学 位 論 文

Diagnostic accuracy of a predictive scoring tool for patients who are eligible for home discharge from a palliative care unit

緩和ケア病棟から自宅退院に適切な患者を予測する
スコアリングツール

富山大学臨床腫瘍学講座

中嶋和仙

Diagnostic accuracy of a predictive scoring tool for patients who are eligible for home discharge from a palliative care unit

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ABSTRACT

Background. Staying at a preferred place, principally at home, is of great value for dying patients, and palliative care units have an important role in providing adequate support so that patients can be discharged and go home. I attempted to create and validate a scoring tool to predict whether a cancer patient admitted to a palliative care unit will be discharged home.

Methods. All 369 cancer patients admitted to the palliative care unit of a 533-bed general hospital in Japan from October 2016 to October 2019 were enrolled. As outcomes, I recorded whether patients were discharged to home, died in hospitals, or were discharged to other hospitals. Attending physicians recorded 22 potential scale items at admission, including 1) demographic variables, 2) patient general conditions, 3) vital signs, 4) medications, and 5) patient symptoms. Training-testing procedure to develop a screening score was performed.

Results. Among 369 cancer patients admitted to the PCU, I excluded 10 cases for whom a death location could not be identified. Among the remaining 359 patients, 180 were analyzed in the development phase and 179 in the validation phase. Multivariate logistic regression analysis identified five items as independent factors associated with discharge to home, and a prediction equation was created using the regression coefficients: sex (female, 4 points), calorie intake (520 kcal or more, 19 points), availability of daytime caregivers (11 points), family's preferred place of care (home, 139 points), and symptoms that resulted in hospitalization (not fatigue, 7 points). Using a cutoff point of 155, the area under the curve (AUC) value was 0.949 with 95% confidence intervals of 0.918 to 0.981. In the validation sample, the sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV), and error rate were 75.3%, 86.3%, 82.2%, 80.6%, and 18.4, respectively.

Conclusions. Whether a patient admitted to a palliative care unit can discharge to home could be predicted using the simple clinical tool. Further validation and outcome studies are warranted.

Keywords: terminally ill, patient discharge, prognosis, Japan, family caregivers

Introduction

Staying at a preferred place, principally at home, is of great importance for dying patients; moreover, patients who die at home

experience higher ‘quality of death’ than those who die at acute hospitals (1-4). Empirical data, however, indicates that a considerable number of patients do not die in places of their own choosing (5-10). In recent years, an increasing number of medical institutions have been proactively providing discharge support. Some studies have suggested that patients and families have a better experience and more survival benefits when patients can remain at home than when they are admitted to palliative care units (11-13).

It is valuable to be able to identify patients who are eligible for home discharge from palliative care units so timely care coordination can be provided. To date, several empirical studies have generated data for the purpose of developing predictive tools to identify such patients (14-16). Discharge from palliative care units to home was associated with younger age, good performance status, and admission that was not due to intensive symptom control (i.e., absence of dyspnea, unnecessary oxygen therapy, and ascites drainage). One nationwide study developed a clinical tool to predict whether a cancer patient receiving home care dies at home, and this measure can predict the outcome with a sensitivity of 0.72 and a specificity of 0.81 (c-statistic, 0.84), using five parameters: caregivers’ preferences for home death, availability of visiting physicians, 24 hr contact between physicians and nurses, caregivers’ experiences of deathwatch at home, and patients’ insights as to their own prognosis (16). These models may be useful, but they still have several limitations, such as coming from retrospective studies with no formal validation process or being developed with populations that were not limited to patients admitted to palliative care units.

Therefore, I attempted to create and validate a scoring tool to predict whether a patient admitted to a palliative care unit is likely to die in the hospital or be discharged home using prospectively recorded data from inpatients in a palliative care unit (PCU) to assist medical personnel in making decisions about the transition to home. I present the following article in accordance with the STARD reporting checklist.

Methods

I conducted a single-center retrospective cohort study analyzing prospectively collected data on patients with cancer who are terminally ill. For each patient, the attending physicians recorded the structured data collecting sheet on the data related to admission and discharge. The data were collected and reported in patients’ electronic medical records as a part of routine practice. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethical Review Committee for Clinical Research of Toyama Kouseiren Takaoka Hospital. (Approval No. 20190829003; the full protocol is available from the corresponding

author). Informed consent was waved due to the national guideline by the Ministry of Health, Labour and Welfare, i.e., Ethical Guidelines for Medical and Biological Research Involving Human Subjects.

In the Japanese healthcare system, 459 certified palliative care units provide specialist palliative care for patients with advanced malignancies; this specialist care is fully covered by the national insurance. Each PCU has an average of 20 beds and at least one attending physician, and the PCU usually belongs to a general hospital. The PCU plays a major role in end-of-life care but must also facilitate smooth transitions to home care services if appropriate. Per unit, the average number of patients admitted and the number of patients who died at the PCU was 187 and 153 per year, respectively. In 2016, the average length of stay of 32.2 days.

Subjects

All consecutive cancer patients admitted to the Palliative Care Unit (PCU) of the Kouseiren Takaoka Hospital, a 533-bed general hospital in Toyama Prefecture in Japan from October 2016 to October 2019 were enrolled from the registry system. The palliative care unit had 16 beds and provided active home discharge services (17,18). The data from the first admission for each patient were used for this study; rehospitalizations (e.g., second or subsequent hospitalizations) were excluded.

Measurement outcomes

The recorded outcomes included whether patients were discharged home. The follow-up period was from the patient's admission to the PCU until their death, and the location of death was identified.

On the basis of the literature review (5–10, 14–16) and discussion among the authors, I measured 22 potential scale items available on the first day of PCU admission, including 1) demographic variables (age, sex, primary sites of cancer, metastasis sites, marriage status, the presence or absence of a spouse, whether there is a daytime caregiver, whether the primary caregiver is the spouse, two or more family members living together, and whether there are multiple generations living together); 2) patient general conditions at admission according to the Eastern Cooperative Oncology Group [ECOG] performance status scale, the Palliative Prognostic Index, PPI (19), and calories ingested on the first day); 3) vital signs at admission (systolic blood pressure, pulse, SpO2); 4) medications (opioid dose, oral morphine equivalent in mg); 5) patient symptoms at admission (fatigue, dyspnea, nausea and vomiting, abdominal distention, disturbance of consciousness, delirium, edema, dysphagia, motor disturbance, itching sensation, bleeding of the tumor, abdominal pain,

aching pain, and anorexia), and 6) preferred place of care and death (the patient's preferred place of care, the patient's preferred place for death, the family's preferred place of care, the family's preferred place for death).

The primary cancer sites were divided into the following categories: hematology and lymphology, urology, hepatobiliary and pancreatic, breast, gynecology, respiratory, gastroenterology, skin, head and neck, bone and soft tissue, and unknown primary. Cancer metastasis sites were found in the liver, lungs, brain, and bones. The admission period was calculated from the day a patient came to the PCU. The ECOG scale provides a consistent reference of measurement indicating the level of function of patients with cancer in terms of caring for themself, their activities of daily living, and their physical abilities. The items are scored from "0" (fully active, able to carry on all pre-disease performance without restriction) to "4" (completely disabled; cannot carry on any self-care; totally confined to bed or chair) (19). The Palliative Prognostic Index measures a patient's general conditions based on performance status and several symptoms, such as dyspnea, delirium, oral intake, and edema (20). Scores range from 0 to 15, with higher scores indicating poorer general condition.

Patients' caloric intake was calculated based on the designated calories of the meals provided by the hospital and the percentage of the food consumed (e.g., a patient offered a 1200 kcal meal who ate 20% of the meal was considered to have ingested 240 kcal). The caloric content of meals served in the hospital was routinely reported in the medical record by nutritionists. The percentages of the food consumed were also routinely recorded by ward nurses in 10% increments. Also, food from family members was allowed, and the number of calories eaten was reflected based on the nurse's report. Patient symptoms were measured using the Japanese version of the Support Team Assessment Schedule (STAS-J) using a scale from "none"' (0) to "severe" (4) for each symptom (21,22). The reliability and validity of the Japanese version of the STAS were confirmed in a previous study (21), and I recorded one symptom with the highest score as a "major symptom" that results in admission.

Statistical analyses

I used the training-testing procedure to develop and validate the scoring tool. All eligible patients were dichotomized by an alternating method and assigned to the development model group and the validation group. For example, the patients who were discharged home were defined as the home discharge group, and those who were not discharged (i.e., died in the hospital) were defined as the hospital death group. For the patients who were discharged to other hospitals, I classified them into hospital death group because I followed all of them until death and confirmed that they died in hospitals.

In the development phase, first, to investigate factors associated with home discharge, a univariate logistic regression analysis was performed for each factor between the two groups: the home-discharge group and the hospital-death group. I used ad-hoc cutoff points for all variables because there are no confirmed cutoff points relevant to this study's aim. No indeterminate or missing cases were identified.

Second, multivariate logistic regression analysis (variable reduction method - likelihood ratio) was performed to examine the association of each factor with items having a p-value < 0.2 in univariate logistic regression analysis and basic patient characteristics (age and sex). A probability of removal of a p-value of less than 0.1 was set, and factors with $p < 0.05$ were identified as factors linked to home discharge. The following equation was developed using the identified factors (denoted as A1, A2, ...); their odds ratios were rounded to the nearest whole number (denoted as B1, B2, ...).

Score = A1×B1＋A2×B2＋…

A: 1 if applicable to the identified factors, 0 if not applicable

B: Rounded odds ratios for items with p-values <0.05

The total score for each patient was calculated using the created model group, and the highest sum of sensitivity and specificity was set as the cutoff value of the score formula by receiver operating characteristic (ROC) analysis. An ROC curve is a statistical method used to analyze the usefulness of a diagnostic method. The curve is formed on the graphical plot by connecting them with a polygonal line. The area under the curve (AUC) is used to quantify the sensitivity and specificity. The AUC value approaches "1" if the diagnostic method has high discriminative power. In my study, if the total score was greater than the cutoff value, the patient was determined to be eligible for discharge home, and this was used as the scoring tool.

In the validation phase, the scoring tool was applied to the validation group for verification. Validation was evaluated in terms of sensitivity, specificity, positive predictive value, and negative predictive value. I also evaluated the error rate, which represents the ratio of the number of predictions that differ from the actual observation value to the total number of predictions. Validity was evaluated based on sensitivity, specificity, positive predictive value, negative predictive values of at least 80% each, and an error rate of less than 20%. No formal sample size calculation was performed due to the exploratory nature of this study. IBM SPSS Statistics ver. 27 (IBM Corporation) was used for the analysis.

Results

During the study period, a total of 369 cancer patients were admitted to the PCU. Of them, I excluded 10 cases for which a death location could not be identified; the remaining 180 cases (of which 64 were discharged home) were included in the development of the model, and 179 cases (of which 72 were discharged home) were included in the validation phase. All data used for calculating scores were obtained on the day of admission. Among 136 patients who were discharged home, a total of 67 (49.3%) died at home eventually.

Development phase

The characteristics of the patients are summarized in Table 1. Mean age was 73.7 (range, 36–99); 112 (62.2%) patients were male, and 68 (37.8%) were female. The percentage of the patients whose spouse was the primary caregiver was 77% (86/112) among males and 38% (26/68) among females. The mean performance status was 3.1, and the median PCU admission period was 18.5 days (range, 1–105).

Univariate analyses

The univariate logistic regression analysis results are shown in Table 1. Factors associated with patient outcomes (discharge to home or die in hospitals) included performance status, PPI score, systolic blood pressure, pulse, SpO2, calorie intake, use of opioids, married and spouse alive, availability of a daytime caregiver, primary caregiver (spouse), primary tumor site, metastasis sites, and symptoms.

Multivariate analyses

The results of the multivariate logistic regression analysis are shown in Table 2. Independent factors associated with the outcome regarding whether a patient was discharged home were sex (female), calorie intake (520 kcal or more), availability of a daytime caregiver, family's preferred place of care (home), and symptoms that resulted in hospitalization was not fatigue).

Development of scoring model

The most accurate model consisted of four factors: 1) sex (female), 4 points; 2) caloric intake at admission (>520 kcal), 19 points; 3) having a daytime caregiver, 11 points; 4) family preference for home care, 139 points; and 5) symptoms other than fatigue that resulted in hospitalization, 7 points. From these results, I developed the formula as follows:

Score = (female x 4) + (first day calorie intake of 520 kcal or more x 19) + (presence of daytime caregiver x 11) + (family

preferred place of care home or facility x 139) + (symptoms that resulted in hospitalization were not fatigue x 7)

Accuracy of the developed model

The value with the highest sensitivity + specificity was used as the cutoff value, and a score of 155 or less was determined to be hospital death, and a score of 155 or more was determined to be home discharge (Table 3). The AUC (area under the curve) using this cutoff value was 0.949, with 95% confidence intervals of 0.918 to 0.981 (Figure 1).

Validation phase

Patient characteristics were similar in the development phase (data not shown). The scoring tool was applied to the validation group for verification. The sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV), and error rate were 75.3%, 86.3%, 82.2%, 80.6%, and 18.4 respectively (Table 4). Consequently, the accuracy of the score formula was considered to be valid: a score of more than 155 indicates a high likelihood of returning home.

Discussion

The accuracy of this scoring tool developed in this study is high. The tool is also simple, using only five parameters, and has been validated in oncology palliative care settings. The difference from an existing tool is sample (patients receiving home care vs. patients admitted to palliative care units), outcomes (home death vs. discharge to home), and variables (variables obtained from nursing facilities vs. variables from patients on admission) (16). This constructed score could be calculated based on the patient factors and could be used as a useful tool for healthcare providers to easily identify patients necessary for planning their discharge to home.

In the score formula created, five factors were selected: female, calorie intake, presence of a daytime caregiver, family’s preferred place of care is home, and having something other than fatigue as the main symptom that resulted in hospitalization. Meta-analyses have not identified sex as an independent determinant for home death (7, 8). A possible reason women were more likely to be discharged home in this cohort is that less than 40% of the female patients reported their spouse as the primary caregiver compared with approximately 80% of the male patients. This marked difference may indicate that the caregivers for the female were younger people capable of caring for patients. For example, children often become the caregivers for their mothers when they are discharged and moved back to their homes.

The results indicate that calorie intake, having a daytime caregiver, and the family preferring home as the place of care are factors associated with being discharged home; these results are consistent with existing studies (7-10). Miura et al. reported that the higher the calorie intake on the first day, the more likely the patient was to transition home, according to the results of a multivariate analysis of the study exploring predictors of possible discharge to home from a palliative care ward (15). Similarly, I found that a "calorie intake of 520 kcal or more on the first day" could be a useful factor for patients to be discharged home. Furthermore, multiple empirical studies have shown that “home” being the family's preferred place of care is a particularly strong factor facilitating discharge to home (7-10, 15,16).

Furthermore, fatigue was known to be a symptom that is associated with a high level of distress (23,24). However, there is conflicting evidence as to whether fatigue, or any other physical symptoms, are associated with home death (7,8). A potential interpretation of the finding in this cohort that fatigue was associated with hospital death (i.e., less likely to discharge to home) is that treatment options to overcome fatigue are limited, and fatigue has a significant impact on daily life that results in a lower possibility of discharge to home (15). The presence of fatigue might also mean that the patient’s general condition has deteriorated; thus, substituting the fatigue item with other items, such as performance status, prognostic scores, or vital signs, might be of value in future studies.

There are several limitations of this study. First, this is a single-center study, and validation in a multicenter study is needed. Second, I did not include the economic status of the patient’s family because, in the Japanese healthcare system, all medical costs are covered by the national insurance program; the upper limits for self-payment are about 1,000 USD per month, even in populations with relatively high incomes. Third, the sample size was relatively small. There was a heavy weight on one item in the equation (i.e., 139 points for family preference for home death). Fourth, although sex was identified as a predictive factor of home discharge, there might be complex interactions among variables such as the patient’s sex, their relationship to the primary caregiver (spouse or not), and the age of the primary caregiver. Fifth, I used ad-hoc cutoff points for all variables. Sixth, there would be cultural differences in interpreting the study results; for example, the culture of looking after one’s elderly family member at home differs among countries. Seventh, I could not explore the effect of the inclusion of admission length before PCU transfer due to lack of data, and future study could be improved if admission length is added as a variable. Eighth, although I adopted “home discharge” as an outcome, “length of stay at home” may be a more important outcome. The finding that the rate of home death was sufficiently high in my patients who had been discharged home (49% compared with the national average of 13%) provides some rationale indicating the value of this outcome. Future studies might

explore “length of home stay” or “home death” as outcomes.

In conclusion, whether a patient admitted to a palliative care unit can discharge to their home could be predicted using the simple clinical tool described in this study. However, further validation and outcome studies are warranted.

Table 1
Factors associated with discharge to home or die in hospitals: univariate logistic regression analysis

		Home discharge group (64 patients)		Hospital death group (116 patients)		
	Items	**n**	**%**	**n**	**%**	**P-value**
Patient background	Over 80 years old	22	34	35	30	0.562
	Female	26	41	42	36	0.558
	PS 2-4 at admission to the hospital ward	56	88	115	99	<0.001
	PPI 4.5 or less at admission to the hospital ward	50	78	37	32	<0.001
	Systolic blood pressure 136 mmHg or higher	58	91	97	84	0.144
	Pulse 83 beats/min. or higher	12	19	39	34	<0.001
	SpO2 97% or higher	42	66	59	51	0.056
	Calorie intake on the first day: 520 kcal or more	52	81	40	34	<0.001
	Use of opioids	31	48	72	62	0.077
	Delirium within 3 days of admission	10	16	24	21	0.406
	Married and spouse alive	54	84	83	72	0.053
	Multiple generations living together	37	58	63	54	0.651
	Daytime caregivers	56	88	71	61	<0.001
	Primary caregiver is spouse	46	72	66	57	0.047
	The patient’s preferred place of care	55	86	42	36	<0.001
	The patient’s preferred place for death	25	39	33	28	<0.001
	The family’s preferred place of care	59	92	21	18	<0.001
	The family’s preferred place for death	31	48	10	9	<0.001

Primary site	Blood and Lymph	0	0	1	1	1.000
	Urinary apparatus	6	9	3	3	0.070
	Hepatobiliary	10	16	28	24	0.180
	Breast	1	2	2	2	1.000
	Gynecology	2	3	5	4	1.000
	Respiratory organs	21	33	32	28	0.461
	Digestive apparatus	12	19	35	30	0.095
	Unknown primary	1	2	1	1	1.000
	Skin	1	2	1	1	1.000
	Head and neck	9	14	7	6	0.070
	Bone and soft tissue	1	2	1	1	1.000
Metastatic site	Liver metastasis	14	22	38	33	0.123
	Lung metastasis	13	20	25	22	0.845
	Brain metastasis	9	14	20	17	0.579
	Bone metastasis	13	20	9	8	0.014
Symptoms that resulted in hospitalization	Fatigue	8	13	24	21	0.169
	Dyspnea	8	13	22	19	0.265
	Nausea and vomiting	1	2	11	9	0.058
	Abdominal distension	3	5	5	4	1.000
	Disturbance of consciousness	2	3	9	8	0.332
	Edema	0	0	0	0	*
	Dysphagia	1	2	0	0	0.356
	Motor disturbance	0	0	1	1	1.000
	Itching sensation	0	0	1	1	1.000
	Bleeding of the tumor	1	2	0	0	0.356
	Abdominal pain	0	0	1	1	1.000
	Aching pain	37	58	38	33	0.001
	Anorexia	3	5	4	3	0.700

*Calculation not possible because there are no applicable patients in the development model group.

PS: Eastern Cooperative Oncology Group [ECOG] performance status.
ECOG performance status measures a patient's level of functioning in terms of their ability to care for themself, daily activity, and physical ability, ranging from 0 (fully active) to 4 (completely disabled).
PPI: Palliative Prognostic Index measures patient general conditions based on performance status and symptoms. Higher score means poor general condition, ranging from 0 to 15.

Table 2

Independent factors associated with discharge to home or die in hospitals: multivariate logistic regression analysis

		Home discharge group (64 patients)		Hospital death group (116 patients)		P-value	Odds ratio	95% confidence interval	
	item	applicable	%	applicable	%			Minimum	Maximum
Patient background	Female	26	41	42	36	0.028	4.077	1.166	14.251
	Calorie intake on the first day: 520 kcal or more	52	81	40	34	<0.001	19.096	4.775	76.371
	Daytime caregivers	56	88	71	61	0.004	10.791	2.162	53.869
	Family's preferred place of care (home or facility)	59	92	21	18	<0.001	139.280	29.274	662.677
Symptoms that resulted in hospitalization	Fatigue	8	13	24	21	0.018	6.928	1.387	34.600
	Nausea and vomiting	1	2	11	9	0.102	18.913	0.556	643.104

Table 3
Sensitivity and specificity with different cutoff points

Likely to be discharged home when greater than or equal to	Sensitivity	Specificity	Sensitivity+ specificity
152	0.906	0.853	1.759
155.5	0.891	0.871	1.762
159	0.828	0.922	1.75

Cutoff point was determined ≤155 vs. >155.

Table 4

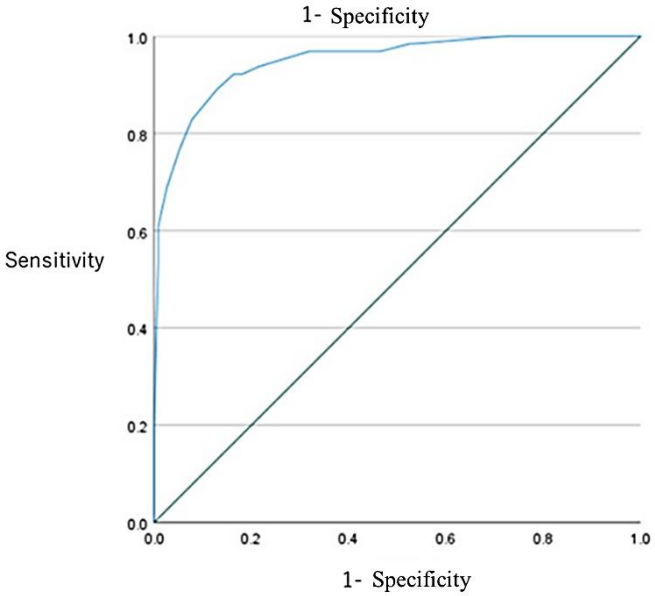
Validity of the developed scale: validation phase (n=179)

	Outcomes		Total		
	Home discharge	**Hospital death**		Sensitivity	75.3%
				Specificity	86.3%
Positive	58	14	72	Positive predictive value	80.6%
Negative	19	88	107	Negative predictive value	82.2%
Total	77	102	179	Error rate	18.4%

Positive: score of more than 155. Negative: score of 155 or less.

Figure 1

ROC curve of the developed model



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Footnote

Conflict of Interest: All authors have completed the ICMJE uniform disclosure form. The authors have no conflicts of interest to declare. Reporting Checklist: The authors have completed the STARD reporting checklist.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethical Review Committee for Clinical Research of Toyama Kouseiren Takaoka Hospital. (Approval No. 20190829003; the full protocol is available from the corresponding author).

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