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► **To cite this version:**

Clara Gasne, Maud Ranchet, Myriam Evennou, Marie-Caroline Delebecque, Isabelle Hoang, et al.. Fitness-to-drive recommendations in post-stroke patients: a retrospective study. *Journal of Stroke and Cerebrovascular Diseases*, 2024, 33, 10.1016/j.jstrokecerebrovasdis.2024.107781 . hal-04698903

HAL Id: hal-04698903

<https://hal.science/hal-04698903v1>

Submitted on 16 Sep 2024

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Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Journal of Stroke and Cerebrovascular Diseases

journal homepage: www.elsevier.com/locate/jstroke

Fitness-to-drive recommendations in post-stroke patients: a retrospective study

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ARTICLE INFO

Keywords:

Fitness-to-drive

Stroke

Multi-professional assessment

Retrospective study

Recommendation

ABSTRACT

Background: Stroke sequelae can have an impact on daily life activities such as driving. French legislation stipulates that post-stroke patients should undergo a multi-professional fitness-to-drive assessment before being allowed to drive again. This retrospective study aims to explore the determinants of multi-professional fitness-to-drive recommendations.

Methods: Sixty-six post-stroke patients assessed for fitness to drive in the Kerpape Center, France in 2019 were included. Favorable or unfavorable driving recommendations were attributed to patients following a joint decision by a multi-professional team. Individual characteristics obtained from medical records were compared.

Results: Findings showed that 64% of stroke patients received a favorable fitness-to-drive recommendation. Across all demographic, clinical, and driving characteristics, the time interval between stroke and assessment was significantly longer for patients designated as unfit to drive than for those designated as fit to drive ($P = .004$). Furthermore, the proportion of instrumental sequelae was higher in patients designated as unfit to drive than in those designated as fit to drive ($P = .022$). Stepwise logistic regression showed that the presence of instrumental sequelae, mainly aphasia, was the best predictor of fitness-to-drive recommendations.

Conclusions: The post-stroke time interval and the presence of instrumental sequelae explained the difference between patients recommended as fit-to-drive and unfit-to-drive. Furthermore, aphasia was found to be the best predictor of a fitness-to-drive recommendation. It is possible that aphasia impacts the understanding of instructions during on-road testing. These findings emphasize the need for a standardized multi-professional fitness-to-drive assessment, since the determinants of fitness-to-drive recommendation differ between studies.

Introduction

Every year in France, strokes affect 140 000 people, and are the first cause of acquired disability in adults.¹ Stroke is an interruption of blood flow in the brain caused by blood clot (ischemic stroke) or blood vessel rupture (hemorrhagic stroke). Ischemic stroke occurs in about 87% of patients.² The main sequelae of stroke affect balance (50%), memory (42%), motor ability (37%), and induce visual (23%) language, and communication (34%) impairments.³ Stroke (ischemic or hemorrhagic) sequelae also have negative repercussions on daily activities such as driving.^{4,5,6}

Since 2016, French legislation has recommended that stroke patients should undergo a multi-professional fitness-to-drive assessment before being allowed to drive again.^{7,8} This includes a medical examination,

neuropsychological assessment and an on-road test.⁹ Based on this assessment, the multi-professional team (doctor, occupational therapist, on-road assessor) submits a joint recommendation on fitness to drive. According to a systematic review, 46 % of post-stroke patients who underwent an official on-road test were deemed unfit to drive.¹⁰ However, no study on post-stroke patients who were officially assessed for fitness to drive has been conducted in France. The objective of this exploratory study is therefore to investigate the determinants of multi-professional fitness-to-drive recommendations in patients assessed in the Kerpape Mutualist Center

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<https://doi.org/10.1016/j.jstrokecerebrovasdis.2024.107781>

Received 20 October 2023; Received in revised form 3 May 2024; Accepted 18 May 2024

Available online 19 May 2024

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Materials and methods

Participants

This study is bicentric and was conducted in parallel at the Henry Gabrielle hospital and the Kerpape Center. It includes 173 patients, assessed for fitness to drive, in 2019. Because at the Henry Gabrielle hospital, the proportion of drivers designated as unfit to drive was lower (inferior to 7%) than the proportion of drivers designated as fit to drive, we chose to focus only on data from the Kerpape center. The selected sample therefore consisted of 85 post-stroke patients, who participated in an official fitness-to-drive assessment in the Kerpape Center, France. Seventeen patients subsequently refused to be included ($n = 15$) or died ($n = 2$). Finally, data from 66 patients were retrospectively included in the sample. Diagnosis of stroke was the only inclusion criterion. The study was approved by the French biomedical ethics committee on 03/11/2022 (Comité de Protection des Personnes Nord Ouest II Réf. CPP: 2018-01 N°ID RCB:2017-A03187-46) (CPP: 22.03355.000139). Individual consent was obtained from all patients.

Procedure

Socio-demographic and driving characteristics

Individual information relating to the post-stroke period was collected and investigated from medical records. Age, sex, driving experience, the time interval between stroke and on-road testing, as well as the number of on-road tests, and number of hours of training between on-road tests were collected.

Clinical characteristics

Different types of clinical characteristics were also collected. These included comorbidities, which are defined as the presence of one or more disorders that occur in addition to the primary disease. The presence of several sequelae types such as sensory sequelae (disturbances in the perception of stimuli from the environment), motor sequelae (partial or total impairment of motor skills, e.g., hemiplegia, paraplegia), cognitive sequelae (e.g., attention, memory deficit) and instrumental sequelae (e.g., aphasia, apraxia) was listed.

Fitness-to-drive recommendation

A multi-professional synthesis was carried out after the on-road test to decide on the fitness-to-drive recommendation. Drivers were then given either a favorable or an unfavorable recommendation. Patients in the favorable category were found to be fit to drive with or without adaptation of their vehicle (e.g., automatic transmission, spinner knob) or driving restrictions (e.g., no night driving or long journeys). Patients in the unfavorable category were judged unfit to drive either temporarily or definitively.

Data analysis

Variables were assessed for normality using Kolmogorov–Smirnov tests. Since all the variables did not follow a normal distribution, differences between groups were examined using independent 2-tailed Mann-Whitney U tests. For categorical variables, differences between groups were examined using χ^2 tests. Cramer's V (V) was used to measure the effect size for χ^2 tests. An effect size ≤ 0.2 indicated only a weak association between variables. An effect size between 0.2 and 0.6 showed only a moderate association between variables. An effect size > 0.6 indicated a strong association between variables.¹¹ Bravais Person r was used to calculate the correlation value of the statistical test. A correlation value of 0 indicated no correlation, 1 indicated a total positive correlation. A correlation value of 0.7 between two variables indicated a significant and positive relationship.¹² Multivariable stepwise logistic regression models were used to investigate which variables were the

best predictors of fitness-to-drive recommendations. Only variables that differed significantly between the two categories were included in the models. $P < .05$ was considered significant. All statistical procedures were performed using SPSS 28.0.1.1 (15) (SPSS, Inc., Chicago, IL).

Results

Sociodemographic and driving characteristics

Sixty-six post-stroke patients (58 years old \pm 14) were included (Table 1).

The time interval since stroke was significantly longer for patients in the unfavorable category (649.46 days \pm 907.80) than in the favorable category (303.3 days \pm 543.2) ($p = .004$; $r = 0,72$) (Table 1).

Clinical characteristics

A significantly higher proportion of patients in the unfavorable category than in the favorable category had two or more sequelae types (87.5 % and 54.8 % respectively, $p = .022$; $V = 0.34$). Only instrumental sequelae differed between the two groups. A significantly higher proportion of patients in the unfavorable category than in the favorable category had instrumental sequelae (45.8 % and 11.9 % respectively, $p = .002$; $V = 0.38$). And of these instrumental sequelae, all but one participant in the unfavorable category presented with at least aphasia (Table 2).

Logistic regression

Significant differences were found between patients in the favorable/unfavorable categories in terms of sequelae types and time intervals between stroke and on-road testing. A stepwise logistic regression model was used with these two variables to investigate which factor was the best predictor of fitness-to-drive recommendations. The stepwise regression revealed that the number of different types of sequelae was the best predictor of a fitness-to-drive recommendation. This variable accounted for 17 % of the total variance. More post-stroke patients in the unfavorable category had two or more sequelae types compared to those in the favorable category.

In the light of this result, different types of sequelae were analyzed more closely. Because significant differences in the presence of instrumental sequelae, mainly aphasia, were found between favorable/unfavorable categories, a stepwise logistic regression model was used on instrumental sequelae and time interval between stroke and on-road

Table 1

Sociodemographic and driving characteristics of the total sample, according to the fitness-to-drive recommendation

Variables ^a	All n = 66	Favorable n = 42	Unfavorable n = 24	p value ^b
Age, years, m \pm sd	58 \pm 14	57 \pm 12	59 \pm 16	0.248
Sex, female %	42.4	35.7	54.2	0.145
Driving experience, years m \pm sd	36.0 \pm 14.0	36.0 \pm 14.0	37.0 \pm 18.0	0.539
Time interval between stroke and on-road test, days m \pm sd	429.1 \pm 711.3	303.3 \pm 543.2	649.5 \pm 907.8	0.004
Number of on-road tests, m \pm sd	2.0 \pm 1.0	1.5 \pm 0.8	1.50 \pm 0.9	0.636
Training duration, hours m \pm sd	9.2 \pm 6.1	9.3 \pm 11.3	9.0 \pm 4.0	0.104

^a Missing variables: driving experience, favorable category $n = 15$, unfavorable category $n = 6$; training duration, favorable category $n = 31$, unfavorable category $n = 17$.

^b Mann-Whitney U tests were used for age, driving experience, time interval between stroke and on-road test, number of on-road tests, and training duration; χ^2 tests were applied for sex

Table 2

Clinical characteristics of the total sample, according to fitness-to-drive recommendation

Variable ^a , %	All n = 66	Favorable n = 42	Unfavorable n = 24	p value ^b
Stroke type,				
Hemorrhagic	6.2	7.3	4.3	0.56
Ischemic	78.1	80.5	73.9	
Cerebral vascular malformation	15.6	12.2	21.7	
Comorbidities,				
0	10.6	14.3	4.2	0.473
1	18.2	16.7	20.8	
2 and more	71.2	69.0	75.0	
Sequelae type,				
0	4.5	7.1	0.0	0.022
1	28.8	38.1	12.5	
2 and more	66.7	54.8	87.5	
Sensory sequelae	18.2	16.7	20.8	0.673
Motor sequelae	65.1	61.9	70.8	0.464
Cognitive sequelae	66.7	61.9	75.0	0.278
Instrumental sequelae ^c	24.2	11.9	45.8	0.002

^a Missing variables: stroke type, favorable category n = 1, unfavorable category n = 1.

^b χ^2 tests were applied for stroke type, comorbidities, sensory sequelae, motor sequelae, cognitive sequelae, and instrumental sequelae; Fisher's Exact tests were applied for sequelae type.

^c Mainly aphasia

testing. The stepwise regression revealed that the presence of instrumental sequelae was the best predictor of a fitness-to-drive recommendation, as it represented 18 % of the total variance ($p = .004$) (Table 3). More post-stroke patients in the unfavorable category presented with aphasia than those in the favorable category.

Discussion

This is the first retrospective study in France which investigates the characteristics of post-stroke patients during an official assessment for fitness to drive. In this sample, 78% of patients had an ischemic stroke, and 21% had a hemorrhagic stroke or cerebral vascular malformation. This is consistent with the profile of the stroke population in France (where 80 to 85% of strokes are ischemic, and 5 to 15% are hemorrhagic or due to cerebral vascular malformation¹). In this present study, 64% of patients received a favorable fitness-to-drive recommendation. This rate is similar to the rate observed in a meta-analysis in which the percentage of post-stroke patients designated as fit-to-drive was 54 %.¹⁰ However, it is lower than in another study, where 78% of stroke patients were designated as fit-to-drive by the on-road assessor.¹³ These differences can probably be explained by variations in protocols from one center to another. The rate can also vary depending on which category of professional makes the fitness-to-drive recommendation. In the above-mentioned cohort, in which the on-road assessor gave a favorable fitness to drive recommendation to 78% of patients, 86 % were designated as fit-to-drive by the physician.

Findings of this exploratory study indicated that the time interval between stroke and on-road assessment was significantly longer in patients in the unfavorable category than patients in the favorable category. This suggests that patients in the unfavorable category may have more sequelae and need a longer recovery time. Our result is in line with previous studies that showed a link between time interval between stroke and on-road assessment, and pass rate.¹⁴ As discussed by these authors, this result confirmed that post-stroke patients need time to recover from sequelae before they resume driving.

The contribution of this present study is novel in that regression analyses revealed that the presence of instrumental sequelae, mainly aphasia, best predicts the outcome of a fitness-to-drive assessment.

Table 3

Summary of variables kept in the models

Models	Variable	OR (95% CI)	P value
First model	Sequelae type	5.31 (1.44 - 19.50)	0.012
Second model	Instrumental sequelae type	6.26 (1.83 - 21.46)	0.004

OR = odds ratio

CI = Confidence Interval

Aphasia was the only instrumental sequela present in post-stroke patients with unfit-to-drive recommendations. According to several studies, post-stroke aphasia is very frequent and involves more than just loss of speech.¹⁵ Aphasia can also affect language comprehension and expression. Consequently, this disorder can be assumed to have an impact on the understanding of instructions given by the on-road assessor during driving, and on the recognition of traffic signs.¹⁶ This hypothesis is consistent with the results of a study that showed that patients with aphasia had significantly lower scores in traffic sign recognition and comprehension of written and spoken descriptions of traffic signs than patients without aphasia.¹⁷

A previous study in post-stroke patients found that other determinants of fitness-to-drive recommendation also varied depending on the professional category of the examiner.¹³ For the physician, previous visits to the Center and the number of comorbidities best determined medical fitness-to-drive recommendations, whereas for the on-road assessor, age, previous visits to the Center, binocular acuity and driving experience were the best determinants. These findings argue in favor of the need for a standardized multi-professional fitness-to-drive assessment in post-stroke patients, in accordance with French legislation regarding fitness-to-drive assessment in medical conditions.⁷

Limitations of this retrospective study are its small cohort size, and the fact that it was conducted in a single French center, limiting the generalizability of the results. A future bicentric study with the Henry Gabrielle Hospital will investigate what has become of post-stroke patients from this present study, three years after their official fitness-to-drive assessment.

CRedit authorship contribution statement

Clara Gasne: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft. **Maud Ranchet:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – review & editing. **Myriam Evennou:** Conceptualization, Investigation, Methodology, Writing – review & editing. **Marie-Caroline Delebecque:** Conceptualization, Data curation, Investigation, Methodology, Project administration, Writing – review & editing. **Isabelle Hoang:** Conceptualization, Methodology, Writing – review & editing. **Pauline Coignard:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Writing – review & editing. **Laurence Paire-Ficout:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare no conflict of interest with respect to the present study.

Grant support

This work was supported by the Road Safety Delegation; and Fond de dotation Centre Mutualiste de Kerpape.

Acknowledgments

The authors thank the Kerpape center staff for their fitness-to-drive

evaluations. This research received no specific grant from any funding agency in the public commercial or non-profit sectors.

Sponsor's Role

No sponsor.

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