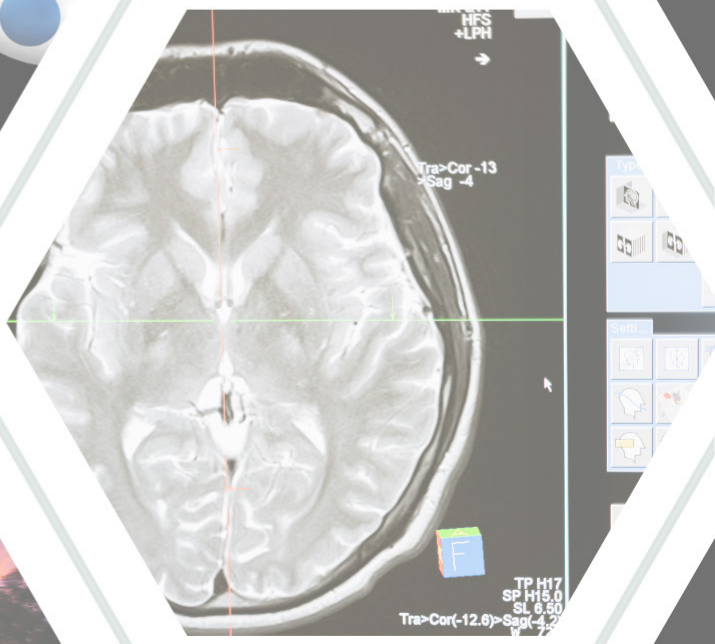
Assessing the Potential Role of Simulated Driving in Assessing Fitness to Drive








Assessing the Potential Role of Simulated Driving in Assessing Fitness to Drive

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Abstract

Background:
Stroke is the third leading cause of death in Ireland and the leading cause of acquired disability and impairment, affecting over 10,000 people in Ireland each year[1]. Despite its prevalence, there is limited information about returning to drive after stroke. The result is that there are no standardised guidelines for assessing fitness to drive after stroke. As a result, occupational therapists and other healthcare professionals must carry out off-road, clinic-based assessments using non-specific assessment methods[2]. There is a wide geographical variation in the assessment methods used.

Methods & Results:
A review was carried out of the relevant literature, with a specific focus on current practice in Ireland. Simulated driving has the potential to improve the system for assessing fitness to drive after stroke as it is safe, assesses skills that are relevant to driving, provides a near-realistic driving experience, allows for standardisation and is safe for all involved[3].

Conclusion:
Although simulated driving technology is not yet sufficiently developed, it is likely that any investment in this technology would lead to higher compliance with existing guidelines and make the roads safer for all road users.

Introduction:

Stroke is the third leading cause of death in Ireland and the leading cause of acquired disability and impairment, affecting over 10,000 people in Ireland each year[1]. Despite its prevalence, there is limited information about returning to drive after stroke[4]. The result is that there are no standardised guidelines for assessing fitness to drive after stroke. This is challenging for health professionals, specifically occupational therapists, who must complete off-road driving assessments using non-driving specific assessment methods. There is potential for simulated driving to remedy many of the problems that exist in the current system for assessing fitness to drive after stroke.

Methods:

A search was carried out of PUBMED, UCD Library One Search and the Cochrane Library of Systematic Reviews in December 2020. Specific documents were sourced from the Road Safety Authority and the Irish Heart Foundation. Articles related to driving after stroke or transient ischaemic attack, assessing fitness to drive after stroke, simulated driving after stroke and the effects of driving on stroke were included. Articles related to simulated driving for purposes other than assessing fitness to drive and articles related to assessing fitness to drive after non-neurological conditions were excluded. Review articles were prioritised, though some original research was reviewed. In total, 17

articles were reviewed.

The Effects of Stroke on Driving:

Stroke has the potential to cause many impairments which may negatively impact on an individual's ability to return to driving, including cognition, perception, vision, visuo-spatial, hearing, sensorimotor and behavioural impairments[5]. While physical and sensory deficits may be considered when assessing fitness to drive, it is the higher-order thinking skills such as awareness and insight, executive functions, judgment, problem solving and reasoning that may have a greater impact on an individual's ability to drive safely[2].

Research shows that levels of driving cessation after stroke vary widely across the world. An Irish patient and caregiver survey found that 29% of their cohort ceased driving after stroke whereas some studies from the United States have reported up to 70% driving cessation after stroke[6-8]. There has been some research into the safety of returning to drive after stroke, but much of it is not useful when assessing individuals. For example, a systematic review carried out by Rapoport et al. in 2019 concluded that "the evidence does not support a robust increase in risk of MVCs (Motor Vehicle Collisions)"[9]. This finding has limited utility, though, as stroke prevents some individuals from returning to driving and impairs ability in others, whereas some are unaffected. The review also notes that "individualised assessment and clinical judgement must continue to be used in assessing and advising those stroke patients who return to driving about their own MVC risk"[9].

While Rapoport et al. demonstrated that there was no statistically significant increase in motor vehicle collisions after stroke, Hird et al. (2015) found that individuals who had suffered acute mild stroke on average committed over twice as many errors as healthy age and education matched controls in a simulated driving environment[10]. Stroke survivors were found to be able to maintain driving performance during basic tasks (e.g. straight driving, right turns) and that deficits became apparent during more complex tasks (e.g. left turns with traffic*, bus following)[10].

The results of this research into the safety of returning to driving after stroke is limited in its utility as each individual will have different types and severities of impairments which affect their ability to drive. This highlights the importance of a comprehensive, standardised assessment of fitness to drive after stroke as the safety of the individual and all road users is of paramount importance.

For many stroke survivors, driving is essential for maintaining independent living status, and for this reason it is one of the key goals of stroke rehabilitation[9]. It is considered an Important Activity of Daily Living as it allows survivors to complete activities such as working, shopping and attending medical appointment[11-12]. Non-driving stroke survivors participate in fewer social activities and are more likely to develop depression[8]. It can also affect their health - loss of driving privileges after stroke can lead to poor health outcomes, increased healthcare costs and decreased access to care3. Those who return to driving post-stroke often report changes

to their pre-stroke driving patterns, such as reduced driving frequency[2]. Although many stroke survivors in Ireland may qualify for free travel on public transport, use of public transport by stroke survivors is affected by confidence and availability of services[13]. As public transport services in Ireland are concentrated in cities, returning to driving after stroke may be particularly important to survivors from rural areas. Due to the evident importance of returning to driving post-stroke, fitness to drive should be considered within stroke rehabilitation programmes. These programmes should not only assess fitness to drive, but also provide information about driving post-stroke and other transport options that may be available[2].

Current Guidelines Regarding Fitness to Drive Post-Stroke:

The Sláinte agus Tiomáint Medical Fitness to Drive Guidelines state that driving is not permitted for four weeks after a stroke, which is in line with international guidelines1[4-16]. The guidelines state that a person is "permitted to drive after [a four-week period] provided the clinical recovery is satisfactory". They also highlight specific areas of concern, including impairments of limb function, cognition, visual fields, visual neglect and attention deficits that may negatively affect an individual's fitness to drive[2]. The National Clinical Guidelines and Recommendations for Stroke and Transient Ischaemic Attack (TIA) also state that particular emphasis should be placed on the identification of any stroke-related impairment that may impact on the person's fitness to drive, particularly those that may result in a recommendation to cease driving[17].

The National Clinical Guidelines, in line with international research, recommend that a comprehensive fitness to drive assessment should consist of a clinic-based, off-road assessment, usually carried out by an occupational therapist, and an on-road assessment if necessary[17-19]. The guidelines do not, however, provide a standard for how this determination and decision of fitness to drive is reached, or what should be assessed during a fitness to drive assessment. For clinic-based, off-road assessments, there is no gold standard[2]. It is clear that assessment of fitness to drive is important after stroke to ensure the safety of the individual and other road users. Evaluating the driving performance of patients after a stroke is a significant challenge for healthcare professionals. While many of the potential contraindications of driving after stroke are not difficult to measure, such as visual field defects, neglect and paralysis, it is the more subtle impairments, such as deficits in executive functioning, that can be much more challenging to measure[10]. As there are no standard guidelines for how an assessment of fitness to drive after stroke should be carried out, it is not always clear which assessment methods are the best predictors of post-stroke driving ability[3].

Current Methods of Assessing Fitness to Drive After Stroke:

Given the wide variety of non-specific recommendations regarding assessment of fitness to drive after stroke, and the lack of definite guidance on what exactly occupational therapists should be including in their assessment, Stack et al. (2018) carried out an investigation of the current Occupational Therapy practice in Ireland[2]. It was found that there were a wide

variety of assessment methods used by occupational therapists when conducting off-road assessments, and that the majority of these were not driving-specific. The occupational therapists reported choosing assessment methods that were readily available and which targeted skills important for driving safely, but also placed a significant importance on functional assessment when determining fitness to drive[2]. There has been much research into the efficacy of various off-road assessment methods for assessing driver impairment, including vision tests, cognitive and neuropsychological evaluations and reaction-time measurement[3]. This research has produced mixed results, with each assessment method presenting unique weaknesses, such as poor predictive ability, poor face validity, poor sensitivity or specificity and limited reliability[3]. It has been argued that visual and cognitive off-road assessment methods are not appropriate for assessing fitness to drive as driving is a complex activity which requires timely interaction of multiple motor, visual, cognitive, and perceptual skills[3]. However, this evidence is still emerging, and the strength of each assessment method varies across research papers. Stack et al.'s research showed that current Irish practice is in line with, and supported by published research[2].

On-road driving assessments are considered the most thorough way to assess fitness to drive, but they are not without drawbacks[12]. They can be expensive, difficult to schedule, lack repeatability and pose a danger to the driver and assessor[3, 12]. Furthermore, Stack et al.'s research reported that "all the respondents reported that the outcome following on-road assessment matched their expectation of outcome based on their impression following the off-road assessment"[2]. This calls into question the utility of on-road testing. The research also reported that there were "inequalities in service provision for clients with stroke depending on which part of the country they reside in" and that there was a wide variation in assessment methods across geographical regions. It is clear that although occupational therapists in Ireland are operating within guidelines and in line with current research, the lack of standardised guidelines for assessment of fitness to drive after stroke has created a system that is not fit for purpose. Assessment methods that are non-specific and the subject of conflicting research are being used, and there is a wide geographical variation in assessment methods.

One of the main factors that renders the current system of assessing fitness to drive after stroke not fit-for-purpose is that single-construct visual and cognitive measures are being used to assess potential performance of a complex and dynamic activity. Driving involves the simultaneous interaction of multiple motor, visual, cognitive and perceptual skills, and should be assessed as such[3]. In light of the advances in simulation technology, simulator-based evaluation of driving performance may be a useful approach to overcoming many of the limitations of current clinical tests. Simulated driving can assess the skills required for driving, provide a near-realistic driving experience and may be easier to standardise than other assessment methods. It also presents very few safety risks to the individual or assessor.

Simulation as an Assessment Method:
In contrast to traditional methods, which involve the use of off-road tests, many of which are neither road-related nor developed to assess driving skills, driving simulators can be used to evaluate and rehabilitate driving-related skills in a context similar to real-life driving[3]. It allows for the assessment of tactical skills (e.g. choice of speed and lane position) and operational vehicle control (e.g. steering and braking). It also allows for the evaluation of the visual, perceptual, cognitive, and motor skills needed for safe driving. If attention, perception, memory, and executive and emotional functions are not well integrated and coordinated, impairment will be revealed in the form of poor driving behaviours, which lead to errors that can cause collisions[3].

The use of simulators to assess driving behaviours could be an effective method of assessing fitness to drive. Driving simulation allows for a close approximation of a realistic driving experience. Even if a simulation scenario lacks ''photorealistic'' quality (as may be the case in some lower-cost systems), driving simulation can nonetheless closely match the actual on-road experience because it has been shown to be valid and correlated with real-world driving. It evokes the perceptual, cognitive, and motor processes used in real-world driving[3, 10]. This allows for evaluation of driving behaviours in response to complex or challenging road and traffic conditions, as well as adverse weather and lighting conditions. These behaviours would be impossible or inappropriate to assess by any other means. These features enhance the potential utility of driving simulation as a tool for assessing fitness to drive post-stroke.

Although there is limited research in this area, driving simulation has been shown to predict on-road driving performance with better accuracy than performance in neuropsychological tests[3]. Further research into the use of simulation as an assessment strategy is required, as much of the research in this area explores the role of simulated driving in retraining. A systematic review revealed that there is "limited evidence that the use of a driving simulator may be beneficial" as only one randomised control trial was eligible for inclusion in the review[20].

The aspect of driving simulation that has the most potential for improving the current assessment system is the possibility of standardisation. Simulation allows for driving assessment to be presented with perfect repeatability, no safety risk and under full clinician control[12]. Currently, the lack of standardised guidelines for assessing fitness to drive post-stroke has created a system that is not fit-for-purpose and driving simulators could potentially remedy that.

Limitations of Simulated Driving:

Although the technology is promising, there are some issues preventing the wide use of driving simulators. Currently, there are no common hardware and software standards across different simulator platforms that would allow comparability of data across different conditions and geographical settings, though low-cost, high-quality simulators are becoming widely available[3]. Akinwutan et al. have proposed a list of ten developments that must be made within the technology before it could be widely used[3]. These are:

- Specific operational definitions of measures of safe versus unsafe driving;
- Factors contributing to error commitment and recovery;
- Validation of scenarios for evaluation and training by condition;
- Standardisation of scenario components and definitions, such as car following, hazard avoidance, curve negotiation, and others;
- Standardized specifications for vehicle dynamics;
- Streamlined data reduction and interpretation
- Age norms and condition profiles of driving scenarios;
- Integration of complementary technologies within the simulation (eg, eye-tracking devices);
- Internet-based software as a service for data repositories; and
- Population-based trends and benchmarking for enhanced medical decision making.

The research indicates that driver compliance with guidelines for returning to driving after stroke is low internationally[4, 21]. It has been suggested that "the need to return to the road may act as a powerful motivation to disregard negative advice about driving, making compliance with professional recommendations a potential problem", but there is also research to suggest that low compliance with guidelines may be due to ignorance of the guidelines rather than disregarding them[8]. Therefore, it has been reported that "most stroke survivors follow the advice they receive about driving" and that "programs to evaluate post-stroke drivers would be cost-effective because of high-compliance with recommendations"[8].

Conclusion:

Stroke is an important condition which affects a large number of people in Ireland each year. Due to the lack of standardised guidelines for assessing fitness to drive after stroke, occupational therapists and other healthcare professionals must carry out off-road, clinic-based assessments using non-specific assessment methods. Simulated driving has the potential to improve the system for assessing fitness to drive after stroke as it is safe, assesses skills that are relevant to driving, provides a near-realistic driving experience, allows for standardisation and is safe for all involved. Although the technology is not yet sufficiently developed, it is likely that any investment in this technology would lead to higher compliance with existing guidelines and make the roads safer for all road users.

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