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Driving after a stroke

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Many patients are concerned about driving a car in the months following a stroke. Their doctors are also concerned. People who have recently had a stroke may be recovering from the injury. They may have weakness in one part of their body. They may be experiencing slowness of movement. In some people, depending where in the brain the stroke has occurred, they might have new problems with their vision, attention, or coordination. Any or all of these neurologic issues could interfere with how well a person can drive.

In most places, driving is often essential to completing errands, traveling to medical appointments, and socializing with family and friends. Many people associate driving with independence. They may feel that it is a burden to ask a friend or family member to be their “chauffer.” Conversely, patients who have suffered a stroke may be concerned about problems with their vision, movement, or thinking. They may fear that these problems could lead to dangerous situations while driving. They may wonder if they will be able to react quickly enough if needed.

There are many ways to assess driver safety. After a stroke, some doctors will refer their patients for a safety evaluation. The most thorough way to assess driver safety is with an on-road driving assessment. The assessment involves driving for about 45 minutes with a trained evaluator (or driving in a computer simulator). Afterwards, the evaluator gives feedback. He or she may provide permission to resume driving. The evaluator might recommend additional driving lessons, or suggest that the person stops driving a car altogether. However, on-road assessments have drawbacks. They often cost hundreds of dollars and can be difficult to schedule.

Doctors are always searching for simple tests that can assess driver safety. For instance, are there tests that can be done in the doctor’s office? Perhaps the doctor could give a test which would at least tell him or her whether or not an on-road driving test is needed. In short, is there a test that can be done in the office that accurately predicts whether or not it is safe for a patient to drive after a stroke?

WHAT DID THE RESEARCHERS DO? In their article, “Screening for fitness to drive after stroke: a systematic review and meta-analysis,” Dr. Devos et al.¹ tried to answer this very question. They carefully reviewed the medical lit-

erature on this topic, and combined the results of many previous studies about driving after a stroke.

Combining the results of similar studies is important for several reasons. Studies that start with the same scientific question sometimes lead to very different answers. For example, one study found that 88% of drivers who took an on-road assessment after a stroke passed the test.² Another study found only a 24% passing rate.³ When there is such a large difference in results, it can be difficult to know which is the correct answer. Many factors can influence a study’s results. For instance, different studies include participants of varying ages, backgrounds, and geographic locations. When looking at people who have had a stroke, the location (in the brain) of where the stroke occurred might affect how well the person did after the stroke. In addition, the size of the stroke might matter. It seems logical to think that a person who had a small stroke would do better than a person with a large stroke. By mathematically combining studies, researchers are sometimes able to give one unified answer to this kind of question. Also, by unifying many study results, the answer may help a greater number of people than the answers from individual, smaller, studies.

There are several ways to combine study results. Groups of experts have agreed on a standard way of performing these techniques. Systematic reviews and meta-analyses are examples of the techniques for combining studies. Dr. Devos and colleagues carefully followed the expert guidelines. The authors first gathered all studies that had anything to do with driving after stroke. From this group of hundreds of studies, they selected 30 to include in their article. These studies were selected because they measured the same thing: passing or failing the on-road assessment. This meant that the studies could be easily combined. Next, the authors recorded findings from the tests that doctors used in the office in each study prior to the on-road assessment. Finally, the authors combined the information from the 30 studies by using mathematical equations.

The authors were interested in 3 main questions. First, they tried to determine how many drivers who had a stroke were able to pass an on-road assessment. The authors evaluated the type of training that was most helpful for passing the on-road assessment. Next, the authors wanted to identify tests that doctors could

conduct in the office to predict performance in an on-road assessment. Finally, they wanted to determine if patients who resumed driving after a stroke were more likely to be involved in car crashes than other drivers.

WHAT WERE THE RESULTS? The authors found that 54% of the 1,728 stroke patients who took an on-road assessment were able to pass. The amount of time between the stroke and the driver assessment varied. Some patients took the on-road assessment as soon as 2 months after a stroke. Other patients waited for more than a year after a stroke to take the assessment. By combining the results of different studies, the authors found that the age of the drivers did not affect passing or failing the on-road assessment. How much driving experience a person had before the stroke also did not seem to make a difference.

Six of the 30 studies asked if training for the on-road assessment affected pass rates. Two types of training were studied. One type included on-road driving and using driving simulators. The other type involved vision and coordination training without practicing any driving-specific skills. The authors found that driving-specific training led to a higher pass rate than the other type of training.

The authors also found 3 office-based tests that were fairly accurate in identifying which patients were likely to pass or fail the on-road assessment. The 3 tests are called Road Sign Recognition, Compass, and Trail Making Test part B. Each test takes just a few minutes in a doctor's office, and can be done easily during a doctor's appointment. The Road Sign Recognition test involves matching road signs to particular driving situations. The Compass test is an examination of vision, attention, and mental speed. Trail Making Test part B involves drawing lines between letters and numbers.

Four of the studies that the authors reviewed looked at the rate of car crashes in patients who had passed an on-road assessment after a stroke. Three of these studies found that patients who had passed the on-road assessment did not have more crashes than other drivers of similar age and background. However, the authors did not find a specific in-office test that predicted whether or not patients would be involved in car crashes.

WHY IS THE STUDY IMPORTANT? Individual studies of driving safety after stroke have had inconsistent results. This study combined all previous studies to give a unified answer. The results of this study may be important to patients who have had a stroke. The authors found that more than half of the patients who took an on-road assessment passed. Practicing actual driving or using a driving simulator was more helpful than certain types of vision or coordination training after a stroke.

The study suggests that doctors may be able to predict driving performance using 3 simple tests in the office. Those who "fail" may need further, more specific driver evaluation. For instance, patients who score below a certain level on the office tests may receive a referral for an on-road assessment. Studies suggest that patients who "pass" the on-road driver evaluation testing are no more likely to be involved in car crashes than other drivers. In other words, a "pass" appears to mean "safe" for driving. Of course, all people who have had a stroke should discuss driving and driver safety with their doctor.

DRIVING AND MEDICAL ILLNESSES Many medical illnesses can affect driving. For instance, certain heart conditions may cause a person to pass out unexpectedly. Diabetes causes problems with the amount of sugar in the bloodstream: when blood sugars are very high or very low, a person cannot function well, and may even pass out. Other medical illnesses may cause problems with vision. Cataracts, macular degeneration, and diabetes (which can cause a diabetic retinopathy) may affect how well a person can see. This has obvious implications for driving. In most states, a driver must pass specific vision testing before a driver's license is issued.

Because of their medical expertise, doctors (and in many places, occupational therapists) are often asked for their opinion about a driver's safety.⁴ In some instances, the answer may be clear. For instance, a person with epilepsy may have unpredictable seizures which cause loss of consciousness. Even if the seizures were rare, driving is unsafe. If a seizure happened to occur while driving, the person would be unable to control the car, and could hurt themselves or someone else.

Neurologists meet with people who may have had a stroke, seizures, movement problems (like PD), or a disease that causes problems with vision, thinking, memory, and judgment. When a person has a stroke, assessing driver safety is not always clear. Strokes can occur anywhere in the brain. The location of the stroke is important. Strokes that occur in the vision area of the brain affect how well a person can see. A stroke that occurs in the motor region may cause weakness in one part of the body. Other strokes may cause slowness of movement which could affect a person's reaction time.

Because the answer is not always so clear, doctors would like to perform testing that predicts how well a driver would perform on the road. Many tests are available, but studies do not always agree as to which test (or combination of tests) is "best." Studies like the one by Dr. Devos begin to identify ways in which doctors can assess driver safety more accurately. Although the study does not provide all the answers, it provides some suggestions. Further study is needed to confirm the results of Dr. Devos' study.

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About stroke

Adapted from: Leonard AD, Brey RL. Blood pressure control and stroke: an ounce of prevention is worth a pound of cure. Neurology 2002;59:E1–E2.

WHAT IS STROKE? A stroke, or brain attack, is caused by the sudden loss of blood flow to the brain or bleeding inside the head. A stroke can cause brain cells to die. This damage can cause paralysis, speech problems, loss of feeling, memory and reasoning problems, coma, and possibly death. Fortunately, there are effective ways to prevent stroke. If you have a stroke, seeking immediate medical attention can help reduce your chances of death and disability.

WHAT ARE THE WARNING SIGNS OF STROKE? The “Give Me 5” uses easy-to-remember words to help identify the 5 signs of stroke³:

- Walk—Is their balance off?
- Talk—Is their speech slurred or face droopy?
- Reach—Is one side weak or numb?
- See—Is their vision all or partly lost?
- Feel—Is their headache severe?

HOW COMMON IS STROKE? Every year, about 780,000 people in the United States have a stroke and about 160,000 die. Stroke is the nation’s number 3 killer after heart disease and cancer. Stroke is the number 1 cause of adult disability.

Stroke is an emergency. Call 911 immediately if you or someone you know experiences any of the above warning signs. Jot down the time the symptoms started. Sometimes these warning signs last for only a few minutes and then stop. But, even if that happens or if you feel better, call 911 for help.

RISK FACTORS FOR STROKE THAT CAN BE TREATED OR CHANGED

- High blood pressure
- Atrial fibrillation (an irregular heartbeat)
- Diabetes
- Cigarette smoking
- Hyperlipidemia (high fat level in the blood)
- Alcohol abuse
- Obesity
- Sickle cell disease

WHAT CAUSES A STROKE? There are 2 types of stroke or brain attack. Ischemic stroke is caused by an

interruption of blood flow to the brain. Hemorrhagic stroke is caused by bleeding inside the brain.

About 85% of all strokes are ischemic. Ischemic stroke can be caused by narrowing of the large arteries to the brain, also known as atherosclerosis. If a clot forms in the neck vessels, pieces can break off and block a brain blood vessel. Clots may also form in the heart and travel by blood flow to the brain vessels, where they become lodged.

Hemorrhagic stroke is caused by the bursting of a blood vessel in the brain. It accounts for about 15% of strokes. Subarachnoid hemorrhage occurs when there are weak spots on brain arteries (aneurysms) that burst and cover the brain with blood. Blood vessels in the brain can also burst if they are weakened by high blood pressure, diabetes, and aging.

WHAT ARE THE TREATMENTS FOR STROKE?

Immediate medical care is critical for the person who is having a stroke or brain attack. New treatments work only if given within a few hours after the onset of a stroke. For example, a clot-busting drug must be given within 3 hours of stroke onset.

HOW IS STROKE PREVENTED? Some risk factors—age, sex, race, and a history of stroke in the family—cannot be changed. However, many others can be controlled. Most controllable risk factors relate to the health of the heart and blood vessels. The following can help prevent stroke:

- Having regular medical checkups
- Controlling high blood pressure
- Not smoking; stopping if you do
- Treating heart disease, especially an irregular heartbeat called atrial fibrillation
- Improving diet: avoiding excess fat, salt, and alcohol
- Exercising
- Controlling diabetes
- Seeking immediate medical attention for warning signs of stroke

FOR MORE INFORMATION

AAN.com for Patients & Caregivers

<http://patients.aan.com/>

National Stroke Association

<http://www.stroke.org/site/PageNavigator/HOME>

American Stroke Association
<http://www.strokeassociation.org/presenter.jshtml?identifier=1200037>
National Institute of Neurological Disorders and Stroke
<http://stroke.nih.gov/>

REFERENCES

1. Devos H, Akinwuntan AE, Nieuwboer A, Truijzen S, Tant M, De Weerd W. Screening for fitness to drive after stroke: a systematic review and meta-analysis. *Neurology* 2011;76:747–756.
2. Smith-Arena L, Edelstein L, Rabadi MH. Predictors of a successful driver evaluation in stroke patients after discharge based on an acute rehabilitation hospital evaluation. *Am J Phys Med Rehabil* 2006;85:44–52.
3. Akinwuntan AE, De Weerd W, Feys H, Baten G, Arno P, Kiekens C. The validity of a road test after stroke. *Arch Phys Med Rehabil* 2005;86:421–426.
4. Raof E, Jankowiak J. Driving after a stroke. *Neurology* 2005;65:E13–E14.

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Neurology 2011;76:e35-e38
DOI 10.1212/WNL.0b013e3182104170

This information is current as of February 21, 2011

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