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*Original Article*

# The difference between measured Nichijo-seikatsu-kino-hyokahyo (NSKH) score and predicted NSKH score derived from ADL is related to FIM gain

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**ABSTRACT**

Tokunaga M, Fukunaga K, Sannomiya K, Imada Y, Inoue R, Hamasaki H, Noguchi D, Nakashima Y, Watanabe S, Nakanishi R, Yamanaga H. The difference between measured Nichijo-seikatsu-kino-hyokahyo (NSKH) score and predicted NSKH score derived from ADL is related to FIM gain. Jpn J Compr Rehabil Sci 2013; 4: 61−66.

**Purpose:** To determine if the difference between measured Nichijo-seikatsu-kino-hyokahyo score (NSKH) and predicted NSKH score (measured NSKH-predicted NSKH) derived from the Functional Independence Measure (FIM) score is related to FIM gain, and whether it increases the predictive accuracy of FIM gain.

**Methods:** We studied 102 stroke patients in the Kaifukuki rehabilitation ward with FIM scores at admission between 18 and 58. We analyzed whether a correlation exists between “measured NSKH-predicted NSKH” and “FIM gain”, and performed a multiple regression analysis to predict FIM gain.

**Results:** A significant negative correlation (correlation constant −0.275, $p<0.01$) was detected between measured NSKH-predicted NSKH and FIM gain. The adjusted R-square value increased by 0.101 after incorporating measured NSKH-predicted NSKH into the predictive equation for FIM gain, which included age and FIM score at admission.

**Conclusion:** This study demonstrates that measured NSKH-predicted NSKH correlates with FIM gain, and that measured NSKH-predicted NSKH is an index that increases the predictive accuracy of FIM gain.

**Key words:** Nichijo-seikatsu-kino-hyokahyo, needs of nursing care, Functional Independence Measure, gain

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## Introduction

Accompanying revision of the medical payment system in 2008, the Nichijo-seikatsu-kino-hyokahyo (hereinafter referred to as “NSKH”)[1] that was initially developed as a nursing care needs assessment, was added to the facility standards for hospitalization fees in Kaifukuki rehabilitation wards. In the NSKH, 13 items are scored on a scale of 0−1 or 0−2; the total score (0−19 points) is lower if the patient is independent and higher if a higher level of care is required.

However, apart from being a requirement to claim medical treatment fees, the necessity of the NSKH in Kaifukuki rehabilitation wards is unclear. Sonoda et al.[2] stated that although the NSKH contains elements of activities of daily living (ADL), it remains unclear whether NSKH is compatible with the Functional Independence Measure (FIM), a typical ADL assessment method, and further investigation is required to determine what the NSKH indicates and whether it represents the outcome of rehabilitation. Iwai et al.[3] concluded that “the Nichijo-seikatsu-kino-hyokahyo index is unlikely to result in better prediction of FIM at discharge or predictability of discharge destination”. However, if the NSKH is viewed as an assessment method for care needs level (how much nursing care is required), the necessity of the NSKH in Kaifukuki rehabilitation wards will become clear.

Patients admitted at the same age and with the same total FIM score may have different FIM scores at the time of discharge. This is because FIM gain (FIM score at discharge minus FIM score at admission) is influenced not only by age [4] and FIM at admission, but also by other factors such as pre-onset ADL [5], type of stroke [5], focal site of stroke [5], presence of unilateral spatial neglect [5], presence of aphasia [5], comorbidity [6], smoking habit [7], and the desire and mental state of the patient.

In principle, FIM and NSKH scores are related (patients with lower ADL have higher care needs), and FIM can be used to predict NSKH. We name the NSKH score derived from ADL as "predicted NSKH." Patients whose measured NSKH scores are higher than the predicted NSKH scores are "patients who require care beyond ADL." Hence, there is a possibility that the difference between measured NSKH and predicted NSKH scores is related to FIM gain. In other words, it may be possible to represent a portion of the factors that influence FIM gain with a value calculated as the difference between measured NSKH and predicted NSKH scores (whether care needs are greater than ADL support).

Our study objectives were to (1) determine whether a relationship exists between measured NSKH score minus predicted NSKH score ("measured NSKH-predicted NSKH") and FIM gain, and (2) determine whether measured NSKH-predicted NSKH is an indicator that increases the predictive accuracy of FIM gain.

## Subjects and Methods

In this retrospective epidemiological study, we examined 256 stroke patients in the Kaifukuki rehabilitation ward of Hospital A; these patients had received prior treatments in acute care hospitals. The patients were admitted between February 1, 2011 and March 31, 2012. The range of duration from onset of stroke to admission was 8−60 days, length of hospital stay was 22−180 days, and FIM score at admission was 18−119 (Table 1). The basic attributes of the subjects were similar to those in the nationwide survey [8] and the report of Iwai et al.[3], except for the shorter duration from onset of stroke to admission. The subjects were divided into two groups by FIM score at admission: group A consisted of 102 patients with scores of 18−58 and group B consisted of 154 patients with scores of 59−119 .

All the data required for this study were submitted to the database without any missing value. This study was conducted after obtaining approval from the clinical study review committee of the hospital. All personal information was treated anonymously.

*Assessment 1: Regression equation for the prediction of NSKH scores from FIM scores*

To predict the NSKH score at admission from the FIM score at admission, a simple regression analysis (significance level of less than 5%) was conducted.

*Assessment 2: Measured NSKH-predicted NSKH*

Spearman's rank correlation coefficient was used to examine the relationship between measured NSKH-predicted NSKH and FIM gain. In addition, the FIM gain was compared between the group showing positive (above 0) and the group showing negative (below 0) measured NSKH-predicted NSKH using the Mann-Whitney test. A significance level less than 5% was adopted in both cases.

*Assessment 3: Multiple regression analysis for the prediction of FIM gain*

Multiple regression analysis was conducted to predict FIM gain based on age and FIM score at admission. Next, variable selection-multiple regression analysis was conducted to predict FIM gain using three variables: age, FIM score at admission,

**Table 1.** Clinical characteristics of subjects in this study compared with other studies.

| | This study | National survey [8] | Iwai et al. [3] |
|---|---|---|---|
| Number of patients | 256 | 14,011 | 482 |
| Infarction, hemorrhage, SAH | 145 cases, 92 cases, 19 cases | 67.9%, 26.2%, 5.9% | — |
| Age | 68.4±14.0 | 72.0 | 67.8±13.1 |
| Sex | Male 161, female 95 | 56.8% males, 43.2% females | Male 301, female 181 |
| Duration from onset of stroke to admission | 21.3±10.0 | 36.6 | 33.3±19.4 |
| Length of hospital stay | 88.9±37.0 | 89.4 | 93.6±45.0 |
| FIM score at admission | 67.9±32.5 | 68.4 | — |
| Motor FIM score at admission | — | — | 48.0±23.0 |
| Cognitive FIM score at admission | — | — | 21.7± 9.1 |
| FIM score at discharge | 93.7±31.6 | 85.8 | 92.7±29.9 |
| FIM gain | 25.8±20.0 | 17.4 | — |

FIM, Functional Independence Measure; FIM gain, FIM at discharge-FIM at admission; SAH, subarachnoid hemorrhage. Data for this study are expressed as mean±standard deviation, or number of patients.

and measured NSKH-predicted NSKH (those with F-statistic greater than 2 were selected as effective explanatory variables). The coefficient of determination $R^2$ (i.e., how much the objective variable can be explained by an explanatory variable) was adjusted for the degree of freedom and subsequently compared between results obtained from the two prediction equations.

*Assessment 4: Multiple regression analysis under various conditions*

Multiple regression analysis was conducted by screening all patients (range of FIM scores at admission: 18−119) instead of patients with FIM score at admission of 18−58 or 59−119, using FIM score at discharge instead of FIM gain as the objective variable, and NSKH score instead of measured NSKH-predicted NSKH as the explanatory variable.

## Results

In the simple regression analysis, both groups A and B showed a significant linear expression that predicts the NSKH score at admission (Y) using the FIM score at admission (X) as follows: $Y = -0.169\times(X+17.581)$ ($p<0.001$, $R^2=0.492$) in group A, and $Y = -0.161\times(X+18.415)$ ($p<0.001$, $R^2=0.630$) in group B.

Group A showed a significant negative correlation between measured NSKH-predicted NSKH and FIM gain (correlation coefficient= −0.275, $p<0.01$), whereas group B showed no significant correlation ($p=0.18$).

Figure 1 shows the relationship between FIM score at admission and FIM gain. In group A, 47 patients had measured NSKH-predicted NSKH lower than 0 and 55 patients had higher than 0, and their respective FIM gains were 37.6±26.7 and 26.8±23.9, with a significant difference ($p<0.05$). On the other hand, the corresponding FIM gains in group B were 23.7±13.5 and 19.9±14.1 in 80 and 74 patients, respectively. Although the gain was apparently higher in patients with scores lower than 0, the difference was not significant ($p=0.076$).

The regression coefficient was negative in the multiple regression analysis with age (FIM gain was lower in the elderly); positive with FIM scores at admission below 58 and negative with scores above 59 (FIM gain of moderate care was highest); and negative with measured NSKH-predicted NSKH (FIM gain decreased by 4.068 and 0.714 in groups A and B, respectively, per 1 score of measured NSKH-predicted NSKH) (Table 2). The F-statistic was the highest (388.6) with the FIM score at admission in group B (FIM score at admission had the strongest influence on FIM gain), whereas the F-statistic was largely based on age (54.2 years), measured NSKH-predicted NSKH (18.0), and FIM score at admission (3.3) in group A. The addition of measured NSKH-predicted NSKH to the prediction equation for FIM gain using age and FIM score at admission resulted in an increase in $R^2$ of 0.101 (from 0.312 to 0.413) in group A, indicating an improvement in accuracy of predicting FIM gain using measured NSKH-predicted NSKH, whereas an increase in $R^2$ of only 0.009 (from 0.714 to 0.723) was observed in group B.

$R^2$ was higher when the subjects were divided into two groups based on FIM score at admission (a and c in Table 3) than for the entire study population (e in Table 3), using FIM as the objective variable. On the

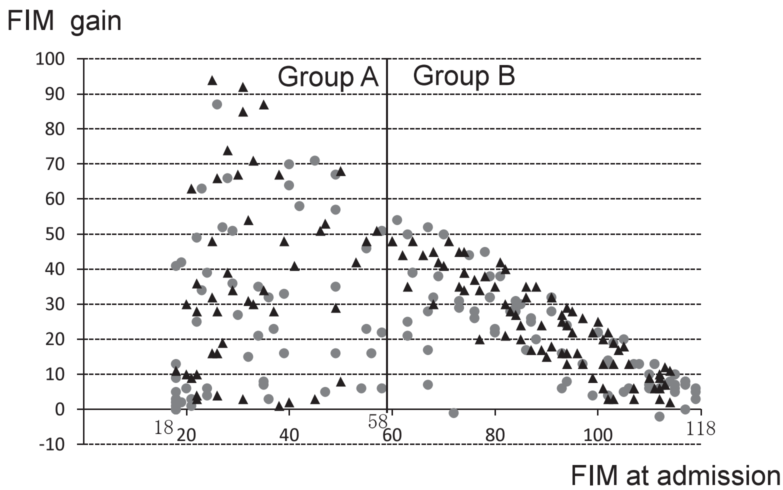


**Figure 1.** The relationship between FIM score at admission and FIM gain.
▲, measured NSKH-predicted NSKH<0; ●, measured NSKH-predicted NSKH≥0 (patients who require nursing care beyond ADL).
Group A, FIM score at admission of 18−58; Group B, FIM score at admission of 59−119.

**Table 2.** Multiple regression analysis for the prediction of FIM gain.

| | Group A | | Group B | |
|---|---|---|---|---|
| | RC (F) | RC (F) | RC (F) | RC (F) |
| Age ($X_1$) | −1.03 (41.1) | −1.101 (54.2) | −0.194 (21.3) | −0.196 (22.6) |
| FIM score at admission ($X_2$) | 0.306 (3.0) | 0.296 (3.3) | −0.692 (375.3) | −0.692 (388.6) |
| Measured NSKH−predicted NSKH ($X_3$) | | −4.068 (18.0) | | −0.714 (6.3) |
| Constant | 94.593 | 99.853 | 98.007 | 98.18 |
| *p* value of regression equation | <0.001 | <0.001 | <0.001 | <0.001 |
| Adjusted R square | 0.312 | 0.413 | 0.714 | 0.723 |

Group A, 102 patients with FIM scores 18−58 at admission; group B, 154 patients with FIM scores 59−119. Regression equation obtained in group A, FIM gain= $-1.031\times X_1+0.306\times X_2+94.593$ ($p<0.001$, $R^2=0.312$). RC, Regression coefficient; F, F-statistic.

**Table 3.** Multiple regression analyses under various conditions.

| | Subjects | Objective variable | Explanatory variables | | | | R square | Incease in R square |
|---|---|---|---|---|---|---|---|---|
| | | | age | FIM at admission | Measured NSKH−predicted NSKH | NSKH | | |
| a | FIM 18−58 | FIM gain | ○ | ○ | | | 0.312 | 0.101 |
| b | FIM 18−58 | FIM gain | ○ | ○ | ○ | | 0.413 | |
| c | FIM 59−119 | FIM gain | ○ | ○ | | | 0.714 | 0.009 |
| d | FIM 59−119 | FIM gain | ○ | ○ | ○ | | 0.723 | |
| e | All patients | FIM gain | ○ | ○ | | | 0.239 | 0.036 |
| f | All patients | FIM gain | ○ | ○ | ○ | | 0.275 | |
| g | FIM 18−58 | FIM at discharge | ○ | ○ | | | 0.516 | 0.071 |
| h | FIM 18−58 | FIM at discharge | ○ | ○ | ○ | | 0.587 | |
| i | FIM 18−58 | FIM gain | ○ | ○ | | ○ | 0.413 | 0.101 (i−a) |
| j | All patients | FIM at discharge | ○ | ○ | | | 0.696 | |
| k | All patients | FIM at discharge | ○ | ○ | ○ | | 0.710 | 0.014 (k−j) |
| l | All patients | FIM at discharge | ○ | ○ | | ○ | 0.708 | 0.012 (l−j) |
| m | FIM 59−119 | FIM at discharge | ○ | ○ | ○ | | 0.421 | |

○, Item input into the multiple regression analysis as an explanatory variable; all patients, FIM scores 18−119.

other hand, when the FIM score at discharge was used as the objective variable, $R^2$ was higher for the entire study population (k in Table 3) than for subjects divided into two groups (h and m in Table 3). $R^2$ was higher when using FIM score at discharge as the objective variable (g in Table 3) than when using FIM gain (a in Table 3). $R^2$ remained the same when the explanatory variable was either measured NSKH-predicted NSKH or measured NSKH score (bi and kl in Table 3).

The magnitude of $R^2$ increase was the greatest (0.101) when measured NSKH-predicted NSKH (b in Table 3) or measured NSKH score (i in Table 3) was added as an explanatory variable to the analysis of subjects with FIM scores at admission of 18−58 using FIM gain as the objective variable (a in Table 3). On the other hand, the magnitude of $R^2$ increase was the smallest (0.014) when discharge FIM score was used as the objective variable and the entire study population was analyzed (j and k in Table 3).

## Discussion

This study showed that in patients with severe disease (FIM scores at admission below 58; group A), (1) measured NSKH-predicted NSKH significantly and negatively correlated with FIM gain, and (2) the addition of measured NSKH–predicted NSKH to the prediction equation of FIM gain using age and FIM score at admission results in an $R^2$ increase of 0.101, showing that measured NSKH-predicted NSKH is an index that improves the prediction accuracy of FIM gain.

The increase in $R^2$ of 0.101 is significant (it influences the FIM gain), because measured NSKH-predicted NSKH was selected as an effective explanatory variable (a>2 F-statistic) and the F-statistic of measured NSKH-predicted NSKH (18.0) was higher than that of FIM score at admission (3.3), although lower than that of age (54.2 years).

In patients with mild disease (FIM scores at admission above 59; group B), FIM gain may have been strongly influenced by FIM score at admission and weakly influenced by measured NSKH-predicted NSKH based on the result of F-statistic in the multiple regression analysis using FIM gain as an objective variable.

Iwai et al.[3] created a prediction equation for FIM score at discharge using four items: age, days from onset of stroke to admission, motor FIM at admission, and cognitive FIM at admission, as explanatory variables ($R^2$=0.675). The addition of NSKH score to this prediction equation resulted in an increase in $R^2$ (0.719) of 0.044. In addition, the determination of hospital-to-home discharge using age, caring capacity, motor FIM at admission, and cognitive FIM at admission yielded 87.8% of the predictable value, whereas the addition of NSKH score did not change the value. Thus, Iwai et al.[3] concluded that “the Nichijo-seikatsu-kino-hyokahyo index is unlikely to result in better prediction of FIM at discharge or predictability of discharge destination”.

The conclusion of Iwai et al.[3] differs from that of the present study, with may be attributed to the differences in conditions used in the multiple regression analysis (Table 3). In assessment 4, all patients instead of only those with FIM scores at admission of 18−58 were included as subjects, and FIM score at discharge instead of FIM gain was selected as the objective variable. In this analysis, the increase in $R^2$ was 0.012, which was as low as the result (increase in $R^2$: 0.044) of Iwai et al.[3]. Hence, due to differences in selection of “subjects” and “objective variable”, Iwai et al.[3] concluded that “the Nichijo-seikatsu-kino-hyokahyo index is unlikely to result in better prediction of FIM at discharge or predictability of discharge destination” whereas our study showed that “NSKH-predicted NSKH is an index that improves the prediction accuracy of FIM gain”.

From the results of the study conducted by Iwai et al.[3], and those of this study, we conclude that in the case of predicting discharge FIM scores by including all patients as subjects, the addition of NSKH score to FIM score at admission barely improves the accuracy of the result, whereas the prediction of FIM gain by narrowing the subjects to those with FIM score at admission of 18−58 and adding the NSKH score improves the accuracy of prediction. Our result may be attributed to the fact that it is easy to prove the significance of the addition of measured NSKH-predicted NSKH when $R^2$ is low.

It is far more difficult to predict FIM gain from FIM scores at admission than to predict FIM scores at discharge from FIM scores at admission. Indeed, in contrast to the $R^2$ of 0.696 (j in Table 3) for predicting FIM score at discharge using all patients as subjects, the $R^2$ for predicting FIM gain is as low as 0.239 (e in Table 3). This low $R^2$ would probably be a situation where the addition of measured NSKH-predicted NSKH may be useful.

Because the influence of FIM score at admission on FIM gain is not linear (FIM gain of moderate care is the highest), this investigation was conducted by dividing the patients into two groups based on their FIM scores at admission instead of using the entire study population. In the prediction of FIM gain, the $R^2$ was 0.312 in patients with FIM score at admission of 18−85 (a in Table 3), in contrast to 0.714 in patients with scores of 59−119 (c in Table 3), showing a low $R^2$ for patients with FIM score at admission of 18−85. Based on this observation, it is easy to prove the significance of adding measured NSKH-predicted NSKH to the prediction equation in patients with FIM scores at admission of 59−119 (group A). However, it is also evident that the study population needs not be divided into two groups when selecting FIM score at discharge as the objective variable, because the investigation using all patients yielded high $R^2$.

In a review of previous articles of prediction using multiple regression analysis, the reported $R^2$ are in the range of 0.46−0.73 [9]. Thus, even though the addition of measured NSKH-predicted NSKH to the prediction equation of FIM gain using age and FIM score at admission resulted in an increase in $R^2$ of 0.101 (from 0.312 to 0.413), the prediction accuracy remains low. However, because it is easy to prove the significance of the addition of measured NSKH-predicted NSKH when $R^2$ is low, we ventured to conduct this investigation under the condition of low $R^2$. Prediction of FIM score at discharge as conducted by Iwai et al. [3] resulted in an $R^2$ value of 0.710 (k in Table 3), which was similar to that (0.719) reported by Iwai et al. [3].

This study had several limitations. First, the use of simple regression analysis for the prediction of NSKH scores from FIM scores is associated with proprietary problems. Although a significant linear expression that predicts NSKH scores from FIM scores was obtained, $R^2$ was 0.492 in group A and 0.630 in group B, which were both low. NSKH includes basic functions not included in FIM, such as the ability of raising either hand to the chest, turning over in bed, and maintaining a sitting position [10]. In addition, NSKH lacks important items of ADL, such as excretion and bathing, while including items such as resting in bed, which is not compatible with Kaifukuki rehabilitation ward [11]. Furthermore, uneven distribution of scores was found in the study population, with more patients having NSKH score 0 (mild) than patients having scores >14 (severe) [10]. Since FIM and NSKH are different evaluation methods, it is difficult to accurately predict NSKH scores from FIM scores using single regression analysis. However, because multiple regression analysis with various conditions (assessment 4) showed no differences in $R^2$ between measured NSKH-predicted NSKH and NSKH score as explanatory variables, measured NSKH score is sufficient (instead of predicted NSKH score that requires single regression analysis) in the multiple regression analysis. Second, analyses were not conducted using motor FIM scores and cognitive FIM scores separately. Third, dysfunction and comorbidity were not included in the prediction equation. For future studies, we plan to create a more accurate prediction equation for FIM gain that incorporates not only age, FIM score at admission and NSKH score, but also dysfunction and comorbidity.

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