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Original Article

Prediction of destination at discharge from a comprehensive rehabilitation hospital using the home care score

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Abstract. [Purpose] This study investigated whether it is possible to predict return to home at discharge from a rehabilitation hospital in Japan using the home care score of patients with cerebrovascular or osteoarticular disease and low activities of daily living at admission. [Subjects and Methods] The home care score and functional independent measurement were determined for 226 patients at admission and at discharge from five hospitals, and receiver operating characteristic analyses were conducted. [Results] The home care score cutoff point for the prediction of return to home at admission and at discharge was 11, and the area under the curve was more than 0.8. The area under the curve of the home care score was 0.77 for patients with low activities of daily living and within this group, the probability of return to home was approximately 50%, as predicted by the functional independent measurement. The home care score increased after receiving intervention at a rehabilitation hospital. [Conclusion] The home care score is useful for the prediction of return to home from a rehabilitation hospital, although prediction using the functional independent measurement is difficult for patients with low activities of daily living. Moreover, comprehensive interventions provided by the rehabilitation hospitals improve the ability to provide home care of the patient's family, which is assessed by the home care score.
Key words: Home care score, Comprehensive rehabilitation, Returning home

INTRODUCTION

The home care score (HCS), which was developed by the study group of the Ministry of Health and Welfare of Japan in 1992, comprehensively measures the condition of patients taken care of by family members and their activity of daily living (ADL) after returning home from a hospital[1]. In 2015, we reported that the prediction accuracy for advisability of home care was high using HCS, approximately 15 years after long-term care insurance, implemented, a system that makes receiving care services easier in Japan[2], was implemented. Furthermore, the prediction accuracy of HCS was higher than that of functional independent measurement (FIM)[2]. HCS and FIM are the evaluation scales that should be used for rehabilitation. However, it is not clear whether HCS and FIM at admission to a rehabilitation hospital are useful for the prediction of return to home.

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Thus, this study investigated whether the prediction accuracy of HCS is high at admission to a rehabilitation hospital.

In Japan, one of the aims of recovery at a comprehensive rehabilitation hospital is that the patients return home. Thus, a comprehensive intervention for patients to return home to their families is provided by the medical staff physical, occupational, and speech therapists; medical social workers, rehabilitation nurses, and rehabilitation doctors) at such hospitals. Interventions at a rehabilitation institution not only reduce the amount of medication prescribed, but also improve patients' ADL[3], family's caregiver skills[4], and patients' motivation[5, 6]. Furthermore, interventions, such as physical and occupational therapy, are performed, which facilitate handrail setting, and getting rid of the steps in patients' homes after discharge from hospital. These items can be measured using HCS[1]. Thus, the hypothesis of this study was that comprehensive intervention provided by medical staff increases the HCS, and whether HCS is increased by comprehensive intervention in rehabilitation hospitals at Japan was investigated.

If the intervention at comprehensive rehabilitation hospitals increases HCS, a difference in HCS between admission and discharge would be found. Therefore, the cutoff point predicting advisability of home care at discharge from hospital may be different from that at admission to hospital. Accordingly, whether a difference is observed in the cutoff point accurately predicting return to home between admission and discharge was also investigated.

When the FIM score at admission to a rehabilitation hospital is low, the probability to the patient returning home is also low, and approximately 50% of ptients will return to home according to prognose based on the FIM score at admission[7]. However, when the FIM score is low, patients with a disability can still return home, if their family adequately supports them[8, 9]. Thus, whether patients with low ADL can return home depends on the condition of the caregiver. HCS includes a measure of the caregiving ability of the family. Therefore, our hypothesiswas that a higher HCS would make it more likely that low-ADL patients would return to home, and the accuracy of HCS in predicting return to home for cases using FIM is difficult, such as patients with low ADL was investigated.

A previous study revealed that the accuracy of advisability of home care using HCS was higher than that using FIM[2]. However, whether the accuracy depends on disease is unclear. The FIM at admission to a comprehensive rehabilitation hospital of patients with osteoarticular disease (OAD) is higher than that of patients with cerebrovascular disease (CVD), and a difference was observed between these diseases in the increase of FIM following interventions at comprehensive rehabilitation hospitals[3, 10]. Furthermore, a positive correlation between FIM and HCS has been reported[2]. These findings indicate that the HCS of patients with OAD may be higher than that of patients with CVD, and there may be a difference in their cutoff points for the prediction of home care. Therefore, this study also investigated whether there are differences in the HCS and the cutoff point between patients with OAD and CVD.

SUBJECTS AND METHODS

The study was performed at comprehensive rehabilitation hospitals in Osaka, Nara, and Wakayama. The inclusion criteria were disease occurring after January 1, 2014; admission and discharge from April 1 to December 1, 2014; independent ADL before the disease onset; and a rehabilitation approach, including physical, occupational, or speech therapy, conducted for more than 2 h/day. Exclusion criterions were stopping rehabilitation due to CVD or OAD recurrence during comprehensive rehabilitation at a hospital. The study subjects were 152 and 74 patients with CVD (91 males and 61 females, 72.9 ± 12.6 years) and OAD (18 males and 56 females, 80 ± 9.9 years), respectively, and 178 and 48 patients were discharged to their homes and nursing homes for the elderly, respectively. Thirty-nine patients did not have a co-resident, and 187 patients had a lodger.

Clinicodemographic parameters, including age, gender, underlying disease, number of co-residents before disease onset, FIM score, and HCS were recorded. The FIM score and HCS were assessed by each subject's physical or occupational therapist 1 week after admission and before discharge at the rehabilitation hospital.

Each subject's ADL was evaluated using FIM[11–15]. The HCS measures the family's ability to take care of the patient at the hospital. The factors evaluated to determine the HCS included the availability of a care provider, the care provider's health and motivation, availability of a substitute care provider, family income, bedroom availability, home environment, the patient's general condition, including the abilities to feed and bathe, and the patient's transfer ability, verbal communication skills, mental status, medical condition, and motivation[1].

Wilcoxon's signed-rank sum test was used to assess the significance of differences in the medians of FIM and HCS between admission and discharge. An alpha level of 0.05 was used for the statistical analysis.

Receiver operating characteristic (ROC) analyses were conducted to determine the optimal cutoff values of the HCS and FIM score. The sensitivity and specificity were determined for each possible cutoff point. In addition, the area under the curve (AUC) was calculated for each ROC curve. The optimal cutoff points were obtained from the Youden index [maximum (sensitivity + specificity − 1)] and the point on the ROC curve closest to (0, 1), which was calculated as the minimum value of the square root of [(1 − sensitivity)(1 − sensitivity) + (1 − specificity)(1 − specificity)]. A higher accuracy is reflected by a larger Youden index and a shorter distance to (0, 1)[16]. Finally, Delong's test for two correlated ROC curves was conducted to determine whether there was a difference between the AUC of HCS at admission and discharge if the AUC of the ROC curve was lower than 0.9 for both scores. All statistical analyses were performed with R (version 2.13.0; R Foundation for Statistical Computing, Vienna, Austria).

Table 1. HCS and FIM at admission and discharge

	HCS		FIM	
	Admission	Discharge	Admission	Discharge
Median	11.5	14	72	101
interquartile range	6	5	48.8	44.8
Maximum Youden index	0.53	0.6	0.55	0.58
Sensitivity	0.76	0.89	0.82	0.76
Cutoff point	11	11	52	87
Specificity	0.77	0.71	0.73	0.81
Positive predictive value	0.92	0.92	0.92	0.94
AUC of ROC	0.84	0.91	0.84	0.87

FIM: functional independence measurement; HCS: home care score

The ethics committee of Shijonawate Gakuen University approved all the study protocols, and the study was conducted in accordance with the principles of the Declaration of Helsinki. Patient information was coded to ensure the anonymity of the subjects.

RESULTS

The results of the ROC curve analyses of the different HCS cutoff points for identifying subjects, included the Youden index, distance of the ROC curve to point (0, 1), sensitivity, specificity, and positive predictive value. The AUCs for HCS and FIM at admission and discharge were 0.84, 0.91, 0.84, and 0.87, respectively. The sensitivity, specificity, and positive predictive value with the maximum Youden index at admission and discharge are shown in Table 1. The HCS cutoff point for the prediction of return to home at admission and discharge was 11 and 11, respectively.

The medians (± interquartile range) of HCS at admission and discharge were 11.5 ± 6 and 14 ± 5, respectively. The Wilcoxon's signed-rank sum test values showed that HCS at discharge was significantly higher than that at admission ($z=8.66$, $p<0.0001$). A significant increase was found in the HCS sub-items, such as ability to feed, toilet use, dressing, transfer between wheelchair and bed, bathing, verbal communication skills, medical condition, and patient's motivation ($p<0.05$). The medians of the FIM scores of all patients at admission and discharge were 72 ± 48.8 and 101 ± 44.8, respectively. The Wilcoxon's signed-rank sum test values revealed that the FIM score at discharge was significantly higher than that at admission ($z=12.6$, $p<0.0001$).

FIM score at admission of 18−36, 37−54, 55−72, 73−90, 91−108, and 109−126 corresponded to return to home probabilities of 42.1%, 64.9%, 84.2%, 87.8%, 95.5%, and 100%, respectively. When the FIM was 54 or less, the probability of returning home was 53.5%. For these cases, the ROC curve analyses of the different HCS cutoff points for identifying subjects were conducted, and the resulting maximum Youden index was calculated as 0.45. At the maximum Youden index, the cutoff point, sensitivity, specificity, and positive predictive value of HCS were 8, 0.83, 0.6, and 0.7, respectively. The AUC for the HCS at admission was 0.77.

When the patients were divided into CVD and OAD groups, the medians (± quartile deviation) of the FIM scores at admission and discharge of patients with CVD were 68.5 ± 42.2 and 102.5 ± 69.5, respectively. The Wilcoxon's signed-rank sum test showed that the FIM score at discharge of patients with CVD was significantly higher than that at admission ($Z=10.3$, $p<0.00001$). The medians of the FIM scores at admission and discharge of patients with OAD were 75.5 ± 54.25 and 97.5 ± 72.75, respectively. The Wilcoxon signed rank sum test showed that the FIM score at discharge of patients with OAD was significantly higher than that at admission ($Z=7.3$, $p<0.00001$).

The medians of HCS at admission and discharge of patients with CVD were 11 ± 9 and 14 ± 10, respectively. The Wilcoxon's signed-rank sum test showed that the HCS at discharge of patients with CVD was significantly higher than that at admission ($Z=7.2$, $p<0.00001$). The items with significant increases were the ability to feed, toilet use, dressing, transferring, bathing, verbal communication skills, medical condition, and patient's motivation.

The medians of HCS at admission and at discharge of patients with OAD were 12 ± 11 and 14 ± 12, respectively. The Wilcoxon signed rank sum test showed that the FIM score at discharge of patients with OAD was significantly higher than that at admission ($Z=4.8$, $p<0.00001$). The items with significant increase were toilet use, dressing, transferring, and bathing.

The ROC curve analysis results of the different HCS cutoff points for identifying subjects, including the Youden index, distance of the ROC curve to point (0, 1), sensitivity, specificity, and positive predictive value, are shown in Table 2. The AUC for the HCS at admission and discharge of patients with CVD and OAD was 0.83 and 0.9, and 0.87 and 0.92, respectively. DeLong's test showed that the AUC of HCS in patients with CVD at discharge was significantly higher than that at admission ($Z=-2.7$, $p=0.007$), but no significant difference was found in the AUC of HCS of patients with OAD ($Z=-1.5$, $p=0.14$).

Table 2. HCS and FIM of patients with CVD or OAD

| | CVD | | | | OAD | | | |
| | HCS | | FIM | | HCS | | FIM | |
	Admission	Discharge	Admission	Discharge	Admission	Discharge	Admission	Discharge
Median	11	14	68.5	102.5	12	14	75.5	97.5
Interquartile range	5.3	6	53.8	44.8	4	5	41.5	43.3
Maximum Youden index	0.51	0.67	0.57	0.1	0.6	0.76	0.54	0.63
Cutoff point	11	12	52	74	12	13	65	92
Sensitivity	0.71	0.83	0.8	0.7	0.69	0.83	0.77	0.7
Specificity	0.8	0.84	0.77	0.2	0.92	0.92	0.77	0.92
Positive predictive value	0.92	0.94	0.92	0.75	0.98	0.98	0.94	0.98
AUC of ROC curve	0.83	0.9	0.84	0.86	0.87	0.92	0.84	0.88

DISCUSSION

The AUCs of the ROC curve used to predict returning home based on HCS and FIM at admission and discharge were 0.84 and 0.91 and 0.84 and 0.87, respectively. If the AUC is between 0.7 and 0.9 or greater than 0.9, the prediction accuracy is considered moderate or high, respectively[17]. The prediction accuracy of HCS and FIM at admission is moderate, while, the prediction accuracy of HCS at discharge is high, and this finding is in accordance with the findings of a previous study[2]. The cutoff point for the prediction of returning home using HCS at admission and discharge was 11. Thus, the prediction of the possibility of returning home at admission or discharge should be made using 11 as the cutoff point.

HCS at discharge was significantly higher than that at admission irrespective of the disease, indicating that comprehensive rehabilitation intervention increases HCS. The items with significant increases were ability to feed oneself, toilet use, dressing, transferring between wheelchair and bed, bathing, verbal communication skills, medical condition, and patient's motivation. Comprehensive intervention at a rehabilitation hospital improves the abilities of eating, dressing, going to the toilet, bathing, and transferring, which are measured by FIM[3, 7, 11–15], and HCS includes an ability of ADL evaluation. Based on these findings, one of the reasons for the increase seen in HCS was the improvement in ADL ability. In contrast, FIM dose not evaluate the patient's medical condition or motivation. Interventions at a hospital improve medical conditions bladder catheterization, treatment after tracheotomy, tube feeding, and patient's motivation for rehabilitation[5, 6]. The HCS measures medical condition and patient's motivation, and in the present study, these significantly improved after comprehensive rehabilitation at a hospital. Thus, HCS can evaluate the possibility of returning home, which involves important factors limited not only to ADL, but also to medical condition and motivation.

The probability of returning home was approximately 50% for patients with FIM scores of 54 or less. Thus, when the FIM score is 54 or less, accurately predicting returning home using the FIM score is difficult. The AUC of HCS in patients with low ADL was 0.77, indicating it has a moderate predictive performance. However, when the AUC is between 0.7 and 0.9, it has a moderate predictive performance[17]. The sensitivity, specificity, and positive predictives value were 0.83, 0.6, and 0.7, respectively. These findings indicate that using HCS to predict returning home for patients with low ADL is useful, although FIM cannot be used for the prediction for these patients.

The values of AUCs for the HCS at admission and discharge of patients with CVD were 0.83 and 0.9, and those at admission and discharge of patients with OAD were 0.87 and 0.92, respectively. When the AUC value is between 0.7 and 0.9, or greater than 0.9, the predictive performances are considered moderate or high, respectively[17]. Therefore, the prediction accuracies of HCS at admission and discharge can be considered as moderate and high, respectively. The AUC of HCS of patients with CVD at discharge was significantly higher than that at admission, indicating that the prediction accuracy of HCS of patients with CVD at discharge is higher than that at admission. Therefore, when predicting the advisability of returning home with care provided by the family for patients with CVD, the most recent HCS after admission should be used. In contrast, no significant difference was found in the AUC of patients with OAD between admission and discharge. This finding indicates that the prediction accuracy of the advisability of returning home using HCS at admission is adequately high. Thus, the accurate prediction of the advisability of returning home from a rehabilitation hospital using HCS at admission should only be made for patients with OAD.

In conclusion, the prediction precision for returning home from a comprehensive rehabilitation hospital using HCS and FIM at admission is high. Moeover, when the probability of returning home predicted by FIM is approximately 50%, the prediction accuracy of HCS is higher. Therefore, HCS is not only useful for prediction, but also substitutes for prediction using FIM. Finally, comprehensive interventions in a rehabilitation hospital improve the ability to provide home care by the patient's family, which is evaluated by the home care score.

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