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A Retrospective Study of Characteristics Influencing Successful Completion of Post-Stroke Driver Rehabilitation Program

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By

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Abstract

Background: Researchers completed a retrospective analysis of driving evaluations in a driver-retraining program post diagnosis of cerebrovascular accident (CVA). The purpose of the research was to determine predictors for a successful return to driving outcomes post-stroke (age 17 years or older).

Method: Data from 41 de-identified charts (23 females; 18 males) of individuals with a diagnosis of a CVA, were collected from a driver training program. Researchers used a mixed-methods approach to analyze data comparing those who were cleared to return to driving and those who were not. Researchers compared factors between successful and unsuccessful groups using Mann Whitney U. Therapist narratives were analyzed thematically.

Results: Of the 41 charts examined, 23 were cleared, and 18 failed to return to driving following evaluation. Quantitative results indicate that standardized assessments, client factors, and behind-the-wheel (BTW) factors were significantly higher for clients who were able to return to driving post-CVA. Thematic analysis revealed two themes: Insight and family support both contributed to a successful return to driving following stroke.

Conclusion: A person's fitness to return to driving post-CVA may be guided by their independence with ADLs and IADLs, insight into deficits, ability to compensate for deficits, performance on standardized and BTW assessments, and the clinical expertise of the CDRS. The therapists' narratives indicated ADL and IADL were important factors, however, specific IADL were not consistently scored during evaluations. Therapists should evaluate specific IADL skills using a standardized assessment to be consistent in determining readiness to drive.

Keywords: driving, CVA, adults, stroke, driving rehabilitation

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According to the Center for Disease Control and Prevention (CDC), stroke is a leading cause of serious long-term disability that presents with varying degrees of physical and cognitive deficits (CDC, 2017). Residual deficits from a new stroke can affect a person's independence in daily life including the ability to operate a vehicle. Deficits that present in an individual after a stroke depend on the type of stroke and the site of the brain it occurred (Devos et al., 2014). Significant predictors for return to driving at one year after stroke included sex, motor deficits, and stroke severity at seven days post-stroke (Jee et al., 2018).

Driving is an instrumental activity of daily living (IADL) that a person depends on to support endeavors at home and in the community (American Occupational Therapy Association [AOTA], 2014). Driving supports engagement in various occupations including driving to work, purchasing groceries, and attending social gatherings (Dickerson, 2014; Gibbons et al., 2017; Chihuri et al., 2016; Stav, 2012; Stineman et al., 2016). Driving is a complex task requiring significant motor, visual and cognitive skills including divided attention, judgment, reaction time, executive function, and visual scanning on-the-road (Devos et al., 2014; Park & Jung, 2015). It is important to determine the factors associated with retiring from driving given that it can limit a person's social interactions and community involvement which can negatively impact an individual's quality of life and lifestyle.

The risk of stroke increases with age and is the most common reason adults are recommended to cease driving (Dickerson, 2014; Stav, 2012). Driving rehabilitation programs consist of a combination of clinical screening and behind the wheel (BTW) assessments. These assessments can be on-the-road or simulated to test an individual's ability to operate a vehicle. Behind the wheel assessments can be expensive and time-consuming (Dickerson et al., 2011).

The Trails Making Test (TMT) is commonly used by occupational therapy practitioners, CDRS because it is cost-efficient, quick, and easy to administer for assessing an individual's executive function, visual-perceptual, and visual motor skills (Classen et al., 2013). The TMT consists of two parts: Trails A and Trails B. The Trails B test is most often used because it is considered to be a reliable predictor of failing on-the-road assessments and with determining fitness to drive (Classen et al., 2013). Measurable components of the TMT-B that influence its use for predicting an individual's driving performance include visual processing speed, divided attention, problem-solving, executive function, working memory, visual scanning, and eye-hand motor control (Classen et al., 2013)

Occupational therapists are responsible for ensuring people are safe to return to driving, offer resources for alternative transportation methods, advise or prepare clients for driving retirement and inform the client of potential risks in their driving performance (Slater, 2014). It is necessary for health professionals and driving rehabilitation specialists to evaluate the effectiveness of assessments and interventions used, to ensure the client's overall safety and well-being and the protection of other drivers. Researchers suggest that occupational therapists use IADL assessments to determine who may be at risk for unsafe driving (Dickerson et al., 2010; Dickerson et al., 2011).

In the present study, researchers aimed to identify factors that contributed to the successful completion of a driving rehabilitation program for adults post-stroke. Researchers endeavored to answer the following research questions: What client factors contribute to the successful return to driving post-stroke? What combination of standardized tests and client factors are indicators of a successful return to driving post-stroke?

Methods

This study was a retrospective review of de-identified driving evaluations from EasterSeals Crossroads driver training program in Indianapolis, Indiana. A retrospective study includes the review data that has often been acquired for reasons other than research, such as medical records (Hess, 2004). Advantages to a retrospective study include reduced cost, pre-existing data, and easier access to specific conditions (Hess, 2004). A mixed-methods approach was used. Researchers used qualitative findings to support quantitative findings.

These records, from clients with a stroke diagnosis, were referred to this specific driver training program via physicians, health care professionals, family, or self-referred. An occupational therapist (OT), Certified Driving Rehabilitation Specialist (CDRS) employed at EasterSeals Crossroads redacted all identifiable information from the records. Data from these records included specific client factors including cognition, IADL performance, ADL performance, residual stroke deficits, and past medical history (PMH).

Participants

No human subjects participated in this research, as all data was retrieved from de-identified charts of adults 17 years and older who were clients in the EasterSeals Crossroad's Driving Rehabilitation program following a diagnosis of stroke. This retrospective study used data from closed client charts, to answer our proposed research questions (Portney & Watkins, 2015, p. 278). As no human participants were involved, this study was determined to be exempt by the Human Research Protections Program at the university.

Instruments

Researchers included data from the Useful Field of View (UFOV), the Optec 5000 Vision Screener, Comprehensive Trails or Trails subparts A and B as well as the occupational therapists, CDRS clinical expertise as information relevant to an individual's ability to drive. The computer

version of the UFOV was used to measure visual processing speed and has been shown to predict driving performance in adults with strong reliability (0.884) and validity (0.735) (Edwards et al., 2005). The Optec 5000 Vision Screener measured near and far distance visual acuity, which allowed for customized test sequences and was found to have the highest validity compared to its older versions (Milburn et al., 2013). Previous researchers found lower scores on Comprehensive Trails or Trails subparts A and B correlated with driving impairments and a decline in executive function in adults (Papandonatos et al., 2015). The occupational therapist, CDRS clinical expertise was captured via the narrative that was transcribed verbatim. The narratives were qualitatively analyzed based on themes and predictive factors more likely to result in success or failure of driving. Narratives included the type of stroke, client factors such as insight, participation in leisure activities, level of independence in ADL and IADLs, and past medical history (PMH) of the client.

Procedures

An OT practitioner from Easterseals Crossroads de-identified clients' charts before providing access to researchers. The researchers used the data obtained from these charts to correlate client factors with the successful completion or failure to complete the driver-retraining program. Client records were assigned a number, and data were collected using a Microsoft Excel© spreadsheet stored on a password-protected computer in a locked office at the University of Indianapolis. All electronic data will be destroyed three years after the completion of the research project.

Data collection. Researchers obtained a narrative of the *on-the-road* portion of the assessment for participants who successfully completed the in-clinic portion of the evaluation. Driving evaluations were reviewed on-site and transcribed into Microsoft Excel©. Data included client's occupational profile, the frequency and duration of driver-retraining sessions, the

previously identified assessments, as well as a narrative from the evaluating therapist regarding the client's potential to return to driving.

An audit trail was maintained for the qualitative data to ensure trustworthiness. These discussions were transcribed and coded to eliminate any bias among researchers. Any discrepancies among researchers regarding the narrative portions of a client's chart were verified with the occupational therapist, CDRS, who was familiar with the client's record. The themes that emerged were discussed with the occupational therapist, CDRS to verify the accuracy of the analysis as member checking.

Data Analysis

Qualitative. Researchers analyzed the therapist's narratives within the evaluation and intervention to identify themes and report "patterns within the data" (Braun & Clarke, 2006). Themes were identified using explicit or surface meanings that progressed from description to interpretation (Braun & Clarke, 2006). The identified themes were cross-referenced to ensure the validity with a CDRS from Easter Seals Crossroads. The thematic analysis included; becoming familiar with data as well as discuss terms with CDRS, generating initial codes based on consistent challenges for clients, the search for themes in the connections found between client factors and characteristics of driver training program, the review of themes, defining and naming themes, and producing reports (Braun & Clarke, 2006).

Forty-one charts were arranged into categories on a Microsoft Excel© spreadsheet for further evaluation offsite. The qualitative section included information about PMH, driving history, family perception, living situation, behavior observations, driving demeanor, and therapists' summary of evaluation and discharge. Researchers divided charts into "pass" or "fail" to differentiate between individuals who returned to driving immediately after evaluation and those who required additional intervention or who were overall unsuccessful to return to driving.

Researchers sorted through the data and identified important factors within the client's evaluation. Important factors within the charts were identified after in-depth discussion with the CDRS and relevant research. Following the initial review, researchers discussed the initial findings between groups to generate codes. The keywords researchers used to code the data initially included the level of independence in ADLs, IADLs, leisure, insight, cognition, and vision deficits. Themes identified were positive family support, left-sided CVA versus right-sided CVA, vision deficits, speech deficits, physical deficits, insight, independence with ADLs and IADLs, motivation, and living situation. Charts were re-analyzed and coded based on themes from the "fail" and "pass" groups. The prevalence of each theme was discussed among researchers and the top four common themes were chosen to be analyzed in greater depth.

Quantitative.

The statistical analysis was conducted using the SPSS Mac Version 25. Based on the qualitative analysis of the therapist narratives some descriptive categories were coded as ordinal data when consistently appearing in evaluations. Researchers assigned a number to each category (i.e. PMH, visual, speech and physical deficits, independence with ADLs/IADLs and insight) to rank items. Missing data points were coded as if the item was intact. An example of this was participants were assigned a "0" if their PMH was unremarkable or not reported by the CDRS, if they did not have any residual visual, speech or physical deficits reported, or if independence with ADLs, IADLs, and insight were not reported by CDRS. This was verified by the OT practitioner on site. Participants were assigned a "1" if they had 1-2 comorbidities, visual, speech or physical deficits were present, were not independent with ADLs/IADLs or lacked insight into their deficits. A number "2" was assigned if they had 2 or more comorbidities, were independent with ADLs/ IADLs and had insight into their deficits.

Spearman rank-order was used to identify any relationships between variables and the successful completion of the driver-retraining program. All of the variables listed in Table 1, which contains Mann-Whitney U results, had a strong to moderate positive relationship ($p < .05$) as determined by Spearman rank-order, with return to driving. Researchers tested for normality of the data using the Kolmogorov-Smirnov test. After determining that the data was not normally distributed, researchers further analyzed the variables using the Mann-Whitney U to determine statistical significance between groups that did or did not successfully return to driving. Researchers identified statistically significant variables from clinical assessment scores and BTW performance, these are shown in Table 1.

Results

The 41 charts analyzed included information about 23 females and 18 males who ranged in age from 17-90 years, with an average age of 61. However, the individuals' ages ranged from 17- 90 years. Of the 41 charts analyzed, 18 individuals returned to driving after the initial evaluation and nine were recommended for additional on-the-road training to ensure safety BTW and to learn how to use adaptive equipment or compensate for residual deficits post-stroke. Seven out of nine individuals who received additional on-the-road training were cleared to drive following the intervention.

Qualitative

Analysis revealed two themes as influential in determining return to driving: family support, and insight. Narratives that indicated these factors to be positive were common for individuals who were able to successfully return to driving.

Family support. Family support included statements of the family perception of the client's driving ability, as well as statements of positive support related to the individuals' recovery from stroke. One example within the documentation that demonstrated family support

included, *"Sister states she doesn't have any concerns of him returning to driving."* This quotation revealed that the family was aware of the client's abilities and purpose of the driving evaluation. The quote, *"Daughter is supportive of her dad's recovery. She feels he is functioning very near baseline and that family feels (participant) is able to return to driving without difficulty,"* showed the family was aware that the patient was close to baseline, but had residual deficits post-stroke which could have affected the safe return to driving. An additional quotation to support this theme included *"Family feels that the client is capable of resuming driving with the visual field cut. Ct is very receptive to the process of determining safety and feels she is compensating very well."* This indicated the family's support and confidence in the client's ability to overcome deficits and demonstrate appropriate awareness of their capabilities.

Insight. Insight was revealed as the drivers' ability to understand their capabilities, deficits, and anticipate any issues they may have with driving. An individual was considered to have insight if they were aware of their deficits, demonstrated safety awareness, understood the need for driving retraining, showed the ability to learn or compensate for their deficits or were receptive to feedback. The following statements from the therapist narratives describe an individual's awareness of their deficits: *"Demonstrated insight into her vision deficits by providing some appropriate compensatory strategies."* An example of safety awareness from the documentation stated, *"Offered insight and cautious approaches she has for living alone."* This indicated that the individual, who successfully returned to driving, was also able to complete IADL tasks such as meal preparation, laundry, financial management and medication management safely at home.

A statement that demonstrated understanding of the purpose for the driving evaluation was, *"Insightful about the reason that she is here for this evaluation,"* which reflected the individual's understanding of the impact of their condition on driving performance. Client

insight is important because certain types of strokes can result in anosognosia, a condition characterized by an unawareness about their deficits. The following quote describes an individual's ability to learn or compensate for deficits: *"Client's insight and ability to learn appear functional."* The ability to learn new skills and safe driving techniques increased the client's ability to safely return to driving following training. A statement which exemplifies receptive to feedback was: *"Open to all suggestions that will make his return to driving safer and more efficient for ct."* Individuals with insight were receptive to the therapist's recommendations to improve their driving performance and increase safety on-the-road.

Quantitative

Spearman rank-order was used to identify variables that had a relationship between the pass and fail groups following the initial evaluation. Mann-Whitney U was used to identify statistically significant differences of evaluation variables between pass/fail groups because the data was not normally distributed. The results from the Mann-Whitney U were used to support qualitative findings derived from the evaluating therapist narratives.

Mann-Whitney U. After determining normality, variables were further analyzed using the Mann-Whitney U (MWU), refer to Table 1 for specifics. There were significant differences between the group who returned to driving after the initial evaluation and those who were advised not to drive in the following categories: the amount of time to complete the Trails A and B, score on the CLQT, UFOV subtest 2 and 3, UFOV risk factors, UE strength, UE coordination, LE ROM, LE strength, LE coordination, ability to park, attention, decision-making when merging, speed modulation, making right and left turns, straightaways, curves, maintaining lane position, using turn signals, divided attention, scanning during driving, independence with IADL, and insight into deficits.

Table 1

Mann Whitney U Results

Category	N Cleared	N Not Cleared	U	P<.05	Z	r
TMT A Sec.	20	16	82	.01	-2.49	-0.41
TMT B Sec.	20	15	73.5	.01	-2.55	-0.43
CLQT	11	12	16	.00	-3.18	-0.66
UFOV (2)	9	10	14	.01	-2.55	-0.59
UFOV (3)	9	10	13.5	.01	-2.64	-0.61
UFOV Risk Factors	9	10	16	.02	-2.42	-0.55
UE Strength	17	8	20.5	.02	-3.26	-0.65
UE Coordination	17	9	43.5	.04	-2.12	-0.41
LE ROM	9	7	0	.00	-3.87	-0.97
LE Coordination	14	8	14	.00	-3.71	-0.79
Parking	18	8	42	.02	-2.27	-0.45
Attention	13	6	13	.00	-3.23	-0.74
Merge Decisions	10	3	2	.02	-2.39	-0.66
Speed Modulation	22	15	103	.01	-2.58	-0.42
Right/Left Turns	22	14	55	.00	-4.28	-0.71
Straight Away	21	11	68.5	.01	-2.76	-0.49
Curves	17	7	42.5	.02	-2.25	-0.46
Lane Position	16	9	16	.00	-4.07	-0.81
Turn Signal	18	10	63	.02	-2.42	-0.46
Divided Attention	19	8	13.5	.00	-4.19	-0.81
Scanning	9	6	9	.02	-2.76	-0.71
Yielding/Merge	19	8	57	.03	-2.22	-0.43
IADL	17	2	26	.01	-2.50	-0.56

There were significant differences between the pass and fail groups in the following categories: employment status, the amount of time to complete the Trails A, attention, alertness, speed modulation, making right and left turns, straightaways, curves, maintaining lane position, using turn signals, divided attention, scanning during driving, independence with IADL, and insight into deficits. Refer to Table 1 for complete results from the MWU. From this data, it was concluded that the following clinical assessments were valuable in determining successful return to driving post-stroke following the initial evaluation: UFOV subtest 2 and 3, UE strength, UE coordination, LE strength, LE coordination, IADL, insight. Behind the wheel factors with a *p*

<.000 level of significance included: right and left turns, lane position, and divided attention all reporting. Behind the wheel factors with a $p < .023$, .024, and .026 level of significance respectively included: parking, curves and yield/merge.

Discussion

Researchers aimed to identify characteristics of individuals following a CVA who were successfully able to complete a driver rehabilitation program. The researchers' findings were consistent with the literature that standardized tests, client factors, social supports, and BTW assessments related to a successful return to driving post-CVA.

Qualitative Themes

Family support & insight. Through a thematic analysis, researchers found that family support and insight into deficits were prevalent in charts of participants who returned to driving. A participant was considered to have insight into their deficits if he or she was aware of deficits, safety awareness, understood the reason for driving retraining, had the ability to learn or compensate for deficits, and was receptive to feedback. Family perception was defined as a family's concern with participant's return to driving, family's observation of participant's compensation for deficits, family's awareness of the purpose of the evaluation, and the family's awareness of participants' capability to return to driving.

Family support is an important predictor for an improved health recovery (Lathem et al., 2015; Tsonuna-Hadjis et al., 2000; Wang, Kapellusch, & Garg, 2014). Lathem et al. (2015) found that people with mobility limitations receiving monetary and unpaid assistance from family members resulted in a 34% increase in odds for recovery. Similarly, Tsouna-Hadjis et al. (2000) determined there was an improvement in functional status for individuals with emotional family support. Family support also plays a role in influencing community re-integration for people recovering from a stroke. Researchers identified strong family or friend support to be as a

predictor of successful return to work based on a comprehensive literature review (Wang, Kapellusch, & Garg, 2014). Successful return to IADLs, such as work, can indicate that a person obtains the skills required to operate a vehicle (Dickerson et al., 2011). Family can provide feedback that can inform the occupational therapist, CDRS about skills that may hinder or support an individual's return to driving, including a participant's insightfulness.

Based on the two themes identified, researchers found a connection between insight and family support and the likelihood of returning to driving post-CVA. The following categories were common within insight: the participant's safety awareness, ability to receive feedback, ability to learn and understanding the purpose of the driving evaluation. Previous researchers found a correlation between self-reported insight into deficits and BTW assessments (Stapleton, Connolly & O'Neil, 2012). Stapleton et al. (2012) identified a positive correlation between the scores of the Adelaide Driving Self-Efficacy Scale (ADSES) and return to driving. These researchers reported that participants cleared for driving scored higher on the ADSES. The drivers that were not cleared for return to driving initially scored themselves at a high level on ADSES but opted out of the BTW assessment (Stapleton et al., 2012). Similarly, Blane et al. (2018) found that drivers who have a lesser understanding of the high complexity of skills required for driving and lack of insight into deficits were more at risk while driving on-the-road. A person's insight is important to capture given that different types of strokes can affect this skill (Jehkonen et al., 2000). Practitioners should consider the participant's insight into deficits and the type of family support when evaluating their fitness to drive post-stroke.

Quantitative Results

The MWU yielded significant results between pass and fail groups for variables except PMH and ADL status between. The MWU outcomes indicated significant results between pass

and fail groups for the following standardized assessments: Trails A and B, CLQT, Short Blessed Test, and the UFOV.

Standardized assessments. Following a stroke, clients often have a decline in their cognitive function (Blane et al., 2018). For example, people who are aware they cannot attend to multiple stimuli would avoid high traffic situations (Blane et al., 2018). In the present study, researchers found that participants with insight into their deficits were more likely to return to driving because they were able to compensate for those deficits. Therefore, it is recommended that occupational therapists evaluate a client's cognition using a standardized assessment that examines insight to contribute to an understanding of a person's fitness to drive.

The researchers found a significant difference between the participants' score on the Trails A/B and UFOV and their successful return to driving post-stroke. Results from the study are supported by other research findings in the driving rehabilitation literature. Research shows subtests two and three from the UFOV to be significant predictors of safe on-the-road driving (Choi et al., 2014). The researchers found subtest two and three of the UFOV to be indicators of a successful return to driving post-stroke, as well as Trails A and B as significant predictors of safe BTW performance (Choi et al., 2014). It has been found that occupational therapists may use the Trails B as a cognitive predictor for on-the-road performance post-stroke (Classen et al., 2013).

Behind the wheel assessment. The comprehensive driving evaluations of the present study is consistent with other driving rehabilitation programs in that it included clinical assessments and BTW assessments (Dickerson et al., 2010). Although BTW assessments have limitations, including a lack of standardization on-the-road, and psychometric properties for the BTW checklist, they are the most factual predictor to determine a client's readiness to return to driving (Devos et al., 2014).

The results of this study indicate that independence in the factors identified in the therapist narratives may be indicative of a person's driving ability. The occupational therapist, CDRS, identified client strengths, weaknesses, and areas of further assessment. In other studies, occupational therapists determined the importance of independent driving for each participant, current level of function, and daily routine through an occupational profile (Dickerson et al., 2010). It is important to assess a client's performance in areas of ADL, and IADL. These findings are congruent with studies conducted by Dickerson et al. (2010) and Dickerson et al. (2011), which indicated that the skill required to complete IADLs can predict successful driving performance. More formalized IADL assessments, as well as those that address cognition, sensory, visual, and perceptual functions should be consistently implemented in practice as part of a driving evaluation.

Conclusion

Implications

The results of the present study support the clinical utility of the BTW assessments, clinical expertise, and standardized assessments used by the occupational therapist, CDRS, at EasterSeals crossroads, to determine a person's ability to return to driving. Occupational therapists, CDRS should confidently offer subjective clinical expertise in addition to analyzing the clinical assessment scores to determine success with driving performance. Clinical expertise and subjective information make a valuable contribution to the overall driving evaluation. A person's readiness to return to driving post-stroke should be guided by their independence with ADLs and IADLs, insight into deficits, ability to compensate for deficits, performance on standardized assessments, and BTW assessments, along with the clinical expertise of the CDRS. The therapists' notes indicated ADL and IADL were important factors, however, specific IADL were not consistently scored during evaluations. Therapists should consider evaluating specific

client's IADL skills to be more consistent when determining if IADL performance is a positive or negative predictor for the client's readiness to return to driving. The occupational therapists, CDRS may benefit by using a standardized IADL assessment during initial evaluations to better gauge the number of training visits the individual will need to successfully complete the program.

Limitations

Limitations of this study include inconsistencies of evaluations and the inability to isolate specific ADL and IADL performance during analysis, leading to inconclusive results. There was a small sample size, with only 41 charts of individuals who have had a stroke evaluated by two different occupational therapists, CDRS, leading to the possibility of type 1 error. Due to the small sample size, it is difficult to generalize the findings to a population of people with a diagnosis of CVA.

Recommendations

The current research highlighted the importance of consistent reporting of outcomes across practitioners who specialize in driving. Access to consistent information across the client's charts would allow for a more thorough collection of data that would improve sample size and the possibility of yielding results that would be generalizable and inform practice. Within each evaluation, IADL should be consistently documented for a more accurate analysis of potential relationships between independence with IADL and driving.

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