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**Driving in stroke survivors aged 18-65 years: The Psychosocial Outcomes In Stroke
(POISE) Cohort Study**

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Table 1: Characteristics of participants who were driving before the onset of acute stroke, over 12 months of follow-up

Table 2: Characteristics of participants who returned to driving within one month of acute stroke

Table 3: Multivariable logistic regression model for return to driving within one month of stroke

Abstract

Background There is limited information regarding return to driving after stroke.

Aims To determine the frequency and predictors of return to driving within one month of acute stroke in younger (age 18 to 65 years) adults.

Methods POISE (Psychosocial Outcomes In StrokeE) was a cohort study conducted in Australia between October 2008 and June 2010. Consecutive patients (age 18 to 65 years) with a recent (≤ 28 days) acute stroke were recruited. Validated demographic, clinical, mental health, cognitive and disability measures including return to driving were obtained.

~~Multivariate~~-Multivariable logistic regression was used to determine factors associated with return to driving within one month of stroke.

Results Among 359 participants who were legally able to drive before stroke, 96 (26.7%) returned to driving within one month. Compared to those without an early return to driving (n=263), drivers were more often male, the main income earner, in paid work before stroke and without symptoms of depression or fatigue. Independence in activities of daily living (odds ratio [OR] 30.05, 95% confidence interval [CI] 3.85-234.45), not recalling receiving advice on driving cessation (OR 5.55, 95% CI 2.86-11.11), and having returned to paid work (OR 3.93, 95% CI 1.94-7.96) were associated with early return to driving.

Conclusions One in four young adults resumed driving within a month, contrary to guideline recommendations. These data reinforce the importance of deciding who is responsible for determining fitness to drive after stroke, when, and whether it is reasonable to enforce driving restrictions on those with minimal disability who are fit to return to work.

Registration: Australian New Zealand Clinical Trials Registry ANZCTR N12608000459325

Introduction

Acute stroke is a common medical condition which can restrict one's ability to resume driving due to cognitive, visual, or motor disability (1, 2). Most people consider driving an important aspect of independent living required to fulfil roles at home and work, and for social, financial and psychological necessity (3). Stroke rates have risen by 25% in those aged between 20 and 64 years, such that they now account for one third of the global burden of this disease (4). However, the impact of stroke in this age group is seldom described, especially in relation to restrictions on driving. 'Driving is the fifth most common reason to phone the Stroke Foundation of Australia's StrokeLine (5). Generally people are confused and frustrated by a lack of information about how long they shouldn't drive for, the pathway back to driving and alternative transport options' (email exchange with J. Czerenkowski, National Manager Community Programs, November 2015).

Guidelines issued by Australia's National Stroke Foundation (NSF) (6) and Austroads, the association of Australian and New Zealand road transport and traffic authorities (2), recommend that people cease driving for at least one month after acute stroke, or for three months in the case of commercial drivers, and for two weeks following a transient ischaemic attack (TIA), to ensure medical stability and recovery of any deficits. In Australia, drivers have a legal responsibility to report to driving authorities any permanent or long-term injury or illness that may impair their ability to drive safely. In the event of a motor vehicle accident, stroke survivors may not be insured if they do not report their condition, or adhere to advice given to them by health professionals or licensing authorities, and they can be prosecuted if their condition is found to have contributed to the accident (2). Health professionals have a duty to consider breaching patient confidentiality in certain situations to report continued driving to the licensing authority; but in most jurisdictions they are protected from liability if they do so in good faith (2). The guidelines outline key features to be taken into account in this determination in the case of someone who has had a stroke.

Australian guidelines (2, 6) recommend that health professionals advise patients against driving for the required time frames. However, less than half of stroke survivors are given such advice and only a small proportion recall the advice given (1, 7, 8). This may reflect a low level of awareness of current driving guidelines among health professionals (9, 10), or avoidance of giving advice (1, 11). Irrespective of the advice given, there is evidence indicating that people self-regulate their driving according to how they perceive their fitness

to drive (7, 12), with those experiencing an acute stroke over-estimating their ability to drive (12). Most people are able to resume driving in the first year after stroke (13-15), but the timing of this varies. One third of patients with minor stroke/TIA in the UK (8) and 50% of those with ischaemic stroke in a hospital-based cohort in US (14) resumed driving within one month after onset. We aimed to provide information on the frequency and determinants of early return to driving after stroke in younger (<65 years) people in Australia.

Methods

The design of the Psychosocial Outcomes In StrokeE (POISE) study has been reported elsewhere (16, 17). In brief, POISE was a prospective observational cohort study that included 440 people aged between 18 and 65 years who survived an acute stroke following admission to one of 20 public hospitals in the Stroke Services New South Wales (SSNSW) clinical network in Australia between October 2008 and June 2010. Eligibility for the study included having had an acute stroke within 28 days and being able to speak sufficient English to participate in computer-assisted telephone interviews (or computer-assisted face to face interviews when necessary). All participants or their approved proxy provided informed consent and the study was approved by the Human Research Ethics committee of the Sydney South West Area Health Service.

Baseline demographic and clinical information was collected by clinical staff at each hospital. All participants were assessed at baseline (28 days), six and 12 months after stroke, by trained interviewers based at The George Institute for Global Health who used computer-assisted forms. The variables included in these analyses were: driving status (before and after stroke), driving license status, job-related driving, recall being told to stop driving after stroke, level of education, paid employment (full-time, part-time or self-employed), independence from others in activities of daily living (ADL), score in cognitive function according to the Telephone Interview for Cognitive Status (TICS-M) (18), level of function according to instrumental activities of daily living on the Frenchay Activities Index (FAI) scale (19), depressive symptoms according to the depression subscale of the Hospital Anxiety and Depression Scale (HADS-D) (20), and fatigue symptoms according to the vitality domain of the 36-item Short Form questionnaire (SF-36) (21). Information regarding paid and unpaid work was collected using modified versions of questions 34-51 of the Australian Bureau of Statistics 2006 Census and selected questions from the job content questionnaire (JCQ) (22).

For statistical analyses, the data are expressed as mean (\pm standard deviation (SD)) or frequency (%), with comparison between drivers and non-drivers post-stroke assessed using the Chi-Square test or two-sample *t* tests. Baseline (28 day) variables for which there was an a priori assumption that they might predict return to driving (age, sex, independence in ADL, in paid work, being told to stop driving), and variables that demonstrated a significant association ($p < 0.20$) with the outcome in bivariate analyses were considered for possible inclusion in multivariable models. Correlation and first order interaction between variables was assessed (none were found). A multivariable logistic regression model was built using all variables significant at $p < 0.20$ in the univariate analyses with adjustment for age. The predictive ability of the model was assessed by area under the curve (AUC). Data are reported with odds ratios (OR) and 95% confidence intervals (CI). All analyses were conducted using SAS version 9.3.

Results

There were 359 (82%) participants who were driving before the onset of stroke. Those not driving before their stroke were less likely to be married or in a de facto relationship, in full-time work, have health insurance and were more likely to have a pre-morbid illness that restricted their activities (~~data available on request~~).

The characteristics of included participants are presented in Table 1. Participants had an average age of 52 (± 10) years, most (67%) were employed in full or part time work and had an ischaemic stroke (83%). ~~86%~~ Eighty-six percent of participants in paid work drove to work by car.

Within one month of stroke, 96 (26.7%) participants had returned to driving and 301 (83.8%) had driven at least once by 12 months. Among the 96 participants who returned to driving within one month, 38 (40%) had also returned to paid work, 43 (45%) did not recall being told to stop driving, and 14 (15%) were considered cognitively impaired on the TICS-M screening tool (Table 2). Of the 14 with cognitive impairment, eight (57%) did not recall being told to stop driving.

Compared to participants who did not return to driving within one month, those who drove were significantly more likely to be male, the main income earner in their household, to be independent in ADL and to have returned to paid work. They were less likely to be

depressed, fatigued, and able to recall being told to stop driving (Table 2). No differences were found in other baseline characteristics.

In the multivariable model, participants were more likely to return to driving within one month of stroke if they were independent in activities of daily living at 28 days (OR 30.05, 95% CI 3.85 to 234.45), did not recall being told to stop driving (OR 5.55, 95% CI 2.86 to 11.11), and had returned to paid work (OR 3.93, 95% CI 1.94 to 7.96, Table 3). The AUC for this model was 0.816.

Compared to participants who drove in the 12 months after stroke, the 58 (16%) who never drove were significantly more likely at baseline to be female, single, smoke, have an activity-restricting illness, other illnesses, a history of depression, to be depressed and to experience fatigue. Non-driving participants were less likely to have post-school qualifications, be the main income earner in the household, work in their own business or to have health or income insurance at the time of their stroke. At 28 days after stroke, non-driving participants were more likely to be dependent on others for their activities of daily living, less likely to recall being told to stop driving, and less likely to be cognitively competent. We did not conduct multivariable modelling due to the small number of participants and the large number of associated variables.

Discussion

In this study, approximately one quarter of younger adults had returned to driving within one month of stroke, contrary to Australian policy and guideline recommendations (6) and despite more than half having been advised against doing so. Similar to research showing minimal disability predicts return to driving within six months, our early driving population tended to be without major residual disability as defined by independence in ADL (12, 14, 23). This is in contrast to those who did not drive at all in the first year after stroke who were more likely to be female, have risk factors for stroke and comorbidity (including being dependent one month after stroke), and less likely to have health or income insurance.

Of note is the finding that those who had returned to work were four times more likely to drive within one month. Since driving a car was the most common way to travel to work in our study population, it is possible that early return to work is leading to early resumption of driving. Given the disparities in access to public transport across urban and suburban areas in

Australia, survivors of stroke may be driving early (despite advice to the contrary) in order to maintain job security due to issues with the availability or affordability of alternative means of transport such as taxi subsidy schemes. Not all rural and regional locations in Australia have an accessible taxi service. In locations where government-funded subsidies are operational, such as the NSW Taxi Transport Subsidy Scheme (TTSS), an applicants' health condition must meet a high threshold of severity, for instance being unable to walk or stand or being mobile outside of home only with a wheelchair due to physical disability, in order to be eligible. An additional difficulty for survivors of stroke is that eligibility requirements and subsidies offered (a maximum of \$30 per trip for NSW's TTSS) are not uniform across all states and territories. Therefore, the challenge of finding alternate accessible transport options may also contribute to early resumption to driving.

Depression has been associated with the cessation of driving after acute stroke (13, 24). Enforced driving cessation can result in a loss of mobility leading to reduced social activities and increased depression. In our study, those who returned to driving were less likely to experience depression or fatigue. Cognition is known to affect the ability to drive after stroke (15, 23). Of concern, was the finding that 15% of those people who had resumed driving were considered to be cognitively impaired on objective testing, although there was no direct assessment of cognitive and/or driving ability.

Although over half of people who returned to driving within one month recalled being given advice not to drive, this did not seem to impact on driving resumption. Health professionals have an important role in advising stroke survivors of the consequences of their medical condition or ability to drive, as well as recommending restrictions and ongoing monitoring (2, 6). All POISE participants were admitted to a stroke unit with medical (neurologist, geriatrician and/or rehabilitation physician), nursing and allied health staff (occupational therapist, physiotherapist, speech therapist, neuropsychologist, social worker, and dietician). It is possible that staff are unclear about who is responsible for discussing or evaluating fitness to drive, and when this should occur. While some may consider it the job of rehabilitation physicians (10), they are unlikely to see patients with minimal or no disability (who are generally discharged directly home from the acute stroke unit) and referral of these patients may be considered unnecessary and time consuming. Reasons for stroke unit staff not advising patients about the driving rules will include uncertainty about the current guidelines, a belief that another health professional would be doing this task, or error.

General practitioners have reported discomfort in assessing fitness to drive, despite the Guidelines clearly stating that GPs have an important role in this duty, due to the potential consequences for their patients, such as a reluctance to give up their licence (11) and its association with social isolation. In addition, assessing fitness to drive may compromise the doctor-patient relationship (25), expose unclear medico-legal responsibilities (25, 26) and poor knowledge of the content of current guidelines (26). One Australian study showed that only 53% of general practitioners were confident in their ability to evaluate fitness to drive in their patients (25), another found that 74% wanted further education to assess fitness-to-drive and 71% on legal obligations (25).

It seems logical that assessment of fitness to drive for those with minimal or no disability after stroke should be a collaborative effort between medical and allied health staff prior to discharge from hospital. There are valid office-based tools available to help with assessment (the Road Side Recognition and Compass components of the Stroke Drivers Screening Assessment (27); Trail Making Test part B(28)) (29) as on-road driving tests are costly, time consuming, and in the case of the minimally impaired, unnecessary. Ideally, the post admission follow-up should be timed for about a month to ensure that those discharged with any disability are checked to ensure no important stroke impairments remain.

For stroke patients with obvious limitations concerning driving, in South Australia and the Northern Territory, health professionals (as defined by state legislation) are the subject of unique mandatory reporting requirements. These provide that where they believe a driver is physically or mentally unfit to drive, they must notify the relevant authority. In all other states, health professionals have more flexibility and can, as required, give supporting evidence for a conditional license or refer stroke survivors for a driver assessment. In addition, as an exception to professional and legal obligations to maintain confidentiality, if health professionals in good faith choose to notify licensing authorities that a patient is unfit to drive, or that it may be dangerous to allow them to hold, be issued or have renewed a driver's licence, they are protected from civil or criminal liability (2).

We did not collect information on fitness to drive, traffic accidents or verify the receipt or quality of driving advice in our study. ~~Therefore, we could not draw observations as to whether stroke survivors who returned to driving were safe drivers or received proper advice.~~ However, ~~†~~the substantial number of younger stroke survivors driving within one month of stroke suggests potential deficiencies and medico-legal issues regardless of fitness to drive or

quality of advice. Most stroke survivors returned to driving after the one month stand-down period and within six months of stroke. However, ~~Therefore, we could not draw observations~~ as to whether any stroke survivors who returned to driving were safe drivers or received proper advice. We recommend that all patients admitted with stroke are asked whether they are current driving license holders and, at discharge ensure that the patient has been advised appropriately.

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Table 1 Characteristics of participants who were driving before the onset of acute stroke, over 12 months of follow-up

	Period post-stroke		
	1 month (n=359)	6 months (n=352)	12 months (n=341)
Pre-stroke			
Driving was a requirement of their job*	122/242 (50.4)		
Post-stroke			
Independent in activities of daily living	355/359 (98.9)	313/351 (89.2)	304/341 (89.2)
Cognitively competent	273/327 (83.5)	283/327 (86.5)	278/315 (88.3)
Not depressed (HADS-D score <8)	282/327 (86.2)	283/327 (86.5)	276/313 (88.2)
Fatigue (SF-36 Vitality Scale score, mean (SD))	38.8 (18.9)	53.5 (25.9)	56.3 (26.0)
Legally able to drive		287/351 (81.8)	283/341 (83.0)
Returned to driving	96/359 (26.7)	254/351 (72.4)	263/340 (77.1)
Returned to paid work*	68/242 (28.1)	168/236 (71.2)	168/231 (72.7)
Recall being told to stop driving	252/356 (70.8)	18/254 (7.1)	36/338 (10.7)
By a hospital doctor	217/252 (86.1)	13/18 (72.2)	24/36 (66.7)
By a nurse	32/252 (12.7)	3/18 (16.7)	1/36 (2.8)
By police		1/18 (5.6)	
By a family member	5/252 (2.0)		
By another person	11/252 (4.4)	2/18 (11.1)	10/36 (27.8)

Return to driving against advice since last assessment	53/252 (21.0)	18/18 (100.0)	4/36 (11.1)
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Numbers are frequency (%) unless otherwise specified;

*Denominator indicative of those who were in paid employment before stroke

HADS-D, score on the depression subscale of the Hospital Anxiety and Depression Scale; SD, standard deviation; SF-36 vitality, vitality domain score of the 36 item Short Form

Table 2 Characteristics of participants who returned to driving within one month of acute stroke

	Returned to driving		OR	95% CI	P Value
	Yes (n=96)	No (n=263)			
Pre-stroke					
Age (years), mean (SD)	53.4 (9.1)	51.9 (10.3)	1.02	0.99-1.04	0.23
Male	74/96 (77.1)	168/263 (63.9)	1.90	1.11-3.26	0.02
Education					
School certificate or less	40/95 (42.1)	90/263 (34.2)	Ref.		
HSC/trade certificate	19/95 (20.0)	76/263 (28.9)	0.56	0.30-1.05	0.09
Diploma/degree	36/95 (37.9)	97/263 (36.9)	0.84	0.49-1.42	0.67
Marital status (partner)					
Never married	10/96 (10.4)	34/263 (12.9)	Ref.		
Married/de facto	20/96 (20.8)	56/263 (21.3)	1.30	0.61-2.77	0.54
Other	66/96 (68.8)	173/263 (65.8)	1.21	0.51-2.90	0.84
Lives in rural area	19/96 (19.8)	45/263 (17.1)	1.20	0.66-2.17	0.56
Lives with others	82/96 (85.4)	219/263 (83.3)	1.18	0.61-2.26	0.63
Number of financially dependent children, mean (\pm SD)	0.6 (0.9)	0.7 (1.1)	0.95	0.75-1.20	0.65
Main income earner	69/95 (72.6)	140/259 (54.1)	2.26	1.35-3.77	0.002
Non-smoker	53/95 (55.8)	153/263 (58.2)	0.91	0.57-1.46	0.69
No illness that restricted activity	72/95 (75.8)	212/263 (80.6)	0.75	0.43-1.32	0.32

No other comorbid illnesses	46/95 (48.4)	139/263 (52.9)	0.84	0.52-1.34	0.46
No history of depression	68/96 (70.8)	160/263 (60.8)	1.56	0.94-2.59	0.08
Frenchay Activities Index, mean (SD)	30.9 (6.5)	31.5 (6.7)	0.99	0.95-1.02	0.48
Low (0 to 15)	3/96 (3.1)	7/263 (2.7)	Ref.		
Moderate (16 to 30)	36/96 (37.5)	92/263 (35.0)	0.91	0.22-3.73	0.97
High (31 to 45)	57/96 (59.4)	164/263 (62.4)	0.81	0.20-3.24	0.67
Work					
Worked full-time or part-time	73/96 (76.1)	169/263 (64.3)	1.77	1.04-3.01	0.04
Self-employed/own business	20/45 (44.4)	40/112 (35.7)	1.44	0.71-2.91	0.31
No health insurance	47/94 (50.0)	135/263 (51.3)	0.95	0.59-1.52	0.82
No income protection insurance	79/95 (83.2)	237/263 (90.1)	0.54	0.28-1.06	0.07
Years in current job, mean (\pm SD)	12.7 (11.2)	11.3 (11.8)	1.01	0.99-1.03	0.32
Driving was a requirement of their job before stroke	38/71 (53.2)	84/169 (49.0)	1.17	0.67-2.03	0.59
28 days post-stroke					
Independent in activities of daily living	92/94 (97.9)	181/246 (73.6)	16.52	3.96-68.98	<0.001
Cognitively competent	79/93 (85.0)	194/234 (82.9)	1.16	0.60-2.26	0.65
Not depressed (HADS-D score <8)	87/93 (93.6)	195/234 (83.3)	2.90	1.18-7.10	0.02
Fatigue (SF-36 vitality score), mean (SD)	43.4 (19.7)	37.0 (18.3)	1.02	1.01-1.03	0.005
Did not recall being told to stop driving	43/96 (44.8)	61/260 (23.5)	2.63	1.61-4.35	<0.001
Returned to paid work	38/96 (39.6)	30/263 (11.4)	5.09	2.91-8.89	<0.001

Numbers are frequency (%) unless otherwise specified

HADS-D, score on depression subscale of the Hospital Anxiety and Depression Scale; SD, standard deviation; SF-36 vitality, vital domain score on the Short Form 36 item questionnaire; OR, odds ratio; CI, confidence interval

Table 3 Multivariable logistic regression model for return to driving within one month of stroke

	Multivariable analysis		
	OR	95% CI	P value
Pre-stroke			
Age	1.02	0.99-1.06	0.20
Male	1.22	0.62-2.44	0.57
Education			
School certificate or less	Ref.		
HSC/trade certificate	0.50	0.23-1.09	0.08
Diploma/degree	0.59	0.30-1.17	0.13
Main income earner	1.35	0.68-2.69	0.39
No history of depression	1.41	0.73-2.71	0.31
Worked full-time or part-time	1.53	0.68-3.42	0.30
No income protection insurance	0.96	0.39-2.36	0.93
28 days post-stroke			
Independent in activities of daily living	30.05	3.85-234.45	0.001
Not depressed (HADS-D score <8)	1.44	0.50-4.15	0.50
Fatigue (SF-36 vitality score)	1.00	0.99-1.02	0.77
Did not recall being told to stop driving	5.55	2.86-11.11	<0.001
Returned to paid work	3.93	1.94-7.96	<0.001

HADS-D, score on the depression subscale of the Hospital Anxiety and Depression Scale; SF-36 vitality, vitality domain score on the 36 item Short Form questionnaire; OR, odds ratio; CI, confidence interval