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# Immediate family support is important to discharge home for cancer patient with bone metastasis after rehabilitation

## A retrospective study

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**Abstract**

The purpose of this study is to investigate the predictive factors of home discharge for rehabilitation patients with cancer bone metastasis.

Cancer patients with bone metastasis who underwent rehabilitation between April 2014 and March 2017 were retrospectively enrolled. Data on discharge destination were collected from medical records as outcomes. Multiple regression analyses were carried out to investigate the predictive factors of home discharge.

Ninety-eight patients (mean age: 68.6 years, 42 females and 56 males) were included. Fifty patients were discharged home, 38 patients were discharged to other facilities, and 10 patients died. There were no skeletal-related events among these patients during their hospital stay. The receiver-operating curve for the predictive factors for home discharge of the Barthel Index at admission, Eastern Cooperative Oncology Group Performance Status at admission, and number of immediate family members living at home were 60 points (area under the curve [AUC] = 0.74, sensitivity = 0.6400, 1-specificity = 0.2766), 2 score (AUC = 0.65, sensitivity = 0.5400, 1-specificity = 0.2222), and 1 family member (AUC = 0.65, sensitivity = 0.9592, 1-specificity = 0.7222), respectively.

In order to plan for cancer patients with bone metastasis to be discharged home, it is important to take into consideration the patients' Barthel Index and Performance Status at the time of hospital admission and the number of immediate family members living at home.

**Abbreviations:** ADL = activity of daily living, AUC = area under the curve, BI = Barthel Index, PS = Performance Status, ROC = receiver-operating curve, SREs = skeletal-related events.

**Keywords:** activities of daily living, bone metastasis, home discharge, rehabilitation, skeletal-related event

## 1. Introduction

In recent years, the survival rate for cancer patients has increased, and the rehabilitation of patients with bone metastases is increasing as a result of advances in rehabilitation.[1,2] Cancer patients often suffer from physical decline due to the cancer itself, side effects associated with chemotherapy and radiation therapy, and secondary disorders due to complications.[3] All of these factors result in a deterioration of the patient's quality of life. Rehabilitation can relieve symptoms and improve the physical functions and level of activities of daily living (ADLs). It is essential for cancer patients to continue treatment that leads to improvements in quality of life.[4] Patients with bone metastases have some risk of skeletal-related events (SREs), such as pathologic bone fracture, palliative osseous radiation, surgical intervention, spinal cord compression, and hypercalcemia of malignancy. Once SREs and spinal paralysis occur, it can be difficult to discharge the patient home. Currently, there are few studies on the outcomes and SREs of patients with bone metastasis, and consensus related to the rehabilitation of bone metastatic patients has not yet been achieved.[5,6] Against this background, it is necessary to investigate the safety of the rehabilitation of bone metastatic patients.

*Editor: Milind Chalishazar.*

*The authors have no funding and conflicts of interest to disclose.*

*All data generated or analyzed during this study are included in this published article [and its supplementary information files].*

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*How to cite this article: Ikeguchi R, Nankaku M, Yamawaki R, Tanaka H, Hamada R, Kawano T, Murao M, Kitamura G, Sato T, Nishikawa T, Noguchi T, Kuriyama S, Sakamoto A, Matsuda S. Immediate family support is important to discharge home for cancer patient with bone metastasis after rehabilitation: a retrospective study. Medicine 2021;100:37(e27273).*

*Received: 30 September 2020 / Received in final form: 12 August 2021 / Accepted: 30 August 2021*

*http://dx.doi.org/10.1097/MD.0000000000027273*

In terms of the location for medical treatment when death is approaching, almost all patients desire to be at home. Although there are many patients who wish to use their home as a place where they can receive medical treatment, in many cases it is difficult to perform home treatment due to the condition of the patient. There are few studies on the discharge outcomes of patients with bone metastases.[7,8] Because the demand for the rehabilitation of patients with bone metastases is expected to increase and the patients are willing to discharge home, researchers should clarify the predictive factors necessary for home discharge that will fulfill patients' desire.

The purpose of this study is to report the predictive factors for the home discharge outcomes of cancer patients with bone metastases who underwent rehabilitation at our hospital. We hypothesize that in the home discharge of cancer patients with bone metastasis, both the patients' level of ADLs and the patients' environmental factors are important and rehabilitation can be performed safely without SREs.

## 2. Methods

### 2.1. Design

We conducted a retrospective observational cohort study of cancer patients with bone metastasis who underwent rehabilitation at Kyoto University Hospital between April 2014 and March 2017.

### 2.2. Subjects

During the study period, 98 patients with bone metastasis received rehabilitation in the rehabilitation unit. No patients were excluded from the study. All patients received physical therapy, occupational therapy, or speech therapy every weekday.

### 2.3. Ethics considerations

This study was approved by the ethics committee of Kyoto University (Kyoto University Graduate School and Faculty of Medicine, Ethics Committee). All patients provided written informed consent before study participation.

### 2.4. Data collection

We reviewed the electronic medical records of all patients to determine the response variable for home discharge after treatment. Patients were divided into 3 groups based on whether they were discharged to home, to another facility, or if they died. The medical record for every identified patient was reviewed and studied: age, sex, details regarding Barthel Index (BI) at hospital admission and hospital discharge, Eastern Cooperative Oncology Group Performance Status (PS) at hospital admission and hospital discharge, Katagiri Score at hospital admission, number of bone metastases, type of bone metastasis (lytic or blastic metastases), length of hospital stay (days), number of times attending rehabilitation therapies, and number of immediate family members living at home, not including the patient.[9]

The following patient-related explanatory variables were studied: age, sex, BI at hospital admission and hospital discharge, PS at hospital admission and hospital discharge, number of bone metastases, type of bone metastasis (lytic or blastic metastases), length of hospital stay (days), number of times attending rehabilitation therapies, and number of immediate family members living at home with the patient.

### 2.5. Statistical analysis

Descriptive statistics for explanatory variables were calculated for the study cohort. All variables were analyzed using available data. Missing data were excluded. Data were compared using analysis of variance. When a significant difference was detected, the Bonferroni *post hoc* test was applied. Differences were considered statistically significant at $P < .05$. The predictive factors for home discharge were evaluated using receiver-operating curve (ROC) analysis. All statistical analyses were performed with JMP pro software version 15.10.0 (SAS Institute Inc., Cary, NC).

## 3. Results

### 3.1. Patient demographics

The mean age of the 98 patients in the study was 68.6 years (Table 1). Forty-two patients were female, and 56 patients were male. The mean follow-up period was $18.8 \pm 3.4$ months. Primary cancers were 36 lung cancer, 15 prostate cancer, 9 breast cancer, 9 multiple myeloma, 5 gastrointestinal cancer, 5 uterine cancer, 5 renal cancer, 3 skin cancer, 2 bladder cancer, 2 lymphoma, and 7 others. Previous cancer treatments were 25 surgeries, 94 chemo/hormonal therapies, and 56 radiation therapies.

### 3.2. Collected data

The sites of bone metastasis were 81 spine, 49 pelvis, 35 femur, 16 rib, 6 scapula, 3 humerus, 3 skull, 2 clavicle, 1 sternum, and 1 forearm bone (Table 2). The number of bone metastases was 6 in 4 patients, 5 in 8 patients, 4 in 14 patients, 3 in 23 patients, 2 in 24 patients, and 1 in 17 patients. Bone metastasis treatments were 17

**Table 1**

**Patient demographics.**

| | All patients (%) |
|---|---|
| Sex | |
| Female | 42 |
| Male | 56 |
| Age(y) | 68.6 |
| Range | 13–92 |
| Type of primary cancer | |
| Lung | 36 (37) |
| Prostate | 15 (15) |
| Breast | 9 (9) |
| Multiple myeloma | 9 (9) |
| Gastrointestinal | 5 (5) |
| Uterine | 5 (5) |
| Renal | 5 (5) |
| Skin | 3 (3) |
| Bladder | 2 (2) |
| Lymphoma | 2 (2) |
| Other | 7 (7) |
| The previous treatment of primary cancer | |
| Surgery | 25 |
| Chemo/hormonal therapy | 94 |
| Radiation therapy | 56 |

**Table 2**

**Bone metastasis sites, numbers, treatments, and rehabilitation therapies.**

| | Number (%) |
|---|---|
| The sites of bone metastasis | |
| Spine | 81 |
| Pelvis | 49 |
| Femur | 35 |
| Rib | 16 |
| Scapula | 6 |
| Humerus | 3 |
| Skull | 3 |
| Clavicle | 2 |
| Sternum | 1 |
| Forearm bone | 1 |
| The numbers of bone metastasis | |
| 6 | 4 (4) |
| 5 | 8 (3) |
| 4 | 14 (14) |
| 3 | 23 (23) |
| 2 | 24 (24) |
| 1 | 17 (17) |
| The treatments of the bone metastasis | |
| Surgery | 17 |
| Chemo/hormonal therapy | 62 |
| Radiation therapy | 81 |
| The mean days of rehabilitation therapy | 48.2 ± 43.7 |
| Range | 3–377 |
| Type of rehabilitation therapies | |
| Physical therapy | 95 |
| Occupational therapy | 22 |
| Speech therapy | 3 |

surgeries, 62 chemo/hormonal therapies, and 81 radiation therapies. No patients had SREs. The types of bone metastasis were lytic in 79 patients and blastic in 19 patients. The mean length of hospital stay was 48.2 ± 43.7 days. Rehabilitation therapies included 95 physical therapies, 22 occupational therapies, and 3 speech therapies.

The mean BI at admission was 51.5 ± 27.3 and the BI at discharge was 55.0 ± 24.9 (Table 3). The mean PS at admission was 2.54 ± 0.94 and PS at discharge was 2.48 ± 0.97. The number of family members living at home was 4 for 4 patients, 3 for 11 patients, 2 for 28 patients, and 1 for 38 patients. Seventeen patients lived alone. The mean family number (not including patients) was 1.49 ± 1.025. Fifty patients were discharged home, 38 patients were discharged to other facilities, and 10 patients died.

### 3.3. Statistical analysis

The BI at admission in home-discharged patients (62.0 ± 4.1) was significantly higher than that in patients who were discharged to other facilities (43.8 ± 4.1, $P = .0003$) and that in deceased patients (30.5 ± 7.6, $P = .0012$) (Table 4). PS at the time of hospital admission for home-discharged patients (2.22 ± 0.12) was significantly better than that for patients who were discharged to other facilities (2.73 ± 0.142, $P = .0087$) and that for deceased patients (3.36 ± 0.26, $P = .0002$). The number of family members living at home for home-discharged patients (1.71 ± 0.90) was significantly higher than that for patients who were discharged to other facilities (1.16 ± 0.99, $P = .0145$); that

**Table 3**

**Patients' ADL levels, number of family members, and discharge destinations.**

| | (%) |
|---|---|
| Barthel Index | |
| At admission | 51.5 ± 27.3 |
| At discharge | 55.0 ± 24.9 |
| Performance Status | |
| At admission | 2.54 ± 0.94 |
| At discharge | 2.48 ± 0.97 |
| Number of family living together | |
| 4 | 4 (15) |
| 3 | 11 (9) |
| 2 | 28 (29) |
| 1 | 38 (29) |
| 0 | 17 (17) |
| Discharge outcome | |
| Home | 50 (51) |
| Other facility | 38 (39) |
| Died | 10 (10) |

ADL = activity of daily living.

for deceased patients was 1.64 ± 1.43 and there was no significant difference between home-discharged patients and deceased patients. The number of bone metastases was 2.67 ± 0.21 in home-discharged patients, 2.60 ± 0.24 in other facility-discharged patients, and 2.55 ± 0.44 in deceased patients. There was no statistical difference among the 3 groups. The patient number of blastic-type bone metastases was 10 in home-discharged patients, 7 in other facility-discharged patients, and 2 in deceased patients. The number of deceased patients within 3 years was 21 (42.0%) in home-discharged patients and 21 (55.3%) in other facility-discharged patients. There was no statistical difference between the 2 groups.

The ROC of the BI at the time of hospital admission was 60 points and is a predictive factor for home discharge (area under the curve [AUC] = 0.74, sensitivity = 0.6400, 1-specificity = 0.2766) (Fig. 1). The ROC of PS at the time of hospital admission was 2 and is a second predictive factor for home discharge (AUC = 0.65, sensitivity = 0.5400, 1-specificity = 0.2222). The ROC of the number of family members living at home was 1 and is a third predictive factor for home discharge (AUC = 0.65, sensitivity = 0.9592, 1-specificity = 0.7222).

## 4. Discussion

Although exercises for cancer patients require risk management, they are generally safe and effective for improving physical

**Table 4**

**Comparison of 3 groups with ADL levels, number of family members, and number of bone metastases.**

| | Home discharge | Other facility | Died |
|---|---|---|---|
| Barthel Index at admission | 62.0 ± 4.1 | 43.8 ± 4.1<br>$P = .0003$ | 30.5 ± 7.6<br>$P = .0012$ |
| Performance Status at admission | 2.22 ± 0.12 | 2.73 ± 0.142<br>$P = .0087$ | 3.36 ± 0.26<br>$P = .0002$ |
| Number of family | 1.71 ± 0.90 | 1.16 ± 0.99<br>$P = .0145$ | 1.64 ± 1.43 |
| Number of bone metastasis | 2.67 ± 0.21 | 2.60 ± 0.24 | 2.55 ± 0.44 |

ADL = activity of daily living.

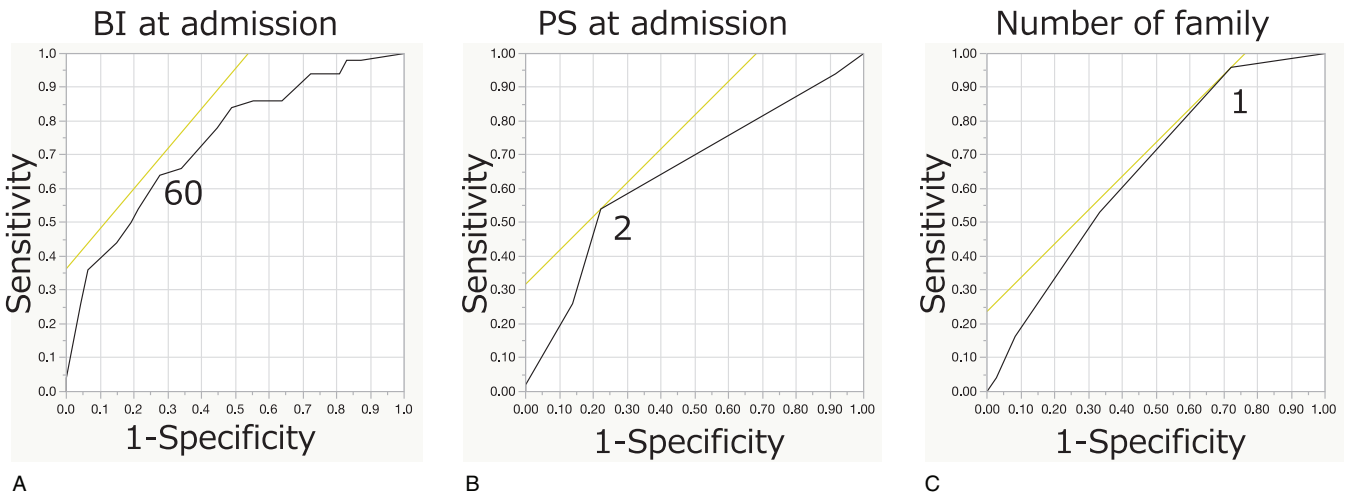


**Figure 1.** The ROC curve for home discharge for BI at admission, PS at admission, and number of family members living at home. The cutoff value of 60 for BI at admission, 2 for PS at admission, and 1 family member are the points closest to the upper left corner of the curve, where sensitivity is closest to 1.0 and 1-specificity is closest to 0. BI = Barthel Index, PS = Performance Status, ROC = receiver-operating curve.

strength, muscle strength, and quality of life.[10] For patients with bone metastases, there is a risk of pathological fractures or paralysis due to bone fragility and spinal cord compression, and special consideration is thus necessary to address these risks. Despite the special consideration, some authors have reported that rehabilitation is effective for patients with bone metastasis.[5,6,11]

Rief et al[5] conducted a randomized control trial for paraspinal muscle strengthening training in patients with spinal metastases who had undergone radiation therapy. Training was feasible in 25 of the 30 cases assigned to the exercise group. Rehabilitation was conducted 5 times a week for 2 weeks and consisted of muscle strengthening exercises. Respiratory training and physical therapy were performed on the control group. In the exercise group that underwent muscle strength training, a significant improvement was obtained in the chair stand test and the pain score was significantly improved. McKinley et al[11] investigated 32 spinal metastases cases in which rehabilitation therapy was performed. They reported that the amount of assistance (such as transfers) was significantly reduced at hospital discharge compared to hospital admission. Eighty-four percent of patients were discharged to home. Bunting et al[6] investigated 58 patients admitted to a rehabilitation hospital for pathological fractures due to bone metastases. No patients could transfer or walk at hospital admission, but at hospital discharge, 45% were able to transfer and 40% were able to walk. In addition, 59% of patients were discharged to home. The Kenny's ADL score was also significantly improved at discharge compared with that at admission. They report that home discharge is critical for cancer patients, including those with bone metastasis. When death is approaching, patients cite staying in their home as one of their main reasons for living. In the current study, the predictive factor for home discharge is a BI at hospital admission of 60 points, a PS of 2 at hospital admission, and 1 family member living with the patient. There is no significant difference in number of bone metastases, which partly represents the severity of cancer. These findings are consistent with another researcher's report that the BI for predicting home discharge had a threshold value of 60.[7] Our data also indicate that, in addition to pre-rehabilitation condition, patient environment is important. Environmental factors such as living with immediate family are some of the most important factors in the World Health Organization's International Classification of Functioning, Disability and Health. Taking the patient's social environment into consideration is one of the keys to rehabilitation. Patients living with more than 1 family member are better candidates for rehabilitation in case of bone metastasis. For patients with more than 60 points BI and a PS of more than 2, rehabilitation can be commenced with the aim of home discharge.

SREs influence patient activities. SREs such as pathological fracture of the femur deprives patients of the ability to transfer and also decreases their level of ADLs. In the current study, we had no SREs. We usually hold a conference among the rehabilitation doctors and therapists as well as other medical staff such as radiologists, primary cancer doctors, and orthopedic surgeons to evaluate a patient's bone metastasis. This inter-professional team collaboration may be the reason why we experienced no SREs. In rehabilitation treatment, the risk of adverse events must be considered by various hospital staff and sufficient consideration to safety must be given whenever possible when promoting activities. By assessing the risk of adverse events and providing appropriate training regimens, rehabilitation can be advantageous for bone metastatic patients and the side effects of SREs can be avoided. The frequency of these adverse events during rehabilitation is not expected to be high and clinical research should be conducted to gather sufficient sample numbers.

The risk of paralysis due to pathological fractures and spinal cord compression results in excessive activity restrictions that can lead to disuse syndrome. Since cancer patients also have risk factors for deep vein thrombosis and delirium, activity restrictions may increase the risk of these complications. In addition, activity restriction reduces patient quality of life. Activity restrictions for cancer patients should therefore be minimized. In rehabilitation treatment, an evaluation of the risk of adverse events and the promotion of safe activities are key.

This study has several limitations. First, this is a retrospective study that included the rehabilitation patients, not all patients with bone metastasis. As such, this is a limited and heterogeneous

study that may include variables that significantly modify the results. Second, the number of patients was too small. The results expressed as a percentage could be incorrect. Further research is needed with a larger sample size and a prospective study design. Metastases should be classified according to type, number, and location. Third, although we conducted BI and PS for patient evaluation, a Functional Independence Measure should also be used to measure ADL levels. Finally, the ROC for the predictive factors for home discharge revealed that the number of immediate family members living at home was 1 family number. However, the number of family members living at home were $1.71 \pm 0.90$ for home-discharged patients, $1.16 \pm 0.99$ for patients discharged to other facilities, and $1.64 \pm 1.43$ for deceased patients. The number of family members is not an absolute condition. It should be considered as just 1 factor for home discharge. Further studies are needed.

In conclusion, in rehabilitation for cancer patients with bone metastasis, patients' BI and PS at the time of hospital admission and the number of family members living at home must be examined when considering home discharge. The predictive factors for home discharge are a BI of more than 60 points at admission, a PS level of more than 2 at admission, and more than 1 family member living at home. Rehabilitation for cancer patients with bone metastasis can be performed without SREs. Inter-professional team collaboration is also essential in preventing SREs. Researchers should continue to present evidence of the effectiveness of rehabilitation for cancer patients. Future research is needed to investigate the effectiveness of rehabilitation for cancer patients and the predictive factors for activity improvement by rehabilitation.

## Author contributions

**Conceptualization:** Ryosuke Ikeguchi, Akio Sakamoto, Shuichi Matsuda.
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**Writing – original draft:** Ryosuke Ikeguchi.
**Writing – review & editing:** Ryosuke Ikeguchi, Akio Sakamoto, Shuichi Matsuda.

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