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Is it safe to drive after acute mild stroke? A preliminary report ☆

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ABSTRACT

Background: Most guidelines recommend that patients should refrain from driving for at least one month after stroke. Despite these guidelines, and the fact that patients post-stroke may be at an increased risk for driving impairment, many patients report resuming driving within the acute phase of injury. The aim of this study was to investigate the driving performance of patients with acute mild stroke.
Methods: The current study compared the driving simulator performance of ten patients with acute mild ischemic stroke (>48 h and <7 days) to that of ten healthy, age- and education-matched controls.
Results: During the City Driving and Bus Following Scenarios, patients on average committed over twice as many errors (e.g., collisions, center line crossings, speed exceedances) as controls (12.4 vs. 6.0, $t(18) = 2.77$, $p < 0.01$; and 8.2 vs. 2.1, $t(17) = 2.55$, $p < 0.05$; respectively). Although there was no difference between patients and controls in the number of errors committed during simple right and left turns, patients committed significantly more errors than controls during left turns with traffic (0.49 vs. 0.26, $U = 26.5$, $p < 0.05$).
Conclusion: Results suggest that patients with acute mild ischemic stroke may be able to maintain driving performance during basic tasks (e.g., straight driving, right turns) and that deficits may become apparent during more complex tasks (e.g., left turns with traffic, bus following). The results highlight the importance of healthcare professionals providing driving advice to their patients post-stroke, particularly in the acute phase of injury.
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1. Introduction

Evaluating the driving performance of patients after a stroke is a significant challenge for health professionals [1]. Many of the impairments associated with stroke, such as visual field defects, neglect, and paralysis are fairly reliable contraindications of driving ability. However, in cases of minor stroke where impairments are more subtle, such as deficits in executive functioning [2], evaluating driving performance can be much more challenging.

Physician guidelines established by prominent governing bodies including the Canadian Medical Association (CMA) [3] and the Driver and Vehicle Licensing Agency (DVLA) [4] state that patients should refrain from driving for a minimum of one month after stroke. When in place, driving guidelines typically capture the window in which stroke and transient ischemic attack (TIA) patients are at an increased risk of recurrence. Patients are often allowed to resume driving if (1) no significant motor, cognitive, or perceptual deficits are present; (2) there is no significant risk of sudden recurrence; (3) the underlying cause of the stroke has been treated; and (4) the patient did not experience a post-stroke seizure [5]. Despite these guidelines, and the fact that cognitive deficits are present in the acute phase of injury and can persist several months after injury [6], approximately 35% of minor stroke and TIA patients resume driving within the one-month period [7]. Furthermore, as low as 9% of patients report receiving driving advice from a physician immediately post-stroke [7]. This number increases to 52% of patients receiving driving advice when other healthcare professionals as well as friends and family are included in addition to physicians [8].

There is a paucity of empirical research that has investigated the driving performance of patients immediately after mild stroke. Thus, it remains unclear whether driving within the acute phase of recovery after minor stroke represents a significant safety risk for the patient and the general public. The current study used driving simulator technology to characterize the driving performance of acute mild stroke patients and to compare their performance to that of age- and education-matched, healthy adults. Given that patients presented with mild deficits, it was hypothesized that stroke patients would maintain

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driving performance during more routine aspects of driving (i.e., straight driving, right and left turns without traffic), which require fewer brain resources; however, patients would exhibit more errors in general as well as during the more demanding aspects of driving (i.e., left turns with traffic), which require greater recruitment of brain resources [9].

2. Materials and methods

2.1. Participants

Twenty participants were included in the study (acute stroke, n = 10; controls, n = 10). All patients were diagnosed and consecutively recruited by members of the Stroke Assessment and Treatment Team (SATT) at St. Michael's Hospital, including stroke neurologists, a physiotherapist, and an occupational therapist. Patients sustained a stroke within one week of testing (range = 2–7 days) and presented with minimal language and motor deficits (see Table 1 and Fig. 1). Patients were required to meet the vision standards outlined by the CMA (i.e., visual acuity no less than 20/50 with both eyes open and examined together, visual field of 120° continuous along the horizontal meridian and 15° continuous above and below fixation with both eyes open and examined together, and no diplopia within the central 40° of primary gaze) [3]. Visual screening was conducted by a stroke neurologist and an occupational therapist, and if there was any indication of visual impairment, patients received a comprehensive visual assessment. Patients with a neurological deficit (e.g., moderate to severe weakness, neglect, severe visual impairment, or ataxia) or a history of dementia were excluded. AlphaFIM® scores were >80 (mean = 109.6 ± 6.7) and the National Institutes of Health Stroke Scale (NIHSS) scores were <5 (mean = 1.2 ± 1.4), indicating mild impairment [10]. AlphaFIM® is a standardized measure of assessing functional status and disability in the acute care setting and contains four motor tasks (e.g., bed-to-chair transfer, walking, bowel management, toilet transfer) and two cognitive tasks (e.g., expression and memory), scored on a seven-point scale (1 = "total assistance" and 7 = "complete independence") [11]. All healthy control participants were recruited from volunteers in the local community and had no prior history of psychiatric or neurological illness. All participants held a valid driver's license at the time of testing. Self-reported years of driving experience and number of collisions are reported in Table 2. Ethical approval for the study was obtained by the Research Ethics Board at St. Michael's Hospital in Toronto, Canada. All participants provided written informed consent prior to their inclusion in the present study.

2.2. Procedure

2.2.1. Primary outcome: driving simulation

The driving performance of participants was assessed using a STISIM Drive® (version 2.08.08, Logitech G25 model) driving simulator, equipped with a fully functioning steering wheel, pedals, and signaling system. Participants first completed a training session to become familiar with the simulator environment. Two experimental driving scenarios were administered: (1) City Driving Scenario and (2) Bus Following Scenario. The City Driving Scenario involves straight driving, routine right and left turns, and left turns with traffic. In conditions with higher cognitive demands (i.e., left turns with traffic), participants need to make decisions about when it is safe to turn in order to avoid oncoming traffic and pedestrians. These decisions are associated with processes of selective attention, visual–spatial ability, and motor control [9]. In the Bus Following Scenario, participants are required to follow a bus while maintaining a safe distance from the vehicle. The vehicle is constantly changing its speed throughout the scenario. This complex task requires

Table 1
Stroke characteristics and neurological symptoms of acute stroke patients.

	Infarct location	Neurological symptoms (on admission)	NIHSS score	Time between onset and driving evaluation
Patient 1	R MCA R corona radiata R posterior putamen	Dysarthria L sided weakness	0	5 days
Patient 2	R MCA R frontal cortex	Dysarthria L sided weakness	1	5 days
Patient 3	R MCA R lateral anterior putamen	Dizziness L facial droop	3[a]	5 days
Patient 4	L PCA L occipital cortex	Alexia R visual field scotomas	1[a]	4 days
Patient 5	L ICA L parietal cortex L frontal cortex	Headache Visual changes	0	3 days
Patient 6	L MCA L frontal cortex L corona radiata L posterior parietal cortex L temporal cortex	Slowed Speech Dysarthria	0	2 days
Patient 7	L MCA L caudate L putamen L insula L parietal cortex L frontal cortex	R sided weakness Dysarthria Mild expressive aphasia	1	7 days
Patient 8	R PCA R occipital cortex	L lower quadrant visual field deficit[b]	4[a]	6 days
Patient 9	R MCA R insula R corona radiata R centrum semiovale R precentral gyrus	L sided weakness	2	5 days
Patient 10	L MCA L parietal cortex	Dysarthria R sided weakness	0	4 days

NIHSS, National Institutes of Health Stroke Scale; L, left; R, right; MCA, middle cerebral artery; ICA, internal carotid artery; PCA, posterior cerebral artery.
[a] NIHSS scores were retrospectively calculated by a stroke neurologist.
[b] Visual field: maintained 120° continuous along the horizontal meridian, with no defect within the central 20°. Visual field deficit subsequently resolved at retest.

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