Original Article

Prognostic Accuracy of Patients, Caregivers, and Oncologists in Advanced Cancer

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BACKGROUND: In caring for patients with advanced cancer, accurate estimation of survival is important for clinical decision making. The purpose of this study was to assess the accuracy of 2-year survival probabilities estimated by oncologists, patients, and caregivers and to identify demographic and clinical factors associated with prognostic accuracy. **METHODS:** This was a secondary observational analysis of data obtained from a cluster randomized controlled trial. Participants included 38 oncologists, 263 patients with advanced nonhematologic cancer, and 193 of their caregivers from clinics in Sacramento and Western New York. Discrimination within each group (oncologists, patients, caregivers) was evaluated using the C statistic, whereas calibration was assessed by comparing observed to predicted 2-year mortality using the chi-square statistic. **RESULTS:** The median survival from study entry was 18 months, and 41.8% of patients survived for 2 years. C statistics for oncologists, patients, and caregivers were 0.81 (95% CI, 0.76-0.86), 0.62 (95% CI, 0.55-0.68), and 0.72 (95% CI, 0.65-0.78), respectively; oncologists' predictions were better than the predictions of both patients ($P = .001$) and caregivers ($P = .03$). Oncologists also had superior calibration: their predictions of 2-year survival were similar to actual survival ($P = .17$), whereas patients' ($P = .0001$) and caregivers' ($P = .003$) predictions diverged significantly from actual survival. Although most oncologists' predictions were classified as realistic (62.0%), approximately one-half of patients' and caregivers' predictions (50.0% and 46.0%, respectively) were unduly optimistic. Among patients, nonwhite race and higher levels of social well-being predicted undue optimism ($P < .05$). **CONCLUSIONS:** Compared with oncologists, patients and caregivers displayed inferior prognostic discrimination, and their predictions were poorly calibrated, primarily because of overoptimism. ***Cancer* 2019;125:2684-2692**. © *2019 American Cancer Society*.

KEYWORDS: advanced cancer, calibration, discrimination, optimistic, pessimistic, prognostic accuracy.

INTRODUCTION

In the care of patients with advanced cancer, clinical decisions regarding the appropriateness of disease-directed, life-extending, and comfort-oriented approaches to care often hinge on estimates of life expectancy.[1,2] Ideally, shared decision making about treatment options would occur in the context of common understanding of prognosis among the oncologist, patient, and caregivers. However, physicians themselves do not always estimate prognosis accurately,[3,4] nor are they uniformly effective communicators of prognosis.[1,4-6] Furthermore, some patients do not wish to be fully informed,[1,5] whereas others may misinterpret the information they hear. One study found that 69% of patients with advanced colorectal cancer and 81% with advanced lung cancer unrealistically believed that their chemotherapy treatments were curative rather than life-extending.[7] Another study showed that 55% of patients with advanced cancer across 11 countries had inaccurate perceptions of curability and that these perceptions varied across demographic factors.[8]

Prior research has shown considerable discordance in prognostic estimates between physicians and patients. Gramling et al noted in a recent analysis that 68% of 238 patients estimated their chances of 2-year survival substantially more favorably than their oncologists, and only 11% of the patients were aware of this discrepancy.[9] Although undue prognostic optimism may have short-lived psychological benefits,[10] the long-term consequences can be deleterious. When patients overestimate their own prognosis, they may pursue aggressive or invasive treatments that detract from quality of life (QOL).[5]

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Several gaps in the literature motivate the current analysis. First, few studies on patients with advanced cancer have compared prognostic estimates with actual survival. Second, the extent to which patients, caregivers, and oncologists are accurate prognosticators has not been directly compared. Finally, little evidence exists on the factors associated with prognostic accuracy. Therefore, we conducted this study to address the following research questions: 1) What is the *discrimination* (ability to differentiate between those who will survive and those who will not) and *calibration* (ability to assign meaningful survival probabilities) of 2-year survival predictions generated by patients, caregivers, and oncologists; and 2) What demographic and clinical factors are associated with unduly-pessimistic, realistic, or unduly-optimistic predictions?

MATERIALS AND METHODS

This article is a secondary analysis of data obtained from the Values and Options in Cancer Care (VOICE) Study, a cluster randomized controlled trial (RCT) to promote high-quality communication between patients, their caregivers, and oncologists. The RCT was conducted from August 2012 to June 2014, and participants were followed until October 2015. The ethics boards at the University of Rochester and the University of California at Davis (UC Davis) approved the study. Details of the VOICE study are fully reported in other publications.[11,12]

Population and Eligibility

Thirty-eight oncologists from the UC Davis Cancer Center (n = 14) in Sacramento and practices (nonacademic, hospital-based and community-based outpatient) in Western New York (n = 24) were recruited. The eligibility criteria for patients (n = 263) included age ≥21 years; ability to understand spoken English and provide consent; and either American Joint Committee on Cancer (AJCC) TNM stage IV nonhematologic cancer or stage III cancer plus an oncologist who "would not be surprised" if the patient died within 12 months.[13,14] Hospitalized and hospice patients were excluded. All caregivers of the selected patients were eligible; 194 were recruited. Two patients and 1 caregiver were excluded from this analysis because they did not provide an estimate of 2-year survival probability.

Measures

Patients completed previsit surveys at the beginning and postvisit surveys within a week of the first office visit, then every 3 months for 3 years or until death. Prognostic estimates were solicited using postvisit surveys, in which oncologists, patients, and caregivers independently reported the patient's chances of surviving 2 or more years.

Prognostic Accuracy

In postvisit surveys, patients were asked, "What do you believe are the chances that you will live for 2 years or more?" Their caregivers were asked, "What do you believe are the chances that (he/she) will live for 2 years or more?" And their oncologists were asked, "What do you believe are the chances that this patient will live for 2 years or more?" We used a modified version of the SUPPORT self-rated prognosis measure: options included 0%, about 10%, about 25%, 50%/50%, about 75%, about 90%, or 100%.[15] Vital status at 2 years was ascertained by surveying patients, patient contacts, physicians, and local authorities. Patient's recall of the quality of prognostic discussion was assessed by asking: "To what extent have you discussed your prognosis with your doctor (completely, mostly, a little, or not at all)?." Probabilistic estimations were chosen based on prior data showing increased accuracy over temporal estimations.[16]

Prognostic Accuracy: Discrimination and Calibration

Discrimination is the ability to distinguish between those who will or will not develop a particular outcome; it is the "ability to separate classes."[5,17] Prediction through *calibration* is defined as the ability to assign accurate survival probabilities across prognostic groups.[5]

Unduly-Optimistic, Realistic, and Unduly-Pessimistic Predictions

We computed an index of prognostic accuracy by subtracting the 2-year prognosis as predicted by patients, caregivers, and oncologists (on a 0, 0.10, 0.25, 0.50, 0.75, 0.90, 1.0 scale) from the vital status at 2 years (whether the patient lived for 2 years; yes = 1 or no = 0). A difference of ≥0.5 points between actual and predicted survival was defined as unduly pessimistic, whereas a difference of from >−0.5 to <0.5 points was defined as realistic, and ≤−0.5 points was defined as unduly optimistic. For example, if predicted 2-year survival was 75% and the patient was dead at 2-years, the prognostic accuracy would be 0 − 0.75 = −0.75, consistent with an unduly-optimistic prediction (see Supporting Table 1).

Characteristics Potentially Associated With Prognostic Accuracy

We constructed models consisting of demographic, clinical, and attitudinal characteristics to estimate the effects of patient, caregiver, and oncologist characteristics on

TABLE 1. Baseline Characteristics of Patients, Caregivers, and Oncologists

Characteristic	No. (%)		
	Patients, n = 265	Caregivers, n = 194	Oncologists, n = 38
Age: Mean ± SD, y	64.3 ± 11.4	60.7 ± 13.0	44.7 ± 9.6
Sex			
Women	146 (55.1)	129 (66.8)	11 (28.9)
Men	119 (44.9)	64 (33.2)	27 (71.1)
Race[a]			
White	235 (88.7)	171 (88.1)	17 (44.7)
Nonwhite	30 (11.3)	22 (11.3)	21 (55.3)
Site			
Western New York	171 (65.5)	125 (64.8)	24 (63.2)
UC Davis	94 (34.5)	68 (35.2)	14 (36.8)
Education[a]			
≤High school	73 (28.6)	50 (25.9)	
≥Some college	192 (72.4)	143 (74.1)	
Cancer type[b]			
Aggressive	133 (50.2)		
Lung	55 (41.4)		
Pancreatic	27 (20.3)		
GI other than colon	31 (23.3)		
Other	20 (15)		
Less aggressive	132 (48.8)		
Breast	53 (40.2)		
Colon	25 (18.9)		
Prostate	29 (22.0)		
Other	25 (18.9)		
RCT intervention group			
Control	135 (50.9)	101 (52.0)	19 (50)
Experimental	130 (49.1)	93 (48.0)	19 (50)

Abbreviations: GI, gastrointestinal; RCT, randomized controlled trial; UC Davis, the University of California at Davis.
[a]One caregiver "failed" to answer each of the questions and was excluded.
[b]Cancers were classified as "aggressive" versus "less aggressive" in consultation with 2 oncologists. Aggressive cancers included lung, pancreatic, noncolonic GI, and (in the "other" subcategory) bladder, ovary, retroperitoneal sarcoma, and unknown primary. Less aggressive cancers included breast, colon, prostate, and (in the "other" subcategory) anus, carcinoid tumor, GI stromal tumor, head and neck, kidney, melanoma, multiple myeloma, skin, and testicular.

prognostic accuracy. Independent variables included age, sex, race, education level, cancer type (aggressive vs nonaggressive cancer), experimental arm, and site (Sacramento and Western New York). Study measures hypothesized to be associated with prognostic accuracy based on literature review and investigator consensus included The Human Connection Scale[18]; the Functional Assessment of Cancer Therapy - General (FACT-G) Physical Functioning subscale; the FACT-G Social Well-Being subscale[19]; the Perceived Efficacy in Patient-Physician Interactions questionnaire[20]; the McGill Psychological Well-Being subscale; the McGill Existential Well-Being subscale[21]; the Patient Health Questionairre-9; the Peace, Equanimity, and Acceptance in the Cancer Experience questionnaire[22]; and surveys to assess oncologist's self-efficacy with communication and comfort with shared decision making (see Supporting Table 2).[11]

Statistical Analysis

The area under the receiver operating characteristic (ROC) curve[23] (created using logistic regressions) was used to compare discrimination by patients, caregivers, and oncologists using 5 ordinal prognostic categories (0%/10%, 25%, 50%, 75%, 90/100%). Chi-square tests for goodness of fit were used to assess whether observed 2-year survival was calibrated to predict survival by patients, caregivers, and oncologists (using the same 5-point ordinal scale: 0%/10%, 25%, 50%, 75%, 90%/100%). The 0% and 10% categories were combined as were the 90% and 100% categories to ensure statistically meaningful sample size. "Don't know" responses were classified as "50%." Multinomial logistic regression models were applied to examine the associations of patient, oncologist, and caregiver factors with unduly-optimistic and unduly-pessimistic predictions (as defined above). All analyses were conducted in version 9.4 of the SAS System.

RESULTS

Table 1 shows that patients and caregivers were predominantly late middle-aged, women, and white, whereas oncologists were mostly men and nonwhite with a mean age of 44.7 years (SD = 9.6 years). Among caregivers, 48.3% (n = 128) were spouses, 13.6% (n = 36) were

TABLE 2. Distribution of Patients', Caregivers', and Oncologists' 2-Year Survival Predictions[a]

Estimated Likelihood of 2-Year Survival	No. (%)		
	Patients, n = 265	Caregivers, N = 194	Oncologists, N = 38[b]
100%	95 (36.1)	56 (29.0)	2 (0.8)
About 90%	29 (11.0)	20 (10.4)	19 (7.2)
About 75%	33 (12.6)	20 (10.4)	28 (10.6)
About 50%/50% (or "don't know")	77 (29.3)	66 (34.2)	58 (21.9)
About 25%	13 (4.9)	12 (6.2)	52 (19.6)
About 10%	7 (2.7)	11 (5.7)	63 (23.8)
0%	9 (3.4)	8 (4.2)	43 (16.2)
Total no. of predictions	263 (100.0)	193 (100.0)	265 (100.0)

[a]Note that patients, caregivers, and oncologists were asked at baseline to estimate the likelihood that the patient would still be alive in 2 years. Estimates were obtained by asking respondents to choose 1 of 7 categories ranging from 100% to 0%; respondents who chose "don't know" were classified with those choosing "about 50%/50%." Two patients and 1 caregiver did not answer the 2-year survival question and were excluded.
[b]The 38 oncologists provided prognostic estimates for 265 patients (including 2 patients who did not themselves provide prognostic estimates).

children (or, less often, parents), and 38.1% (n = 101) were others (eg, other relatives, friends, neighbors, or paid caregivers). Among patients, 67% reported discussing their prognosis "mostly" or "completely" with their oncologists (data not shown in tabular form).

Table 2 shows the distribution of prognostic estimates for patients, caregivers, and oncologists. Patients and caregivers were far more likely than oncologists to estimate a 75% or better chance of 2-year survival. In contrast, oncologists were more likely than patients or caregivers to estimate a 25% or worse chance of 2-year survival.

Figure 1 shows areas under the ROC curves for patients, caregivers, and oncologists as 0.62 (95% CI, 0.58-0.73), 0.72 (95% CI, 0.65-0.78), and 0.81 (95% CI, 0.75-0.87), respectively, demonstrating that oncologists were more accurate discriminators of prognosis compared with both patients ($P = .001$) and caregivers ($P = .03$). There was no significant difference between caregivers and patients. The results were unchanged when the analysis was limited to the 193 patients with caregivers (see Supporting Fig. 1).

The percentage of patients who survived for 2 years from the time of study entry was 41.8%, and the median survival was 18 months. Table 3 compares patients', caregivers', and oncologists' 2-year survival predictions with actual survival. There were significant differences between actual and predicted 2-year survival by patients ($P = .0001$) and caregivers ($P = .003$), indicating poor calibration between predicted and actual survival. In contrast, there was no significant difference between actual and predicted 2-year survival by oncologists. Oncologists were also less likely to be "certain" (0% or 100% chance of surviving for 2 or more years) compared with patients and caregivers. Oncologists predicted "0% or 100%" survival probabilities for 17% of patients

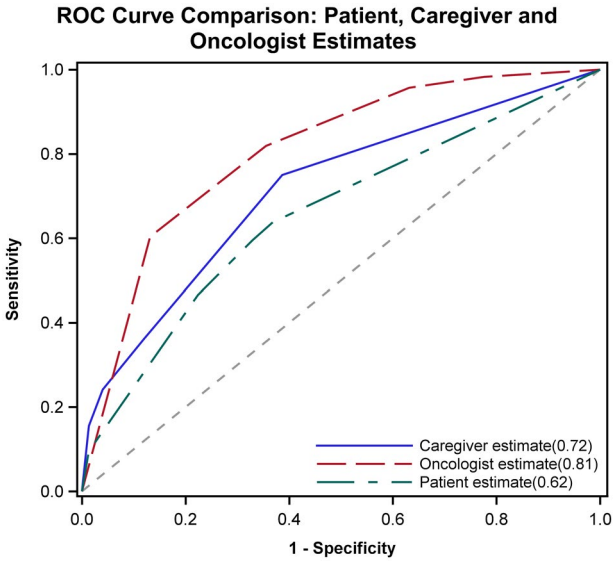

Figure 1. Areas under the receiver operator characteristic (ROC) curves (AUCs) are illustrated comparing discrimination among patients (AUC, 0.62; 95% CI, 0.55-0.68), caregivers (AUC, 0.72; 95% CI, 0.65-0.78), and oncologists (AUC, 0.81; 95% CI, 0.76-0.86). Oncologists were more accurate discriminators of prognosis compared with both patients ($P = .001$) and caregivers ($P = .03$).

(45 of 265) compared with patients and caregivers, who were "certain" 38% (104 of 263) and 33% (64 of 193) of the time, respectively. However, oncologists were more likely to express certainty around predictions of "0%" survival (16%) than around predictions of "100%" survival (0.8%).

Table 4 shows the percentages of patients, caregivers, and oncologists whose predictions were classified as unduly-pessimistic, realistic, and unduly-optimistic (as defined above; see Materials and Methods). Although most oncologists' predictions (62%) were classified as

TABLE 3. Actual 2-Year Survival According to Survival Prediction Category Rendered by Patients, Caregivers, and Oncologists[a]

Estimated Likelihood of 2-Year Survival (Prediction Category)	Actual 2-Year Survival: No. Alive/No. At-Risk (%)		
	Patients	Caregivers	Oncologists
90%-100%	64/124 (51.6)	47/76 (61.8)	17/21 (81.0)
75%	15/33 (45.5)	6/20 (30.0)	25/28 (89.3)
50%	24/77 (31.2)	20/66 (30.3)	34/58 (58.3)
25%	4/13 (30.8)	2/12 (16.7)	21/52 (40.4)
0%-10%	3/16 (18.8)	1/19 (5.3)	14/106 (13.2)
Total no. of predictions for which survival data were available	110/263 (41.8)	76/193 (39.4)	111/265 (41.9)
Chi-square test	31	17.9	7.8
P	<.0001	.003	.17

[a]The chi-square test for goodness of fit (with 5 degrees of freedom) was computed by summing the chi-square deviations for each of the 5 prediction categories. Within a category, the chi-square deviation was computed using the observed number of survivors compared with the expected number, where the expected is determined by multiplying the denominator by the "estimated likelihood" (in the left column). For the top and bottom prediction categories, the midpoint of the "estimated likelihood" range was used (95% and 5%, respectively). Two patients and 1 caregiver did not answer the 2-year survival question and were excluded.

TABLE 4. Unduly Pessimistic, Realistic, and Unduly Optimistic 2-Year Survival Predictions by Patients, Caregivers, and Oncologists[a]

Prediction	No. (%)			Total No. (% of Estimates)
	Patients	Caregivers	Oncologists	
Unduly pessimistic	31 (12.0)	23 (12.0)	69 (26.0)	123 (17.0)
Realistic	101 (38.0)	81 (42.0)	165 (62.0)	347 (47.9)
Unduly optimistic	131 (50.0)	89 (46.0)	31 (12.0)	254 (35.1)
Total no. (% of estimates)	263 (36.5)	193 (26.8)	265 (36.7)	724 (100.0)

[a]The index of prognostic accuracy was computed by subtracting the 2-year prognosis as predicted by patients, caregivers, and oncologists (on the following scale: 0, 0.10, 0.25, 0.50, 0.75, 0.90, 1.0) from the vital status at 2-years (whether the patient lived for 2 years; yes = 1 or no = 0). A difference of ≥0.5 points between actual and predicted survival was defined as unduly pessimistic, whereas a difference from >−0.5 to <0.5 points was realistic, and a difference ≤−0.5 points was unduly optimistic. For example, if predicted 2-year survival was 75% and the patient was dead at 2 years, then the prognostic accuracy would be 0 − 0.75 = −0.75, consistent with an unduly optimistic prediction (see Supporting Table 1).

realistic, approximately one-half of patients' (50%) and caregivers' predictions (46%) were classified as unduly-optimistic. Oncologists were more than twice as likely as patients and caregivers to be unduly pessimistic (26% vs 12% vs 12%, respectively).

Table 5 displays independent associations of patient, oncologist, and caregiver factors with undue optimism and undue pessimism (generated using multinomial logistic regression). Among patients, nonwhite race (adjusted relative risk ratio [ARRR], 3.22; 95% CI, 1.24-8.32; $P = .02$) and higher social well-being scale scores (ARRR, 1.10; 95% CI, 1.02-1.18; $P = .009$) were associated with unduly-optimistic (vs realistic) predictions, whereas higher existential well-being scores had the opposite association (ARRR, 0.79; 95% CI, 0.62-0.99; $P = .04$). Patients with high Human Connection Scale scores were less likely to be unduly pessimistic (vs realistic; ARRR, 0.87; 95% CI, 0.89-0.95; $P = .001$). Oncologists with high self-reported communication skills were more likely to be unduly optimistic than realistic (ARRR, 2.56; 95% CI, 1.01-6.48; $P = .05$).

There were also site differences: *patients* at Western New York were significantly more likely to be unduly optimistic than realistic compared with those at Sacramento (ARRR, 2.71; $P < .0002$), whereas *oncologists* in Western New York were significantly less likely to be unduly pessimistic than realistic compared with those in Sacramento (ARRR, 0.34; $P = .007$). The prevalence of undue pessimism or undue optimism did not substantively differ based on sex, experimental arm (ie, assignment to intervention vs control in the parent study), or education.

DISCUSSION

Our study found that oncologists are more accurate prognosticators than both patients and caregivers, whether assessed in terms of discrimination or calibration. Furthermore, when oncologists erred, they tended to be more pessimistic and less "certain" (predicting 0% or 100% chance of surviving 2 or more years) compared with patients and caregivers. Among patients, optimistic predictions were common and associated with nonwhite race and high social well-being. These findings are in the context of over two-thirds of patients having reported

TABLE 5. Multinomial Logistic Regression Analysis Examining Independent Associations of Patient, Oncologist, and Caregiver Factors With Undue Optimism and Undue Pessimism[a]

	ARRR (95% CI)					
	Patient		Caregiver		Oncologist	
Variable	Optimistic (vs Realistic)	Pessimistic (vs Realistic)	Optimistic (vs Realistic)	Pessimistic (vs Realistic)	Optimistic (vs Realistic)	Pessimistic (vs Realistic)
Site						
Western New York (vs UC Davis)	2.71 (1.45-5.07)[b]	0.62 (0.25-1.58)	1.94 (1.00-3.75)[c]	1.07 (0.40-2.85)	0.50 (0.17-1.46)	0.34 (0.15-0.75)[b]
Sex						
Women (vs men)	1.50 (0.53-4.20)	0.72 (0.39-1.33)	1.0 (0.50-1.96)	1.34 (0.46-3.93)	0.61 (0.18-2.08)	0.44 (0.17-1.10)
Intervention arm						
Experimental (vs control)	1.08 (0.60-1.92)	1.19 (0.49-2.71)	—	—	1.82 (0.75-4.42)	1.14 (0.59-2.20)
Race						
Nonwhite (vs white)	3.22 (1.24-8.35)[c]	0.13 (0.01-1.73)	1.20 (0.42-3.45)	1.92 (0.42-8.82)	—	—
Average age						
Older (vs younger)	1.023 (1.0-1.05)	1.016 (0.98-1.06)				
McGill Quality-of-Life Questionnaire, Existential Well-Being subscale	0.79 (0.62-0.99)[c]	0.82 (0.58-1.15)				
Education						
High school or less (vs more)	1.20 (0.62-2.33)	0.88 (0.30-2.57)	1.98 (0.97-4.04)	0.57 (0.15-2.19)		
The Human Connection Scale	1.04 (0.97-1.11)	0.87 (0.89-0.95)[d]				
Social Well-Being scale	1.10 (1.02-1.18)[b]	1.02 (0.91-1.13)				
Oncologist's self-reported communication skills					2.56 (1.01-6.48)[c]	1.74 (0.87-3.5)

Abbreviations: ARRR, adjusted relative risk ratio; UC Davis, the University of California at Davis.

[a]Note that the results from 3 separate, multiple, multinomial, logistic regression analyses are reported here (patients, caregivers, and oncologists). For each multinomial analysis, a 3-level dependent variable was used, with levels representing unduly optimistic, realistic (reference category), and unduly pessimistic predictions. Only variables with $P < .1$ were included in the table. Other measures also used in the analysis (but not included in this table) were caregiver's education level; the McGill Quality of Life psychological and existential subscales; the Patient Health Questionairre-9; the Perceived Efficacy in Patient-Physician Interactions questionnaire; the Peace, Equanimity, and Acceptance in the Cancer Experience questionnaire and physical well-being subscale; and a measure of comfort with shared decision making.

[b]$P < .01$.

[c]$P < .05$.

[d]$P \leq .001$.

discussing their prognosis "mostly" or "completely" with their oncologists.

In demonstrating accurate estimation of survival probabilities by physicians, these results comport with findings of prior studies.[5,24,25] However, unlike our study, prior studies have shown that, when prognosticating about cancer, physicians tend toward optimism.[2,3,5,25,26] One potential explanation could be differences in patient populations across studies, driven by factors such as "healthy participant" sampling bias, regional variations, or referral bias.

Two components of prognostic accuracy were evaluated in our study: *discrimination* and *calibration*. Oncologists had superior discriminatory abilities and were reliably able to predict whether a patient would survive for 2 years, likely reflecting oncologists' ability to assess meaningful influences on prognosis, such as lack of treatment response, anorexia, or poor functional status.[5] However, discrimination alone fails to differentiate between someone with a 51% chance of survival versus a 100% chance of survival.[27] Therefore, calibration is used to assess prognostic estimates across various survival probabilities. Oncologists in our study demonstrated good calibration across prediction categories compared with patients and caregivers. Similarly, Kiely et al found that oncologists were able to provide relatively well-calibrated and moderately discriminative survival estimates.[24] In contrast, Glare et al showed that survival was on average 30% shorter than predicted by oncologists.[5] The superior prognostication by oncologists in our study could be because of the relative homogeneity of cancer stage in the VOICE Study (all patients were stage III or IV) as well as technological and clinical advances in the practice of oncology. Our findings suggest that oncologists were capable of formulating relatively accurate 2-year survival probabilities, both in an absolute sense and compared with patients and caregivers. Our analysis suggests that future efforts to enhance patients'

prognostic understanding should focus more on communicating oncologists' estimates rather than recalibrating them.

Oncologists were overall less likely to be "certain" (0% or 100% chance of surviving 2 or more years) in their predictions compared with patients and caregivers. However, oncologists tended to be more pessimistically certain (0% chance of survival), while patients and caregivers were more optimistically certain (100% chance of survival). A study by Dawson et al discusses how intuitive judgments are based on low confidence in our methods, but high confidence in our answers.[17] In contrast, analytical judgments usually provide higher confidence in our methods, but low confidence in the correctness of the answer.[17] Patients and caregivers might be more "certain" because of their use of intuitive judgment. Optimistically-certain predictions by patients and caregivers could be based more on emotion,[28] whereas the pessimistically-certain predictions of oncologists could be based more on reason. Oncologists, as experts, have a greater appreciation for unexpected events affecting survival, so they are less likely to be optimistically certain. Other potential explanations for the optimistically-certain predictions seen among patients and caregivers include poor understanding and recall of patient's prognosis, poor patient-oncologist communication, and cognitive rigidity or cultural beliefs that are based on avoiding predictions of death.[1,4-6,28-34] These findings show the importance of considering how contemplating the prognosis of a patient differs from predicting one's own prognosis or the prognosis of a loved one.

Although hope is valuable,[35] false hopes expressed as undue optimism may have deleterious consequences because accurate perceptions of prognosis are necessary for patient-centered end-of-life care planning. In prior research, patients who overestimated their 6-month survival were more likely to undergo life-extending and aggressive treatments.[15] Aggressive treatment at the end of life, in turn, may lead to more suffering at the end of life and possibly shorter survival.[15,36,37] In addition, the ethical principle of autonomy obligates physicians to empower patient decision making by conveying accurate, truthful information. Physicians who are unrealistic in their estimates may not be able to fulfill this ethical imperative. Patients, caregivers, and physicians may need to tolerate contradictions (eg, the need to understand prognosis while simultaneously maintaining hope) without necessarily resolving them.[38]

Many tools have been proposed to improve prognostication. Harrison et al reviewed 222 different prognostic risk tools and found that the majority of the tools used percentage-based survival estimates, whereas a minority (14%) described epistemic uncertainty.[39] Another well known prognostic tool is ePrognosis used by the University of California at San Francisco health system.[40] An important question for future research is how to best implement validated prognostic tools into routine oncologic practice.

The relative overoptimism seen among nonwhite patients has been noted previously.[7,8,36,41] Prior studies also show that, compared with white patients, black patients are less likely to rely on physician prognostic estimates and more likely to turn to their own intuition, clergy, and family.[42-44] In contrast, Christakis and Lamont performed a bivariate analysis and found that race was a nonsignificant contributor to prognostic accuracy.[3] Although they suggest possible racial differences in the perception of prognosis, these findings highlight the need for further study.

Limitations

Our study has several limitations. First, we did not explicitly examine confidence around prognostication. Second, our study only drew from 2 geographical regions, potentially limiting generalizability. Third, there was a heterogeneous group of cancer types included in the study, which makes it difficult to assess differences among various cancer types. By understanding group-specific data, better explanations and solutions for cultural differences in prognostic interpretation can be appreciated.

Conclusion

Although a high proportion of patients in the study claimed to have discussed prognosis with their oncologists, we observed relatively poor prognostic estimation by patients and a large difference between predictions by oncologists and those of caregivers and patients. Our findings suggest that, although oncologists may be less certain, they have good discriminatory ability in their 2-year survival predictions, and their predictions are well calibrated. In contrast, patients and caregivers express greater certainty; however, they have somewhat inferior discriminatory ability, their predictions are poorly calibrated, and they tend toward overoptimism. Finally, various patient factors, such as race/ethnicity and social well-being, may play a role in shaping prognostic accuracy. More research is needed to elucidate the causes of errors in judgments about survival prognosis among patients, caregivers, and oncologists to further improve end-of-life communication.

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CONFLICT OF INTEREST DISCLOSURES

The authors made no disclosures.

AUTHOR CONTRIBUTIONS

Kirti Malhotra, MD: Conceptualization, investigation, writing–original draft. **Joshua J. Fenton:** Conceptualization, investigation, and writing–review and editing. **Paul R. Duberstein**: Conceptualization, investigation, funding acquisition, and writing–review and editing. **Ronald M. Epstein:** Conceptualization, investigation, funding acquisition, writing–review and editing. **Guibo Xing:** Data curation, formal analysis, validation, and writing–review and editing. **Daniel J. Tancredi:** Data curation, validation, supervision, and writing–review and editing. **Michael Hoerger:** Conceptualization and writing–review and editing. **Robert Gramling:** Conceptualization and writing–review and editing. **Richard L. Kravitz:** Conceptualization, investigation, acquisition of funding, supervision, and writing–review and editing.

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