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Prognostic Factors in Patients With Advanced Cancer: Use of the Patient-Generated Subjective Global Assessment in Survival Prediction

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ABSTRACT

Purpose
To determine whether elements of a standard nutritional screening assessment are independently prognostic of survival in patients with advanced cancer.

Patients and Methods
A prospective nested cohort of patients with metastatic cancer were accrued from different units of a Regional Palliative Care Program. Patients completed a nutritional screen on admission. Data included age, sex, cancer site, height, weight history, dietary intake, 13 nutrition impact symptoms, and patient- and physician-reported performance status (PS). Univariate and multivariate survival analyses were conducted. Concordance statistics (c-statistics) were used to test the predictive accuracy of models based on training and validation sets; a c-statistic of 0.5 indicates the model predicts the outcome as well as chance; perfect prediction has a c-statistic of 1.0.

Results
A training set of patients in palliative home care (n = 1,164) was used to identify prognostic variables. Primary disease site, PS, short-term weight change (either gain or loss), dietary intake, and dysphagia predicted survival in multivariate analysis ($P < .05$). A model including only patients separated by disease site and PS with high c-statistics between predicted and observed responses for survival in the training set (0.90) and validation set (0.88; n = 603). The addition of weight change, dietary intake, and dysphagia did not further improve the c-statistic of the model. The c-statistic was also not altered by substituting physician-rated palliative PS for patient-reported PS.

Conclusion
We demonstrate a high probability of concordance between predicted and observed survival for patients in distinct palliative care settings (home care, tertiary inpatient, ambulatory outpatient) based on patient-reported information.

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INTRODUCTION

Prognostication of life expectancy is a significant task for clinicians involved in the care of patients with advanced cancer. Accurate prognostication is needed to make decisions regarding patient care, enhance the dying patient's quality of life, and allow patients to prepare for death.[1] Survival prediction in advanced cancer has been reviewed[1-4]; these works detail specific items and prognostic scores developed to assist physicians in their quest for more accurate prognostication. Although this area is noted for the heterogeneity of studies and inconsistent standards in reporting results, grade B evidence is available for the prognostic value of performance status (PS), symptoms associated with cancer anorexia-cachexia syndrome, dyspnea, delirium, and biologic factors (eg, leukocytosis, lymphocytopenia, and C-reactive protein).[1,3]

Manifestations of anorexia-cachexia related to survival in patients with advanced cancer include weight loss, low dietary intake, and symptoms of anorexia, dysphagia, and xerostomia.[3] Most prognostication efforts include at least one of these features, but they are inconsistently used and appear to be arbitrarily included.[5-8] Currently, there are no standards for reporting these variables. Weight loss is a consistently cited predictor of survival[1,3,4] but is variously reported as a percentage (eg, > 5%, > 10%)[8,9] or amount (eg, > 8.1 kg or > 10 kg)[4,10] lost relative to pre-illness weight or over 1, 3, or 6 months. Dietary intake may be measured directly as kcal/d or indirectly as assessed by questionnaires. Symptoms likely to reduce food intake (nutrition

impact symptoms) such as dysphagia are scored in various ways (eg, present/absent or visual analog scales).[5-7,9-12]

The use of nutrition information in survival prediction for patients with advanced cancer might be improved. We tested the prognostic significance of the individual elements of the patient-generated Subjective Global Assessment (PG-SGA), a validated nutritional screening tool based on patient-reported features of weight change, dietary intake, GI symptoms, and PS.[13-15] The PG-SGA is accepted by the Oncology Nutrition Dietetic Practice Group of the American Dietetic Association as the standard for nutrition assessment of patients with cancer for whom it was specifically developed.[14]

Gotay et al[16] commented on the importance of patient-reported outcomes in survival prediction. The PG-SGA includes a version of the Eastern Cooperative Oncology Group (ECOG) PS[17] expressed in lay language and designed to be completed by the patient. Since we could not find any prior citation of patient-reported PS, this was compared to the physician-reported Palliative Performance Scale (PPS), a validated prognostic tool[18-23] that is based on a modification of the Karnofsky PS.[5]

In this prospective, nested cohort study, we undertook to define elements of the PG-SGA independently prognostic of survival in patients with advanced cancer and to determine their prognostic accuracy. A secondary objective was to compare the predictive accuracy of patient- and physician- reported PS.

PATIENTS AND METHODS

Patients and Data Acquisition

The study was approved by the institutional research ethics board as a minimal risk study (chart review of standard clinical assessments). Patients had metastatic cancer, were age ≥ 18 years, and were referred to the Regional Palliative Care Program (RPCP) serving Edmonton and surrounding areas in Alberta, Canada. Clinical features of tumor burden (number of and sites of metastases) were not recorded, because they are not accurately documented in the clinical record of patients with advanced cancer in palliative care whose disease has become refractory to treatment. The RPCP is a community-based program in which both cancer care and palliative care are centralized. RPCP services are provided in the following settings: tertiary hospitals, home care, hospice, and outpatients at a regional cancer treatment center. General and specific admission criteria[24] for the RPCP are provided in Figure 1. More than 81% of patients with advanced cancer who live in the region are referred to the program.[25] Patients were accrued from palliative home care, an inpatient tertiary palliative care unit (TPCU), and an outpatient pain and symptom control consult service (PSCS) located in the regional cancer treatment center (Fig 1).

The RPCP maintains a database of demographic information and standard clinical assessments conducted on all patients[26] (eg, Edmonton Symptom Assessment Scale, PPS, PG-SGA) with links to provincial health databases and registries.[27] Dates of birth and death, age, sex, primary cancer diagnosis, cancer stage, and data from the PG-SGA and PPS were obtained from the RPCP. PG-SGA and PPS were completed on the date of first referral (home care, PSCS) or admission (inpatient TPCU). The PG-SGA was completed by the patient; caregivers could provide assistance if required, but did not complete the assessment for the patient. The PPS was completed by a palliative care physician.

The inception cohort was prospectively accrued and divided into two groups for analysis: (1) training set: data from palliative home care was used to determine elements of the PG-SGA prognostic of overall survival, build a predictive model including these features, and assess the predictive accuracy of the model. (2) Validation set: data from the PSCS and the TPCU tested the predictive accuracy of the survival model. In the comparison of patient- and physician-reported PS, subsets of patients from the training and validation sets were combined.

Study Design

PG-SGA data included height, weight, weight change, dietary intake, 13 nutrition impact symptoms, and PS. Body mass index (BMI; kg/m^2) and

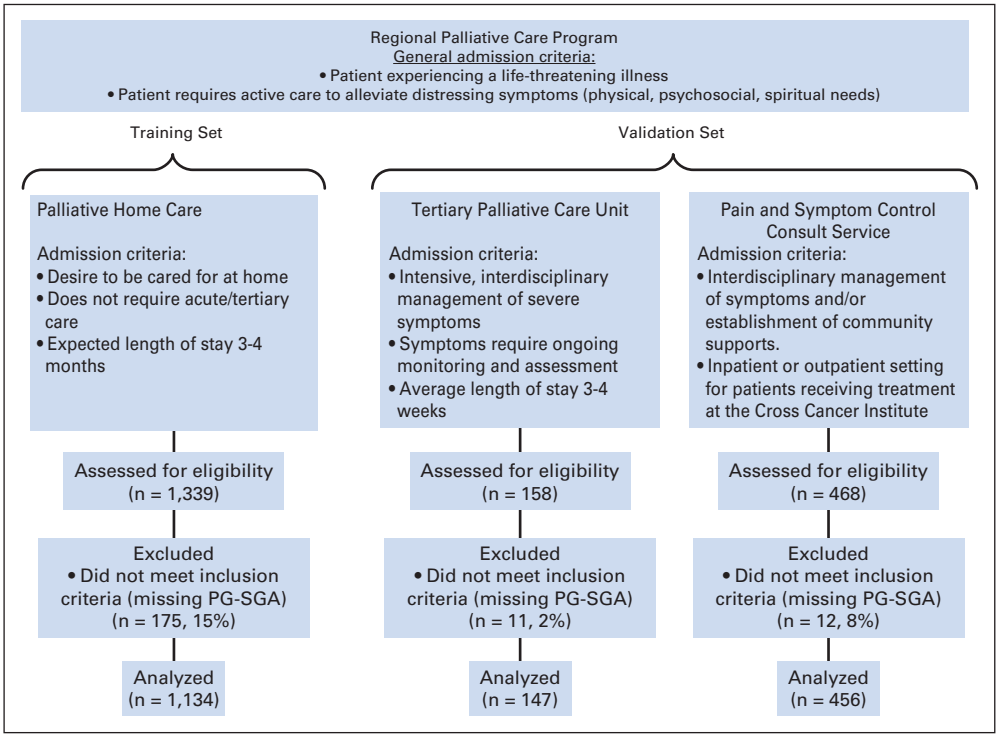

Fig 1. CONSORT diagram includes clinical sites of patient accrual within the Regional Palliative Care Program. Additional program and referral information at www.palliative.org. PG-SGA, patient-generated Subjective Global Assessment.

Table 1. Patient Characteristics

Characteristic	Training Set (n = 1,164) No.	%	Validation Set (n = 603) No.	%	P
Age, years					< .001
Mean	66.8		60.5		
SD	13.0		12.4		
Sex					.76
Male	566	49	288	48	
Female	598	51	315	52	
Diagnosis					< .001
Breast	103	9	86	14	
GI	294	25	126	21	
Genitourinary	118	10	108	18	
Hematology	75	6	26	4	
Lung	333	29	159	26	
Other cancers	241	21	98	16	
PG-SGA PS (patient-reported)					< .001
0	31	3	9	1	
1	253	22	83	14	
2	317	27	140	23	
3	516	44	307	51	
4	47	4	64	11	
PPS (physician-reported)					< .001
Mean	60.7		58.2		
SD	11.7*		13.5†		
PPS survival groups					.008
0%-30%	12	2*	23	4†	
40%-60%	487	63*	319	62†	
≥ 70%	268	35*	174	34†	
Weight (kg)					.12
Mean	67.6		68.9		
SD	16.7		16.0		
Height (cm)					.03
Mean	167.7		168.8		
SD	10.0		9.6		
BMI (kg/m^2)					.57
Mean	24.0		24.1		
SD	5.3		5.0		
Weight change, %					.66
Mean	−4.7		−4.5		
SD	7.3		6.4		
Dietary intake					< .001
Normal food, normal amount	213	18	73	12	
Normal food, reduced amount	576	49	295	49	
Little solid food	193	17	80	13	
Only liquids/nutritional supplements	74	6	50	8	
Very little oral intake	108	9	105	17	
Nutrition impact symptoms					
No appetite	667	57	393	65	.001
Feel full quickly	462	40	278	46	.01
Nausea	449	39	273	45	.004
Altered taste	378	33	251	42	< .001
Constipation	369	32	259	43	< .001
Pain	335	29	329	55	< .001
Dry mouth	323	28	191	32	.09
Altered smell	246	21	177	29	< .001
Vomiting	199	17	147	24	< .001
Dysphagia	175	15	114	19	.04
Other (eg, financial, depression)	125	11	33	6	< .001
Diarrhea	108	9	54	9	.86
Dental problems	101	9	92	15	< .001
Mouth sores	79	7	51	9	.21

Abbreviations: SD, standard deviation; PG-SGA PS, patient-generated Subjective Global Assessment performance status; PPS, Palliative Performance Scale; BMI, body mass index.

*Based on 767 patients from palliative home care.

†Based on 516 patients from pain and symptom control consult services and tertiary palliative care units.

percent weight change (current-previous weight/previous weight) × 100% were calculated. Weight change was recorded beginning at 1 and 6 months before referral or admission. Where possible, 1-month weight change was used; otherwise, it was imputed from 6-month weight change (5% of patients), with minimal impact on interpretation of the results. The relationship between percent weight change and survival was defined; the training data were initially divided into 10 equal parts (eg, from least to most weight loss), and the overall survival of the deciles was examined. BMI was examined using the WHO categories, which are widely accepted: < 18.5, underweight; 18.5 to 24.9, normal weight; 25.0 to 29.9, overweight; and ≥ 30.0 obese.

Dietary intake on the PG-SGA is reported using descriptors: "normal food in a normal amount," "normal food with reduced amount," "little solid foods," "only liquids/nutritional supplements," and "very little of anything." Nutrition impact symptoms are noted as present or absent. Descriptors for the PS component of the PG-SGA are 0 = normal with no limitations; 1 = not my normal self, but able to be up and about with fairly normal activities; 2 = not feeling up to most things, but in bed or chair less than half the day; 3 = able to do little activity, and spend most of the day in bed or chair; 4 = pretty much bedridden, rarely get out of bed. Patients were excluded if data were missing from their PG-SGA.

PPS is based on five domains: ambulation, activity level and evidence of disease, self-care, oral intake, and level of consciousness. PPS has 11 categories (0% to 100%) and is scored in 10% increments only; a lower score indicates worse function (0% = death, 100% = full function). PPS scores were examined as three distinct survival groups (0% to 30%, 40% to 60%, and ≥ 70%).[19,20,22,23] Comparisons were made between the median overall survival, as predicted by PG-SGA PS, and PPS.

Statistics

Descriptive statistics characterizing patient groups are provided. Differences between groups were evaluated with independent *t* tests for continuous variables and χ^2 tests for categoric variables. The primary outcome was overall survival, defined as time between date of clinical assessments (ie, date of referral or admission to RPCP) and date of death. Patients alive on a date chosen by researchers (training set: July 24, 2008; validation set: July 1, 2009) were censored. For survival analysis (training set), nutritional, demographic, and disease-related data were analyzed as categoric variables. The Kaplan-Meier method established the effect of each variable on survival; log-rank tests were used to compare survival curves within each variable. When there were no survival differences between categories within variables, categories were collapsed. The Cox proportional hazard model was used to obtain hazard ratios and their corresponding 95% CIs. Based on standard model building strategies, variables significant at the univariate level ($P < .1$) were entered into the multivariate model. Statistical analysis was conducted using SPSS version 15.0 (SPSS, Chicago, IL); $P < .05$ was considered for statistical significance.

A concordance statistic (c-statistic) was used to assess the discrimination of a model to predict overall survival in the training and validation sets and to compare patient- and physician- reported PS. The c-statistic, introduced by Harrell et al,[28] is the probability that a participant from the event group has a higher predicted probability of an event (ie, death) occurring compared with a participant from the non-event group. A c-statistic of 0.5 indicates that the model predicts the outcome as well as chance (ie, equal numbers of true and false positives), 0.7 to < 0.8 indicates acceptable discrimination, 0.8 to < 0.9 indicates excellent discrimination, 0.9 to < 1.0 is outstanding discrimination, and 1.0 is perfect prediction.[29] The c-statistic is applicable to all regression models, including survival models.[30] The overall c-statistics and 95% CIs were estimated using a macro in SAS version 9.1.3 (SAS Institute, Cary, NC).[31]

RESULTS

Training Set

Data for consecutive patients were collected from palliative home care settings between 2004 and 2007 (Fig 1). Patient characteristics are presented (Table 1). There were 980 deaths, with an overall median survival of 3.2 months (95% CI, 2.9 to 3.5 months), and median follow-up was 3.1 months (95% CI, 0.0 to 38.6 months).

Survival Analysis

The relationship of percent weight change to overall survival, by deciles, was U-shaped; shortened survival was associated with increasing weight loss and weight gain compared with stable weight. Categories defined for percent weight change were based on survival differences (log-rank tests): stable weight ± 1.9%, weight gain ≥ 2.0%, and two categories of weight loss (−2.0% to −13.9% and ≥ −14.0%). Median survival was different ($P < .001$) between stable weight (4.7 months; 95% CI, 3.9 to 5.5 months), weight gain ≥ 2.0% (3.1 months; 95% CI, 2.3 to 3.9 months), and weight loss −2.0% to −13.9% (2.9 months; 95% CI, 2.5 to 3.2 months) and ≥ −14.0% (2.3 months; 95% CI, 1.7 to 2.9 months; Fig 2A). Survival was shorter for all BMI < 30.0 kg/m^2: BMI < 18.5 (3.1 months; 95% CI, 2.3 to 3.8 months), BMI 18.5 to 24.9 (3.0 months; 95% CI, 2.6 to 3.3 months), and BMI 25.0 to 29.9 (3.3 months; 95% CI, 2.7 to 3.8 months) compared with BMI ≥ 30.0 (5.0 months; 95% CI, 3.7 to 6.3 months; $P = .001$; Fig 2B).

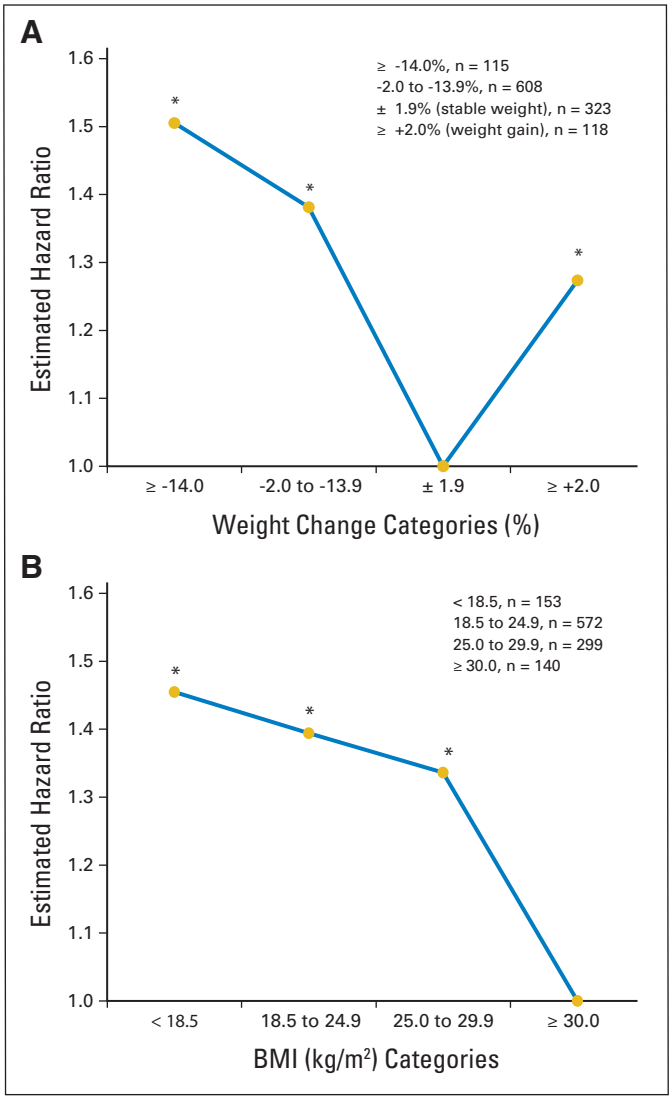

Fig 2. Univariate relationship between survival and (A) percent weight change categories (reference group: stable weight ± 1.9%; hazard ratio 1.0 refers to the lowest risk of shortened survival) and (B) body mass index (BMI; kg/m^2) WHO categories (reference group: largest BMI, ≥ 30.0; hazard ratio, 1.0). (*) Indicates significant difference from reference group ($P < .05$).

Dietary Intake and Symptoms

Shortened survival was associated with the three low food intake categories ("little solid food," "only liquids/nutritional supplements," "very little of anything"), and these were grouped into a single category referred to hereafter as "abnormal intake." Median survival times for patients with "normal intake" (5.0 months; 95% CI, 3.7 to 6.2 months), "normal food at reduced amount" (3.4 months; 95% CI, 3.0 to 3.8 months), and "abnormal intake" (2.1 months; 95% CI, 1.7 to 2.4 months) were different ($P < .001$). Nutrition impact symptoms associated with shorter survival were no appetite (2.6 months [95% CI, 2.4 to 2.8 months] *v* 4.1 months [95% CI, 3.6 to 4.7 months]; $P < .001$); feel full quickly (2.6 months [95% CI, 2.3 to 3.0 months] *v* 3.6 months [95% CI, 3.1 to 4.1 months]; $P = .02$); altered taste (2.5 months [95% CI, 2.2 to 2.8 months] *v* 3.7 months [95% CI, 3.2 to 4.1 months]; $P = .01$); dry mouth (2.6 months [95% CI, 2.2 to 2.9 months] *v* 3.5 months [95% CI, 3.1 to 3.9 months], $P = .02$); and dysphagia (2.6 months [95% CI, 1.9 to 3.4 months] *v* 3.3 months [95% CI, 2.9 to 3.6 months]; $P < .001$).

Demographic and Cancer-Related Features

Women had longer median survival compared with men (3.6 months [95% CI, 3.1 to 4.1 months] *v* 2.8 months [95% CI, 2.4 to 3.1 months]; $P = .01$). Patients with lung and GI cancers had the shortest survival (2.9 months [95% CI, 2.5 to 3.2 months] and 2.8 months [95% CI, 2.4 to 3.2 months]) compared with genitourinary and other cancers (3.6 months [95% CI, 2.1 to 5.2 months] and 3.7 months [95% CI, 2.7 to 4.7 months], respectively) and breast and hematologic cancers (7.0 months [95% CI, 5.2 to 8.8 months] and 4.3 months [95% CI, 2.3 to 6.2 months], respectively; $P < .001$). Age was not related to survival.

Patient-reported PG-SGA PS scores of 0 to 2 were collapsed: patients with PS 0 to 2 had longer median survival (4.3 months [95%

Table 2. Univariate and Multivariate Analysis for the Training Set (n = 1,164)

Variable	Univariate						Multivariate				
	No. of Events	*P*	HR	95% CI	Regression Coefficient	SE	*P*	HR	95% CI	Regression Coefficient	SE
Age, years											
< 65	381		1.00								
≥ 65	599	.70	1.03	0.90 to 1.17	0.03	0.07					
Sex											
Female	598		1.00								
Male	566	.01	1.18	1.04 to 1.33	0.16	0.06					
Primary disease site		< .001					< .001				
Breast	74		1.00					1.00			
Lung	295	< .001	1.90	1.46 to 2.46	0.64	0.13	< .001	1.77	1.37 to 2.29	0.57	0.13
GI	259	< .001	1.85	1.43 to 2.39	0.62	0.13	< .001	1.69	1.30 to 2.19	0.52	0.13
Genitourinary	98	.02	1.44	1.06 to 1.95	0.36	0.15	.08	1.31	0.97 to 1.78	0.27	0.16
Hematology	54	.39	1.17	0.82 to 1.66	0.15	0.18	.38	1.17	0.82 to 1.66	0.16	0.18
Other cancers	200	.01	1.42	1.09 to 1.85	0.35	0.14	.18	1.20	0.92 to 1.57	0.18	0.14
PG-SGA PS (patient-reported)		< .001					< .001				
0 to 2	484		1.00								
3	543	< .001	1.44	1.27 to 1.64	0.37	0.07	< .001	1.39	1.22 to 1.59	0.33	0.07
4	43	< .001	2.40	1.75 to 3.27	0.87	0.16	< .001	2.16	1.56 to 2.99	0.77	0.17
Weight change, %		< .001					.04				
−1.9 to 1.9	256		1.00					1.00			
> 2.0	100	.04	1.27	1.01 to 1.60	0.24	0.12	.02	1.31	1.04 to 1.65	0.27	0.12
−2.0 to −13.9	608	< .001	1.38	1.19 to 1.60	0.32	0.08	.02	1.20	1.03 to 1.40	0.18	0.08
≥ −14	115	.001	1.51	1.19 to 1.90	0.41	0.12	.04	1.28	1.00 to 1.62	0.24	0.12
BMI, kg/m^2		.01									
≥ 30.0	107		1.00								
< 30.0	873	.002	1.38	1.13 to 1.69	0.33	0.10					
Dietary intake		< .001					.001				
Normal food, normal amount	163		1.00					1.00			
Normal food, reduced amount	481	.003	1.31	1.10 to 1.57	0.27	0.09	.05	1.20	1.00 to 1.44	0.18	0.09
Abnormal intake	336	< .001	1.89	1.57 to 2.28	0.64	0.10	< .001	1.48	1.21 to 1.82	0.39	0.10
Nutrition impact symptoms (present *v* absent)*											
No appetite	575	< .001	1.32	1.16 to 1.50	0.28	0.06					
Feel full quickly	392	.02	1.17	1.03 to 1.33	0.16	0.07					
Altered taste	328	.01	1.19	1.04 to 1.36	0.18	0.07					
Dry mouth	283	.02	1.18	1.03 to 1.35	0.17	0.07					
Dysphagia	162	< .001	1.39	1.17 to 1.65	0.33	0.09	.030	1.21	1.02 to 1.44	0.19	0.09

Abbreviations: HR, hazard ratio; SE, standard error; PG-SGA PS, patient-generated Subjective Global Assessment performance status; BMI, body mass index.
*Nausea, constipation, pain, altered smell, vomiting, diarrhea, dental problems, mouth sores, and other symptoms were not significant at the univariate level ($P > .25$); data not shown.

CI, 3.8 to 4.8 months]) than patients with PS 3 (2.5 months [95% CI, 2.2 to 2.8 months]) or patients with PS 4 (1.3 months [95% CI, 0.5 to 2.0 months]; $P < .001$).

Significant predictors of survival by univariate analysis included sex, primary cancer site, PS, percent weight change, dietary intake, and several nutrition impact symptoms (Table 2). Five variables were significant in the multivariate model (Table 2): diagnosis, PS, percent weight change, food intake, and dysphagia. All of the cancer diagnosis groups had similar distributions for the prognostic nutritional variables (data not shown).

Table 3. Discrimination of Overall Survival for a Predictive Model in a Training and Validation Set and for Two Measures of Functional Status

Variable	Training Set (n = 1,164)		Validation Set (n = 603)		PG-SGA PS‡ (n = 1,767)	PPS‡ (n = 1,283)
	Base Model*	Full Model†	Base Model*	Full Model†		
C-statistic	0.90	0.88	0.88	0.87	0.93	0.93
95% CI	0.86 to 0.93	0.83 to 0.91	0.82 to 0.93	0.80 to 0.92	0.90 to 0.96	0.90 to 0.96

NOTE. There are no statistical differences between concordance statistics (c-statistics; $P > .05$).
Abbreviations: PG-SGA PS, patient-generated Subjective Global Assessment performance status; PPS, Palliative Performance Scale.
*Base model includes cancer diagnosis and functional status.
†Full model includes cancer diagnosis, functional status, percent weight change, dietary intake, and dysphagia.
‡The calculations of c-statistics were performed on PG-SGA PS and PPS only (ie, no other variables were included).

Assessment of Predictive Accuracy

Discrimination (c-statistic) was assessed in a base model containing two variables: cancer diagnosis and PG-SGA PS, which demonstrated excellent predictive discrimination (Table 3). The addition of percent weight change, food intake, and dysphagia (full model) did not improve predictive accuracy above that of the base model (Table 3).

Validation

The validation set (Table 1) comprised 627 patients consecutively referred to the PSCS from 2005 to 2009 and to the TPCU in 2008 (Fig 1). Median survival of patients treated in these settings was different (PSCS: 3.8 months [95% CI, 3.4 to 4.2 months] *v* TPCU: 1.1 months [95% CI, 0.9 to 1.2 months]; $P < .001$). Despite the differences, accuracy (ie, c-statistic) of survival prediction was similar for these patients—0.89 (PSCS) and 0.91 (TPCU), respectively—and data were pooled and treated as a single population.

Patients in the validation set were younger and had different distributions of PS and dietary intake with a higher overall symptom burden compared with patients in the training set (Table 1). There were 502 deaths with an overall median survival of 3.1 months (95% CI, 2.7 to 3.5 months), and median follow-up was 2.7 months (95% CI, 0.0 to 44.2 months). Neither median survival nor follow-up differed from the training set; Kaplan-Meier curves for training and validation data were highly similar (Fig 3A). Discrimination of the base and full models of survival prediction was similar to that of the training set (Table 3).

PS Measures

A subset of 1,283 patients (home care, n = 767; PSCS, n = 407; TPCU, n = 109) had a PPS completed on the same date as the PG-SGA (Table 1). The discrimination for overall survival predicted by patient- and physician-reported PS was indistinguishable (Fig 3B). In Table 4, survival is presented by PG-SGA PS (0-2, 3, and 4) and PPS (0% to 30%, 40% to 60%, ≥ 70%) for the cancer diagnoses that had significantly different survival (lung/GI *v* other cancers); both patient- and physician-reported PS gave equal discrimination of survival.

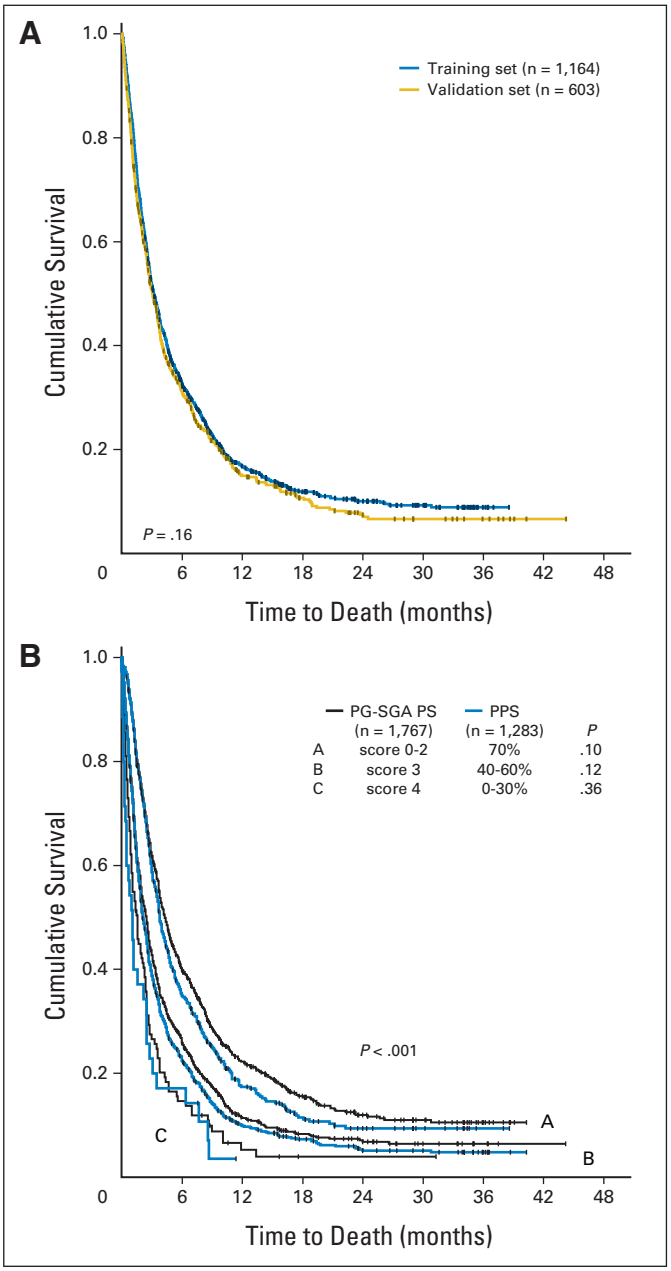

Fig 3. Cumulative survival curves. (A) Training set and validation set. (B) Patient-generated Subjective Global Assessment performance status (PG-SGA PS) categories and physician-reported Palliative Performance Scale (PPS) categories. There were no survival differences between PS measures in categories A, B, and C. $P = .10$, $P = .12$, and $P = .36$ for A, B, and C, respectively.

DISCUSSION

Nutritional variables have been traditionally included in prognostic models in patients with advanced cancer but without specific rationale. We studied a large, population-based data set using a standardized nutrition screening tool. We carefully assessed the relationship of BMI and percent weight change with survival and defined categories of least risk (BMI > 30 kg/m^2, stable weight ± 1.9%) and increased risk. Multivariate analysis demonstrated three independently prognostic nutritional variables (percent weight change, food intake, and dysphagia) in addition to disease site and PS. However, a further assessment of the predictive accuracy of the model including these five variables clearly demonstrates that disease and PS dominate the model and that nutritional variables add no incremental predictive accuracy.

Our use of patient-reported outcomes, although they may have some limitations, is a strength of our approach. Data collection is simple, noninvasive, cost-effective, and only precluded in cases of significant cognitive impairment; in this study, there was a limited amount of missing data (2% to 15%) when using the PG-SGA. The PG-SGA has a dual use as a nutrition screen for referral to nutrition support services and in the collection of data for prognostication. There is evidence to support the reliability of self-reported height, weight, weight history, and patient-perceived level of dietary intake.[32-35] Experts in prognostication have debated the accuracy of physician-predicted survival[36,37] and use of Karnofsky score, ECOG score, and PPS; however, the patient has not been conventionally

Table 4. Median Overall Survival for Disease and PS Categories: PG-SGA PS and Physician-Reported PPS

Variable	Lung and GI Cancers					Other Cancers				
	No. of Patients	No. of Events	Median Survival (months)	95% CI	*P**	No. of Patients	No. of Events	Median Survival (months)	95% CI	*P**
Patient-reported PG-SGA PS (n = 1,767)										
0-2	442	372	3.7	3.3 to 4.1	< .001	391	287	5.9	4.7 to 7.2	< .001
3	419	377	2.0	1.6 to 2.3		404	342	2.9	2.3 to 3.4	
4	51	51	1.0	0.5 to 1.5		60	53	2.4	1.5 to 3.4	
Physician-reported PPS (n = 1,283)										
≥ 70%	222	202	3.4	2.9 to 3.8	< .001	220	165	4.8	3.1 to 6.5	< .001
40%-60%	419	386	1.8	1.6 to 2.1		387	349	2.6	2.2 to 3.0	
0%-30%	13	13	0.3	0.2 to 0.5		22	20	2.5	0.9 to 4.1	

NOTE. There were no significant differences in median survival between groups for patient- and physician-reported performance status (PS).
Abbreviations: PG-SGA, patient-generated Subjective Global Assessment; PPS, Palliative Performance Scale.
**P* value based on log-rank tests for differences between survival curves within each PS measure.

included in evaluation of PS. We demonstrate that the majority of patients referred to a community-based palliative care program are able to rate their own PS, which is as predictive of survival as the widely used PPS. Patient-reported PS may be of considerable practical utility at earlier disease stages than those studied here and could be deployed for nontraditional health status follow-up (ie, by using the Internet).

Prognostication for life-limiting illness is a difficult enterprise, and clinicians are often criticized for providing poor estimates of survival with a tendency toward optimism.[36,37] To have clinical utility, a prognostic model must have excellent predictive value. Small data sets taken in localized settings pose a disadvantage. Thus, we selected a large population-based data set to build our model, ensuring an excess of 10 to 20 events per candidate variable to avoid overoptimistic estimates of predictive validity.[28] Our final model included five variables, with a total of 980 deaths (196 events/variable). We demonstrated a high probability of concordance (c-statistic, 0.87 to 0.90) between predicted and observed responses for patients in distinct settings (home care, tertiary inpatient, ambulatory outpatient). Interestingly, most of the 13 symptoms recorded dropped out of the multivariate model, and we demonstrate high predictive ability independently of overall pain and symptom burden. The high predictive ability of our model makes it potentially valuable in planning for care of patients referred to palliative care services. It will be of interest to repeat this study in patients with advanced solid tumors who have not yet been identified to the palliative care team, to determine the predictive ability of the PG-SGA data.

We sought to evaluate prognostic variables using a robust statistical approach, and these methods might be considered as the basis for development and refinement of new or existing prognostic tools. Although our c-statistics were good, some variation remains unexplained. The discrimination achieved here can potentially be improved with inclusion of additional information such as biologic parameters (signs of systemic inflammation), comorbid conditions, and sentinel events.

Finally, we made observations of potential significance for nutritionists caring for patients with advanced cancer. Our population was characterized by overweight and obesity; the small percentage (13%) of underweight patients (BMI < 18.5) is somewhat surprising given the traditional anticipation of extreme wasting near the end of the cancer trajectory. The physiognomy of patients with cancer, as of the general population,[38] appears to be shifting toward increasing body weight,[39] and cachexia (as conventionally understood) is increasingly rare. Our results may not necessarily contradict prior findings that nutritional deficits associate with shortened survival; it may simply be that contemporary patients with cancer in Westernized countries are less likely to reach states of severe wasting.

Several forms of weight gain are signs of disease progression, including edema, ascites, increased organ volume (ie, hepatomegaly), and increasing tumor burden (including metastasis).[40,41] Our finding that weight gain was a poor prognostic sign may be relevant to the design or interpretation of future clinical trials on anorexia-cachexia, in which weight gain is often the primary outcome. Many patients included in randomized clinical trials of anorexia-cachexia were well within their last 3 months of life.[42,43] Desirable weight gain (specifically lean tissue such as skeletal muscle) resulting from anticachexia treatment might be discriminated from other forms of weight gain using image-based assessments such as computed tomography.[44]

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

The author(s) indicated no potential conflicts of interest.

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