

# Effect of activities of daily living status on resuming driving after stroke

MYOUNG-OK PARK, OT, MPH<sup>1)</sup>, BONG-KEUN JUNG, OTR, OTD<sup>2)</sup>\*

<sup>1)</sup> Department of Occupational Therapy, Division of Health Science, Baekseok University, Republic of Korea

<sup>2)</sup> Department of Occupational Therapy, College of Medical Science, Soonchunhyang University: 22 Soonchunhyang ro, Shinchang-myeon, Asan-si, Republic of Korea

**Abstract.** [Purpose] This study aimed to investigate the effect of the activities of daily living status on resuming driving after stroke. [Subjects] Thirty-one participants with stroke, who visited in Korean national rehabilitation centers, were included in this study. [Methods] The activities of daily living performance and the driving ability of the participants were assessed with the Korean-Modified Barthel Index in combination with the results obtained by using a driving simulator. [Results] Significant correlations were noted among the Korean-Modified Barthel Index, on-road driving total score, reaction time, speed anticipation tests, judgment tests, and steering wheel-pedal operation tests. Results of Stepwise multiple regression also revealed that the Korean-Modified Barthel Index total score and speed anticipation, with an  $R^2$  of 52.9%. In other words, as the Korean-Modified Barthel Index total score and speed anticipation score increased and the driving performance score also increased in patients who had suffered a stroke. [Conclusion] The activities of daily living status was positively correlated with the patients' post stroke driving ability.

**Key words:** Stroke, Activity of daily living, Resuming driving

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## INTRODUCTION

According to the World Health Organization (WHO), stroke is a fatal cerebrovascular disease and the second most prevalent cause of deaths worldwide<sup>1)</sup>. Visual, perceptual, cognitive, and motor control problems are experienced by stroke patients, and these lead to difficulties during functional activities of daily life<sup>2-4)</sup>.

In addition, the ability to participate in community-based daily activities is lost by 75% of stroke survivors<sup>5)</sup>. However, it is suggested in previously conducted research that stroke patients who are able to continue driving are more likely to lead a productive life, during which they are able to carry on with hobbies, work, leisure, and other important everyday activities<sup>6)</sup>. Based on the results, 40% of stroke patients who resume driving are able to sustain a high level of participation in their communities<sup>7)</sup>. It is therefore strongly suggested that stroke patients need to retain independence in activities in order to maintain their quality of life. Driving rehabilitation has been suggested to be an essential part of stroke rehabilitation, according to these results<sup>8)</sup>.

To measure driving ability in stroke patients, various

driving-related assessments have been utilized. It is important that driving evaluations and rehabilitation are accurate to assure sustainable driving in those who have suffered a stroke<sup>9)</sup>. It has been reported by several studies that the activities of daily living assessment is a predictor of the ability to resume driving and that driving ability and activities of daily living status are positively correlated. However, the effect of activities of daily living status on driving has not been well investigated<sup>10, 11)</sup>. Therefore, the effect of activities of daily living on resuming driving after stroke was investigated in this study using driving simulator testing.

## SUBJECTS AND METHODS

Thirty-one stroke patients, who visited national rehabilitation centers in South Korea, were included in this study. All participants were provided with an explanation regarding the purpose and methods, procedure, and ethical issues of the study, in accordance with the ethical principles of the Declaration of Helsinki. This study was approved by the institutional review board of the Soonchunhyang University (IRB NO. 1040875-201412-BM-045). The inclusion criteria required a period of at least 6 months between the stroke diagnosis and the testing, as progressive neurological changes can occur in the motor, visual, perceptual, and cognitive functions within this 6-month period<sup>12, 13)</sup>. Another important selection criterion was that only those who were licensed, experienced drivers before the stroke could be considered. In addition, participants with severe visual or auditory dysfunction were excluded from this study, because

\*Corresponding author. Bong-Keun Jung (E-mail: jungb@sch.ac.kr)

the simulator did not support drivers with auditory or visual impairments. Demographic characteristics of participants are shown in Table 1. To identify the current activities of daily living status of the patients, the modified Korean version of the Barthel Index (K-MBI), developed by Jung et al., was used<sup>2)</sup>. The K-MBI consists of 10 items including hygiene, bathing, eating, toileting, dressing, and bowel and bladder control, among others. It was used to measure the independence level of the participants. The complete independence score for each item is 10 points, totaling to 100 points. To identify the performance-based driving ability of patients, a driving simulator (GDS-300, Gridespace, Seoul, Korea) was used. The software of the driving simulator includes test items for assessing driving ability. These items include 5 sub-tasks: reaction time, judgment, speed anticipation, steering wheel-pedal operation, and on-road driving task. The maximum score is 100 points<sup>14, 15)</sup>. First, the K-MBI was administered by an experienced occupational therapist. The driving ability was measured using the driving simulator. For a statistical analysis of the results, the Shapiro-Wilk test was used to measure the normality of the variables, and descriptive statistics were used for the demographic characteristics. Correlations between the K-MBI score and driving ability were explored using Pearson's correlation coefficient. In addition, stepwise multiple regression analysis was used to determine the predictors for the on-road driving total score. Software of statistical package for social science (SPSS version 20.0. Chicago, IL, USA) was used to perform the statistical analyses.

## RESULTS

A relatively strong correlation appeared between the K-MBI total score and the on-road driving total score ( $r=0.526$ ,

**Table 1.** Demographic characteristics of the study participants (N=31)

	Mean $\pm$ SD	Frequency (%)
Age (yrs)	46.4 $\pm$ 13.1	
Driving experience (yrs)	14.5 $\pm$ 8.4	
K-MBI total score	77.53 $\pm$ 18	
Gender	Male	24 (77.4)
	Female	7 (22.6)
Hemiplegic side	Right	15 (48.4)
	Left	16 (51.6)
Cause of stroke	Infarction	18 (58.1)
	Hemorrhage	13 (41.9)

$p=0.002$ ), and there was a moderate correlation between the K-MBI total score and the reaction time ( $r=0.389$ ,  $p=0.031$ ), speed anticipation ( $r=0.427$ ,  $p=0.017$ ), and steering wheel-pedal operation ( $r=0.497$ ,  $p=0.006$ ). Furthermore, the judgment score showed a relatively strong correlation with the K-MBI total score ( $r=0.551$ ,  $p=0.001$ ) (Table 2). To determine the factors affecting the total road score, a stepwise multiple regression was performed. The results were as follows: On-road driving total score= $35.206+(0.569*\text{K-MBI})+(3.178*\text{speed anticipation})$ . In other words, the higher the K-MBI and speed anticipation scores, the higher the on-road driving total score, with an  $R^2$  value of 52.9% (Table 3).

## DISCUSSION

Various types of rehabilitative methods are used by occupational therapists to assist patients in restoring and maintaining a comfortable and independent life with their residual functions. Helping the client return to work is considered a vital element of this rehabilitation<sup>5)</sup>. To do so, therapists must evaluate the driving ability of clients with brain injuries and those with aging and driving-related functional decline. This study aimed to determine the effect of activities of daily living status on resuming driving after stroke. According to the present study, the on-road driving score and K-MBI total score were strongly correlated. In addition, reaction time, judgment, speed anticipation, and steering wheel-pedal operation scores demonstrated a significant correlation with the K-MBI score. These results are similar to those reported by Gama et al.<sup>16)</sup>, who studied elderly subjects with cognitive impairments but not stroke survivors; according to their report, an increase in the scores for functional activities of daily life was associated with an increase in self-driving scores. In this respect, the activities of daily living status is an important factor affecting resuming of driving after stroke. Therefore, an accurate evaluation and appropriate training for improving activities of daily living status is necessary prior to initiating post-stroke driving rehabilitation.

**Table 2.** Correlation between K-MBI and driving performance skills to the driving total

	K-MBI total score
On-road driving total score	0.526**
Reaction time	0.389*
Judgment	0.551**
Speed anticipation	0.427**
Steering wheel-pedal operation	0.497**

\* $p<0.01$ , \*\* $p<0.05$

**Table 3.** Factors of K-MBI and driving performance skills to the driving total score

	B	$\beta$	t	VIF
(A constant)	35.206		3.482*	
K-MBI	0.569	0.589	4.539*	1.000
Speed anticipation	3.178	0.427	3.293*	1.000

\* $p<0.01$ ,  $r^2=52.9\%$

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