>Strong</td>
<td>Evidence supporting the qualitative conclusion is convincing. It is highly unlikely that new evidence will lead to a change in this conclusion.</td>
<td></td>
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<tr>
<td>Moderate</td>
<td>Evidence supporting the qualitative conclusion is somewhat convincing. There is a small chance that new evidence will overturn or strengthen our conclusion. We recommend regular monitoring of the relevant literature.</td>
<td></td>
</tr>
<tr>
<td>Minimally acceptable</td>
<td>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. We recommend frequent monitoring of the relevant literature.</td>
<td></td>
</tr>
<tr>
<td>Insufficient</td>
<td>Although some evidence exists, the evidence is insufficient to warrant drawing an evidence-based conclusion. We recommend frequent monitoring of the relevant literature.</td>
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<tr>
<th>Strength of Evidence</th>
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</thead>
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<tr>
<td>High</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>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. We recommend regular monitoring of the relevant literature.</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>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. We recommend frequent monitoring of the relevant literature.</td>
<td></td>
</tr>
<tr>
<td>Unstable</td>
<td>Estimates of the treatment effect are too unstable to allow a quantitative conclusion to be drawn at this time. We recommend frequent monitoring of the relevant literature.</td>
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Subjects who did not have TIA or a minor stroke; (4) evaluated the relationship between people who had a stroke to measures of driver safety, such as direct evidence of crash risk and measures of driving-related performance (laboratory and experimental); and (5) evaluated neuropsychological test scores and crash incidence or driving performance in persons who had a stroke.

The risk is highest in the first month after TIA and remains relatively high during the first year after an event.

Additional studies showed that after a TIA, the initial stroke risk may vary and the presence of hypertension, diabetes mellitus, and older age predicted stroke risk at 1 year. Other events may occur soon after TIA, such as hospitalizations for cardiovascular events (2.6%), deaths (2.6%), and recurrent TIA (12.7%).

Summary

There is strong evidence that persons with a history of TIA are at an increased risk for stroke. There is moderate evidence that increase in stroke risk is highest immediately after TIA and decreases as a function of time since the event.
Question 2: Are Individuals Who Have Experienced a Stroke at an Increased Risk for a Motor Vehicle Crash?
In 2 of 3 studies with sample sizes of 51 and 17, respectively, stroke survivors had increased risk for vehicle crashes after adjustment for number of miles driven.21,22 The only study that did not adjust for miles driven did not find an increased risk of vehicle crash.23 An on-road driving study showed that stroke survivors were at increased risk for motor vehicle crashes because of poor driving skills.24 The direct evidence for vehicular crash risk after stroke is limited by the small size of the evidence base and low-to-moderate quality of the studies. Indirect evidence from 2 simulator-based driving studies25,26 are inconsistent and also are limited by absence of direct evidence.

Summary
At present, there is minimally acceptable evidence available to suggest that drivers who have experienced a stroke are at an increased risk for crash because the magnitude of the crash risk was not determined.

Question 3: Can Neuropsychological Testing of Individuals Who Have Experienced a Stroke Predict Crash Risk?
At present, there are no studies that provide direct evidence of the ability of neuropsychological tests to predict crash risk in stroke survivors in general and in CMV drivers in particular. Eleven of the 12 moderate-quality26–37 studies found that ≥1 neuropsychological tests predicted outcome of road tests or off-road evaluations.26–36 These findings could not be combined in a quantitative analysis because no 2 studies used the same array of tests or evaluated the same combination of predictor variables. However, certain tests were found to be significant outcome predictors in multiple studies, such as Figure of Rey,27,28,32,36 Motor-Free Visual Perception Test,26,27,29,33,35 and components of the Stroke Driver Screening Assessment28,31,35,37 (ie, dot cancellation test, the road sign recognition test, and what else is in the square test).

Summary
There is moderate evidence that certain neuropsychological tests can predict the outcome of driving performance measured by a road test or in-clinic driving evaluation. Whether neuropsychological tests can predict actual crash risk, especially in CMV drivers, cannot be determined because there is a lack of evidence from which such conclusions can be drawn.

Recommendations of the Medical Expert Panel
The medical expert panel made 5 recommendations based on review of the current literature and levels of evidence of their findings. The recommendations are presented here and are summarized in Table 2.

Recommendation 1: Single TIA or Minor Stroke and CMV Driver Certification
The medical expert panel recommended that all individuals who have experienced a single TIA or minor stroke should be immediately excluded from driving a CMV. Individuals who have remained free of recurrent TIA or minor stroke for a period of at least 1 year and who are otherwise physically fit may qualify to drive a CMV.

Such individuals must demonstrate that they are able to perform their normal duties by undergoing a thorough evaluation of their physical and mental function by a qualified neurologist or other physician who is well-versed and competent in the diagnosis and treatment of patients with TIA or stroke, and who is knowledgeable about the sequelae of stroke. Individuals with severe disabling stroke needing assistance or supervision in their activities of daily living should be disqualified from driving because of the severity of their impairments.

The certification process should include a mandatory on-road driving evaluation. This takes into consideration the length, width, and weight of the CMV and other challenges to driving, including ability to see objects in the blind angle and the spatial requirements of driving a CMV.

Justification
The risk for stroke recurrence is highest immediately after a TIA or minor stroke. This risk remains relatively high for the first year. Traffic accidents only take a few seconds to occur, even before the symptoms associated with a TIA or minor stroke resolve.

Recommendation 2: Preventive Treatment After a Single TIA or Minor Stroke Event
Individuals who receive immediate (secondary) prophylactic treatment after a TIA are at reduced risk for TIA or stroke recurrence compared to those who do not receive treatment or receive treatment later. However, medical expert panel rec-
Recommendation 3: Annual Recertification

The medical expert panel recommended that individuals who have experienced a TIA or stroke and who have been certified as being physically qualified to drive a CMV (see recommendations 1 to 3) should be recertified on an annual basis. The annual recertification process should include a thorough neurologist assessment performed by a qualified neurologist or other physician who is well-versed and competent in the diagnosis and treatment of patients with TIA or stroke and who is knowledgeable about the sequelae of stroke.

Driving history should also be considered and should include the number of total miles driven, evidence of traffic violations, and crash involvement (at fault or not at fault).

Any history of occurrence of seizures consequent to stroke should also be taken into consideration. The medical expert panel recommends that individuals who experience a seizure after a stroke should not be certified as physically qualified to drive a CMV for at least 1 year, even if they are neurologically intact after stroke. This certification process should include mandatory on-road evaluation.

Justification

Approximately 5% to 20% of all individuals who have a stroke will have subsequent seizures,42–44 but epilepsy (recurrent seizures) will develop in only a small subset of this group. The prospective, multicenter Seizures after Stroke Study Group,42 which enrolled 1897 patients, found an overall incidence of seizures of 8.9%. Recurrent seizures consistent with the development of epilepsy occurred in 2.5% of the patients during a mean follow-up of 9 months. Seizures were more common in the hemorrhagic than in the ischemic stroke group (10.6% vs 8.6%). Most early-onset seizures occurred during the first 2 days after ischemic stroke.42,45 Risk factors for poststroke seizures included cortical location,44 large lesions involving multiple lobes of the brain,46 and initial stroke severity.47 Early-onset seizures after stroke commonly have been simple partial seizures (61%), followed by secondarily generalized seizures (28%).46 Late-onset seizures were more likely to be secondarily generalized.43,49 Status epilepticus occurred in 9% of poststroke seizures and was associated with higher functional disability.50 Findings in these studies suggest that individuals who experience a stroke-related seizure would have experienced a severe stroke and are usually severely and permanently debilitated. Consequently, such individuals will be unable to operate a CMV. Any history of TIA or stroke recurrence should result in permanent disqualification from operating a CMV.

Recommendation 4: Neuropsychological Tests and On-Road Evaluation

The medical expert panel recommended that although neuropsychological tests (eg, Figure of Rey test, Motor-
free Visual Perception Test, the dot cancellation test, road sign recognition test, and square matrix tests from the Stroke Driver Screening Assessment) may provide a reasonable guide as to which person will likely pass a driver evaluation test, the ability of neuropsychological tests to predict likelihood of poststroke crash is unknown, and the on-road driving test remains the gold standard for certification.

**Justification**

One must confirm not only that the individuals who have experienced a TIA or stroke have the mental and physical ability to operate a CMV but also that such individuals must demonstrate that they are actually able to operate a CMV by passing an on-road evaluation, which remains the closest approximation to natural driving performance. On-road test has been used in many studies as the single criterion of driving ability after stroke.\(^{30,31,33–36}\) In a retrospective study that included 104 stroke survivors, performance in an on-road test was the most important predictor of the decision of being fit or not to drive.\(^{32}\) Although a standardized on-road test is a valid and reliable test of driving ability after stroke,\(^{51,52}\) it does not test the full potential for accident proneness. This is because of the unpredictability of traffic during testing and the experience of the examiner in assessing persons with TIA or minor stroke.

**Conclusion**

The medical expert panel recommended that: (1) CMV drivers with TIA or minor stroke should not be allowed to drive a CMV in the first year after the cerebral ischemic event because this is the period associated with increased relative risk of recurrence of cerebral ischemia; (2) CMV drivers who have been free of TIA or minor stroke for 1 year should undergo a thorough mental and physical evaluation by a certified neurologist or other physician who is well-versed and competent in the diagnosis and treatment of patients with TIA or stroke, and who is knowledgeable about the sequela of stroke, and must pass a pre-driving assessment including a practical road test and subsequently should have a yearly history of traffic violations assessed before being recertified as safe to drive a CMV; and (3) neuropsychological tests provide a reasonable guide as to which person will likely pass a driver evaluation test; however, the ability to predict the likelihood of a poststroke crash risk is unknown.

Apart from the direct recommendations for determining fitness to drive a CMV after a TIA or stroke, the medical expert panel recommended that the Federal Motor Carrier Safety Administration should consider funding research investigations that will provide direct evidence of the relationship between TIA or minor stroke and CMV driver crash risk and identify the value of a U.S.-adapted version of the Stroke Driver Screening Assessment in predicting on-road performance of drivers, including CMV drivers, after TIA and minor stroke.

**Acknowledgments**

The authors thank Jessica Williams, PhD, and Stephen Tregear, DPhil (of Manila Consulting Group) for conducting the comprehensive search and systematic review of the literature that was used to develop the recommendations of the medical expert panel.

**Disclosures**

All 3 panel members received an honorarium for participation in the expert panel meeting.

**References**


## Supplemental Material

**Appendix:** Topic specific search terms

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<td>Accident, Citations, Collisions, Crash, Tickets, Wrecks</td>
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<tr>
<td>Driving</td>
<td>Automobile driving, Car driving, Driver license, Driving ability, Driving behavior, Drivers</td>
<td>Drive, Drivers, Driving, Highway</td>
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<tr>
<td>Motor vehicles</td>
<td>Automobiles, Motor vehicle(s)</td>
<td>Bus, Buses, Car, Cars, Lorry, Lorries, Motor, Semi-trailers, Trucks, Vehicles</td>
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<tr>
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<td>Aphasia, Assessments, Battery, Evaluations, Neurocog, Neuropsych, Tests</td>
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<td>Stroke</td>
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<td>Brain infarcts, Cerebral attack, Cerebral infarcts, Cerebral insults, CVA</td>
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