

Impact of Upper Limb Function and Employment Status on Return to Work of Blue-Collar Workers after Stroke

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Background and Purpose: Return to work (RTW) after stroke is the ultimate goal of the working population to achieve economic independence and well-being. Previous studies have reported lower RTW rates of blue-collar workers versus white-collar workers. Thus, investigating predictive factors for RTW of blue-collar workers is meaningful to improve RTW after stroke. Here, we investigate the physical, cognitive, and social factors associated with the RTW of blue-collar workers after stroke. *Methods:* Poststroke rehabilitation data for 71 patients aged 15-64 years who had been active blue-collar workers at stroke onset were analyzed from a single-center observational cohort database. Baseline characteristics, social background factors, and quantitative assessments of the upper limb, lower limb, and cognitive functions at discharge were analyzed to identify any association with RTW. Receiver operating characteristic curve analysis was performed to determine the optimal cutoff value of continuous variables with significant associations. *Results:* Functional upper limb represented by an increasing Simple Test for Evaluating hand Function (STEF) score was independently associated with RTW of blue-collar workers by multivariable logistic regression analysis (odds ratio [OR], 1.08; 95% confidence interval [CI], 1.01-1.14; $p = .017$). Correlation with self-employment status was also significant compared to that with employee status (OR, 185; 95% CI, 1.05-32400; $p = .048$). The cutoff value of the 100-point scale STEF to discriminate between RTW and non-RTW was 82. *Conclusions:* Functional upper limb and self-employment status were independent predictors for the RTW of blue-collar workers after stroke.

Key Words: Stroke rehabilitation—return to work—blue-collar worker—functional upper limb—self-employment

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Abbreviations: RTW, return to work; STEF, Simple Test for Evaluating hand Function; BBS, Berg Balance Scale; MMSE, Mini Mental State Examination; ROC, receiver operating characteristic; ADL, activities of daily living; IQR, interquartile range; OR, odds ratio; CI, confidence interval

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Introduction

Despite progress in prevention and treatment, stroke remains a major cause of mortality and morbidity. Although stroke occurs predominantly in older people, working populations of people aged <65 years account for 14% of all stroke patients in Japan.¹ Thus, it is important to determine the predictive factors of this population for return to work (RTW) because stroke is not only associated with physical but also with economic burden in this age group. Previous studies have described several predictive factors after stroke for the RTW of entire worker populations.²⁻⁴ However, among them, blue-collar workers may require specific brain functions for an RTW because physical skill rather than office work should be emphasized in their jobs.⁵ Here, we examine the physical, cognitive, and social factors at the end of the rehabilitation phase that affect the RTW of blue-collar workers after stroke.

Materials and Methods

This study was reported based on criteria from the Strengthening the Reporting of Observational Study in Epidemiology statement.⁶ The study protocol was approved by the Wafukai-Hashimoto Hospital Research Ethics Committee (Kagawa, Japan) (#001), and waiver of consent was sought and obtained for this cohort study with no unique patient identifiers.

Patient Selection and Study Design

This retrospective cohort study included patients who were discharged from our poststroke rehabilitation center within 180 days after stroke between March 2011 and March 2017. Patients were included when they were aged 15-64 years and working blue-collar occupations at stroke onset (working population). Patient occupation at stroke onset was classified according to the Japanese Standard Classification of Occupations.⁷ We defined the following occupations as blue-collar: service; security; agriculture/forestry/fishery; manufacturing process; transport and machine operation; construction and mining; and carrying, cleaning, and related work. Among the 172 patients who were discharged from our poststroke rehabilitation center in this period, 71 met the inclusion criteria.

RTW as a primary outcome of the present study was determined according to a questionnaire at the clinic or a telephone interview 6 months after stroke. Patients who returned to their former blue-collar work within 6 months after stroke were defined as the RTW group. Patients who started new office work that did not require skills from their former jobs were not included in the RTW group.

Patients' baseline characteristics, job category, occupational status (employer or employee), and stroke subtype (cerebral infarction, intracerebral hemorrhage, or subarachnoid hemorrhage) were retrieved from the patients' medical records. Each patient's upper limb function was evaluated using the Simple Test for Evaluating hand Function (STEF; 0-100 points),⁸ lower limb and balance function using the Berg balance scale (BBS; 0-56 points), and cognitive function using the mini mental state examination (MMSE; 0-30 points), by independent physical, occupational, and speech therapists at discharge. Any association between these independent variables and RTW was investigated using univariate and multivariable analyses. In terms of independent continuous variables with a statistically significant association by multivariable analysis, receiver operating characteristic (ROC) curve analyses were performed to determine optimal cutoff values for predicting the RTW.

A detailed individual interview was performed of patients who revealed an unexpected RTW or non-RTW according to the results of the present study by

asking factors associated with their decision-making processes.

Rehabilitation Program

The recovery phase rehabilitation ward of our institution was approved by the Ministry of Health, Labour and Welfare, Japan and was where stroke patients were admitted within 2 months after stroke onset.⁹ The rehabilitation program (physical, speech, and occupational therapy) is provided for a maximum 3 hours every day including weekends and holidays according to the patient's disability. For instance, speech therapy was used only in patients with an eating disorder, dysarthria, aphasia, or cognitive dysfunction. Speech and occupational therapy were used when patients retained sufficient physical capability for daily activities. The length of stay in our rehabilitation center is determined based on the regained physical and cognitive functions in which patients with less severe symptoms are discharged early, whereas those with severe symptoms remain admitted for several months. After discharge, rehabilitation continues at our clinic once or twice a week according to patient preference. When a patient is likely to restart the job, a rehabilitation staff member visits the workplace with the patient to evaluate whether sufficient function has been regained for an RTW.

Data Analysis

Quantitative variables are expressed as mean \pm standard deviation or median and interquartile range (IQR; 25th-75th percentile) as appropriate. Chi-square analysis was used to test the associations between categorical variables. Non-normally distributed continuous variables were analyzed by the Mann-Whitney *U* test. A Multivariable logistic regression analysis was performed to detect significant associations between RTW and the patients' baseline characteristics and physical/cognitive functions at discharge. Goodness of fit for the multivariable logistic regression model was evaluated by the Hosmer-Lemeshow test, and *p* values greater than or equal to .05 were defined as good. An ROC curve was drawn to evaluate the predictability of an independent variable for an RTW. The area under the curve was calculated to determine the accuracy of prediction and interpreted as good (.9-1.0), moderate (.7-.9), or poor (.5-.7). The optimal cutoff value to discriminate between the RTW and non-RTW groups was determined by identifying the value nearest the upper-left corner of the graph (sensitivity, 1.0; 1-specificity, .0).¹⁰ The odds ratio (OR) and 95% confidence interval (CI) were also determined in the logistic regression analysis. Probability values < .05 were considered statistically significant. All statistical analyses were conducted using R software (version 2.8.1; R Foundation for Statistical Computing; <http://www.R-project.org>).

Results

Patient Baseline Characteristics and Functions at Discharge

The patients’ baseline characteristics, and physical/cognitive functions at discharge are summarized in Table 1. From our poststroke rehabilitation database, 71 patients (54 men, 17 women) with a mean age of 54.4 ± 9.7 years who had worked as active blue-collar workers at stroke onset were discharged from our rehabilitation center. Stroke subtypes included 25 cases of cerebral infarction, 36 cases of intracerebral hemorrhage, and 10 cases of subarachnoid hemorrhage. Patients were admitted to our rehabilitation center 31 [20-42.5] (median [IQR]) days after stroke onset. Job categories at stroke onset included 20 of service work; 1 of security work; 11 of agriculture/forestry/fishery work; 10 of manufacturing process work; 8 of transport and machine operation work; 19 of construction and mining work; and 2 of carrying, cleaning, and related work. Among them, 26 had self-employment status (employers) whereas 45 were employees. Patient STEF, BBS, and MMSE scores at discharge were 85 [0-98], 56 [47-56], and 30 [25-30] (median [IQR]), respectively.

Factors Affecting the RTW of Blue-Collar Workers

Among the 71 patients investigated, 38 (53.6%) returned to their former blue-collar work within 6 months after stroke onset and were categorized into the RTW group. Table 2 shows the results of the univariate analysis of the predictive factors for RTW. All the investigated

Table 1. Baseline characteristics of the patients who had worked on blue-collar work and were discharged from the rehabilitation center after stroke

Variable	Value
Number of patients (%)	71 (100)
Mean age (years)	54.4 ± 9.7
Women (%)	17 (23.9)
Stroke subtype	
Cerebral infarction (%)	25 (35.2)
Intracerebral hemorrhage (%)	36 (50.7)
Subarachnoid hemorrhage (%)	10 (14.1)
Admission from onset (days)	32.5 ± 13.6
Discharge from onset (days)	116.2 ± 48.1
Employment status	
Self-employment (%)	26 (36.6)
Employee (%)	45 (63.4)
Functional scores	
STEF	85 [0-98]
BBS	56 [47-56]
MMSE	30 [25-30]

BBS, Berg balance scale; MMSE, mini mental state examination; STEF, simple test for evaluating hand function.

Data are presented as the mean ± SD, median [IQR], or as the number of patients (%).

functional scores (STEF, BBS, and MMSE) were significantly associated with RTW ($p < .001$ for all; Mann-Whitney U test). Employment status was also significantly associated ($p < .001$; chi-squared test), where self-employed workers were more likely to return to their former work than were employees.

A multivariable logistic regression analysis was performed (Table 3). Age, sex, employment status, and STEF, BBS, and MMSE scores were chosen as independent variables, and goodness of fit was confirmed using the Hosmer-Lemeshow test ($p = .993$). Higher STEF scores remained a significant predictor for an RTW after the adjustment for potential confounders (OR, 1.08; 95% CI, 1.01-1.14; $p = .017$). Self-employment status was also independently associated with the RTW (OR, 185; 95% CI, 1.05-32400; $p = .048$).

Threshold of Upper Limb Function for RTW

Figure 1 shows the result of the ROC curve analysis for the STEF score to discriminate between RTW and non-RTW groups. The optimal cutoff value of the STEF score was 82, with a sensitivity of 84.2% and specificity of 84.9%. The area under the curve was .890, suggesting moderate accuracy for prediction. Cross-tabulation for dichotomized STEF and RTW scores is shown in Table 4. A higher STEF score (≥ 82) was significantly associated with an RTW ($p < .001$; chi-squared test). According to the cross-tabulation, we performed detailed interviews of the 5 patients who retained a STEF score greater than or equal to 82 but were unable to return to work. All 5 patients were employees. Among them, 4 were allowed by their employers to return to their jobs. However, these patients chose voluntary retirement because of miscommunication with employers, lack of self-confidence, or unfounded anxiety. We also interviewed 6 patients with STEF scores < 82 who were able to return to work. Among them, 5 were self-employed. They considered relevant factors facilitating their successful RTW as flexible control of working conditions, including a staged return to work, schedule management, and reasonable task sharing.

Discussion

In this article, we evaluated factors influencing the RTW of blue-collar workers after stroke and characterized upper limb function at discharge of the rehabilitation center as an independent predictor. The association with self-employed status was also significant.

Despite progress in prevention and treatment, cerebral stroke remains a major cause of disability. Although the initial goal of stroke patients is to regain daily activities, an RTW is the ultimate goal for not only economic income but also social restoration, well-being, and life satisfaction of stroke survivors.¹¹ Predictive factors for vocational outcome differ from those for survival and daily activity outcomes.^{12,13} Previous studies described several predictive

Table 2. Univariate analysis of factors for RTW of blue-collar workers

Variable	RTW		p value
	Success (n = 38)	Fail (n = 33)	
Mean age (years)	53.4 ± 11.7	55.6 ± 6.6	.32
Women (%)	7 (18.4)	10 (30.3)	.24
Self-employment (%)	21 (55.3)	5 (15.2)	<.001*
STEF	96 [87.25-100]	0 [0-1]	<.001*
BBS	56 [56-56]	46 [6-52]	<.001*
MMSE	30 [24-30]	25 [13-30]	<.001*

BBS, Berg balance scale; MMSE, mini mental state examination; RTW, return to work; STEF, simple test for evaluating hand function.

Data are presented as the mean ± SD, median [IQR], or as the number of patients (%). Data are analyzed with chi-squared test or Mann-Whitney *U* test. **p* value < .05 is considered to indicate statistically significant difference.

factors after stroke for RTW of entire workers and revealed that blue-collar workers were less likely than white-collar workers to RTW.^{2,14} We assumed that blue-collar workers may need to regain occupation-specific skills to RTW, which is not necessarily required for white-collar workers to RTW.

In our study, all investigated neurological functions, including upper limb function represented by STEF, lower limb, and balance function represented by BBS, and cognitive function represented by MMSE, were associated with RTW on univariate analysis. Notably, a higher STEF score remained a significant predictive factor for RTW on the multivariable analysis while BBS and MMSE did not, suggesting that a functional upper limb is a more specific predictor for the RTW of blue-collar workers. It is possible that upper limb function directly affected the blue-collar workers' ability to work, whereas lower limb and cognitive function did so by deteriorating activities of daily living (ADL).^{15,16} In other words, patients with low ADL rarely returned to work; among patients with high ADL, only those who retained or regained upper limb function were able to RTW. Previous studies described hemiparesis severity after stroke as a significant predictor for RTW.^{2,14} Among them, Saeki et al. demonstrated that functional upper limb was independently associated with

an earlier RTW of entire worker populations while functional lower limb was not, supporting our idea of requirement of upper limb function for blue-collar workers to RTW.¹⁵

In this study, we applied STEF scores to evaluate the RTW of blue-collar workers. Previous studies used qualitative assessments of upper limb function, such as "functional, assistive, and nonfunctional".^{2,14,15} However, we assumed that quantitative scoring may be useful for evaluating the detailed upper limb function of blue-collar workers who must regain occupation-specific functions for RTW. Among several scoring methods of upper limb function, STEF was established with a focus on practical use of the upper limbs for real tasks that may directly link to the functions required for an RTW.^{8,17,18} Because STEF consists of variety of upper limb movements such as grasping, carrying, and rotating, rehabilitation staff members are able to capture patient-specific dysfunctions

Table 3. Multivariable logistic regression analysis of factors for RTW of blue-collar workers

Variable	Adjusted OR (95% CI)	p value
Age	.93 (.82-1.04)	.20
Woman	.83 (.065-10.6)	.89
Self-employment	185 (1.05-32400)	.048*
STEF	1.08 (1.01-1.14)	.017*
BBS	1.01 (.77-3.40)	.94
MMSE	1.53 (.79-1.30)	.28

BBS, Berg balance scale; MMSE, mini mental state examination; RTW, return to work; STEF, simple test for evaluating hand function.

**p* value < .05 is considered to indicate statistically significant difference.

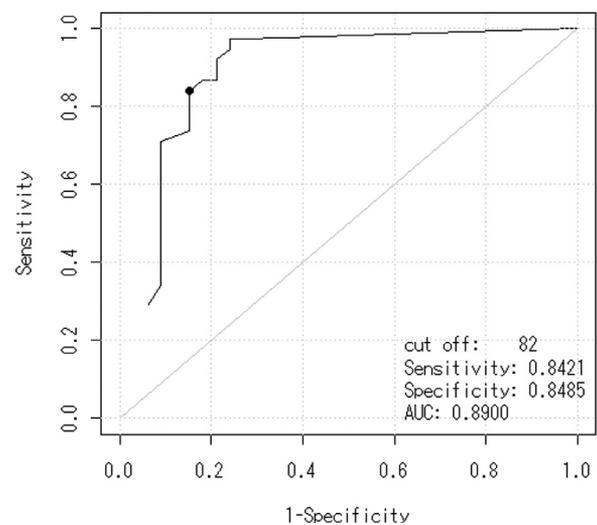


Figure 1. Receiver-operating characteristic curve analysis of STEF score to discriminate between the RTW and non-RTW groups. A STEF cutoff value of 82 (black dot) shows a sensitivity of 84.2% and specificity of 84.9%, with an area under the curve of .89. RTW, return to work; STEF, simple test for evaluating hand function.

Table 4. Cross-tabulation for association of dichotomized STEF and RTW

	RTW success	RTW fail
STEF \geq 82	32	5
STEF $<$ 82	6	28

RTW, return to work; STEF, simple test for evaluating hand function.

Data are presented as the number of patients.

hampering an RTW. In addition, setting quantitative goals for an RTW in a certain scoring method, e.g. a STEF score 82, may motivate both patients and rehabilitation staff members to work to regain skills.

Self-employment status was also independently associated with RTW as compared with employee status, suggesting other relevant factors for the RTW of blue-collar workers. There are several possible explanations for the better RTW rate of self-employed workers. First, according to the detailed interviews of patients who failed to return despite favorable upper limb function and those of patients who successfully returned despite poor upper limb function, we found that blue-collar self-employed workers receive more environmental support regarding working conditions. The flexible control of working conditions would be able to eliminate physical and mental barriers to the RTW. Second, the responsibility of self-employed workers for the company they own may positively affect their RTW. Third, although categorized as blue-collar, self-employed workers' jobs may include less physical (white collar-like) work such as management and office tasks.^{2,14} Previous studies have reported a better RTW rate of white-collar workers than blue-collar workers.^{2,14} In contrast, because blue-collar work demands physical strength and/or skills, employees may worry whether employers accept their disability, predisposing to voluntary retirement of employees with mild motor weakness. The RTW of such employees may be more complicated due to involvement of employer–employee relationships and contract.¹⁹

Our study had several limitations. First, because of its observational design in a single institution, its findings should be interpreted cautiously. In a retrospective study, potential interactions among variables may not be completely excluded by a multivariable analysis. Second, the association between upper limb function and the RTW of white-collar workers was not investigated. Thus, a comparison between blue-collar and white-collar workers was unavailable. Third, we evaluated patients' function at discharge of the rehabilitation phase, but not at RTW. Functional recovery after discharge and functional scores at RTW may be more relevant to RTW rate and should be another concern, although detailed functional scoring at the clinic after discharge is not necessarily feasible. However, the present study suggests that multiple

approaches are available to increase the RTW rate of blue-collar workers. First, the upper limb function represented by the STEF score could be improved by the incorporation of novel rehabilitation methods, including robotics, constraint-induced movement therapy, and transcranial magnetic stimulation.²⁰⁻²² Second, because STEF detects impaired individual upper limb movements (e.g. grasping, carrying, and rotating), tailor-made occupational therapy may be available by focusing on the movement specific to the work the patient wishes to return to. Third, environmental support for RTW according to the patient's social background may be beneficial. For example, more careful support could be proposed for employees who feel difficulty with the RTW, such as counseling, schedule management, task sharing, and intervention in the employer–employee relationship.

In Japan, individuals aged greater than or equal to 65 years (aging rate) comprised 27.3% of the population in 2016; this Figure 1 is estimated to reach 38% by 2060. Accordingly, the number of workers 15-64 years of age will decrease from 77 million in 2016 to 48 million in 2060.²³ In this aging society, increasing the RTW rate would compensate for the nationwide labor shortage of blue-collar workers, which predominantly consist of workers aged <65 years. Despite recent developments in rehabilitation therapy, the RTW rate of poststroke patients has remained unchanged for the past 20 years.²⁴ Further investigations are warranted to confirm favorable factors for the RTW of blue-collar workers and identify the causative mechanisms.

Conclusion

Functional upper limb and self-employment status were independent predictors for the RTW of blue-collar workers after stroke.

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