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Improving Communication in Breast Cancer Treatment Consultation: Use of a Computer Test of Health Numeracy

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Abstract

Background: Communication of statistics and probability is challenging in the cancer care setting. The objectives of this study are to evaluate a novel approach to cancer communication through the use of a computer assessment of patient health numeracy.

Methods: We conducted a pilot study of the Computer Adapted Test of Numeracy Understanding in Medicine Instrument (CAT-NUMi) before the cancer treatment consultation for women with stage 0–3 breast cancer. Patient outcomes included the interpersonal processes of care (IPC) and the decisional conflict scale. We evaluated clinician use of numeric information in the cancer consultation and assessed feasibility outcomes from the clinician and patient perspective.

Results: Patient participants ($n = 50$) had a median (interquartile range) age of 51 years (46–61), 70% were English speaking, and 30% Spanish speaking. Decisional conflict was low with a mean (standard deviation [SD]) decisional conflict score of 17.4 (12.3). The lack of clarity score (range 1–5) on the IPC was low (mean, SD),1.70 (0.71), indicating clear communication. Clinicians more often used percentages in communicating prognosis among those with higher numeracy scores (median, range): high (2, 0–8), medium (1, 0–7), and low (0, 0–8); $p = 0.04$. The patient experience of taking the CAT-NUMi was rated as very good or excellent by 65%, fair by 33%, and poor by 2% of patients.

Conclusion: Screening for health numeracy with a short computer-based test may be a feasible strategy to optimize clear communication in the cancer treatment consultation. Further studies are needed to evaluate this strategy across cancer treatment clinical settings and populations.

Keywords: breast neoplasm, cancer communication, health numeracy

Introduction

Communication in the cancer treatment consultation is complex given the breadth of information that is conveyed and the emotional aspect of facing a potentially life-threatening condition.[1–4] A particular challenge is the communication of numeric information, including stage of disease, efficacy of treatment, risk of recurrence, and overall prognosis.[1,2,5] Health literacy has been defined as the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions.[6]

Health numeracy is one domain of general health literacy. It has been defined as the ability to use numbers, tables, and graphs, probability, and statistics in the context of caring for one's heath and making health care decisions.[7] Persons who

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are more numerate are more likely to feel positively about numeric information and engage with numbers in medical decision making.[8–10]

Although a good proportion of communication in the cancer consultation includes biomedical information, patients seek more information in the domain of outcomes and prognosis.[1,2,11,12] Clinicians express reticence in using numbers to communicate prognosis, citing concern that patients will not understand risk and statistical information.[13–15] However, studies find that communicating risk with numbers increases the accuracy of risk perceptions and the uptake of evidence-based interventions for both low and high numerate persons.[16,17] Furthermore, although persons vary in their preferences for how to receive probabilistic information (numeric or verbal), studies find a shift toward preferring a numeric format when discussing important information.[18]

A strategy to tailor the way numeric information is presented based on a patient's level of numeracy may benefit both lower and higher numerate persons.[19] For example, an Oncotype Dx is a genomic test that predicts risk of recurrence and guides decisions regarding adjuvant chemotherapy for women who are diagnosed with estrogen receptor-positive, lymph node-negative, early-stage breast cancer. The test report includes graphic depictions of risk of recurrence. Such a tool may be most helpful for patients who understand how to read and interpret graphs.[3]

A recent systematic review finds evidence that tailoring health interventions to a patient's level of health literacy may improve health outcomes.[20] However, little is known regarding how to implement this approach, particularly during the early management of new severe illnesses. A strategy of tailoring communication to the patient's health numeracy level requires both measuring patient health numeracy and training clinicians on communication strategies for persons of both low and high health numeracy.

Providing clinician training in communication skills has proven challenging. A study that aimed to train clinicians to involve patients in decision making was successful in increasing collaborative communication skills, but failed to improve the flow or clarity of information provided.[21] Clinicians have viewed formal training as artificial, believing that communication skills come from emulating colleagues.[22] A strategy to reinforce communication training at the point of care has the potential to address previously cited limitations in teaching communication skills to clinicians.[23]

The objectives of this study are to (1) evaluate the feasibility of using a computer adaptive test of health numeracy in combination with a clinician facing report in the context of the breast cancer treatment consultation and (2) explore the impact of this intervention on the format, content, and clarity of communication of numeric information pertaining to prognosis.

Methods

Overview of study design

We conducted a pilot prospective cohort study. Participants were women with a new diagnosis of stage 0–3 breast cancer scheduled for a treatment consultation with a surgical oncologist, radiation oncologist, or medical oncologist. The intervention consisted of administering a computer-adaptive test of health numeracy (Computer Adapted Test of Numeracy Understanding in Medicine Instrument [CAT-NUMi]) to the patient directly before the cancer consultation. The intervention took place at a study visit in a private patient education room.

Clinicians received a report with the patient's health numeracy level and guidance regarding how best to communicate numeric information at the patient's health numeracy level. Preconsultation and postconsultation patient assessments and a postintervention clinician assessment were obtained. Consultations were audio-recorded and underwent a formal qualitative analysis.

Theoretical framework

The intervention was based on dual-process reasoning theory that posits persons make decisions using both a heuristic and a deliberative reasoning pathway.[24,25] The theory holds that deliberative reasoning can be facilitated if information is presented in a way that is easier to process cognitively. The intervention was designed to decrease cognitive barriers to deliberative reasoning by aligning the complexity of numeric information conveyed to the patient's level of health numeracy.

Study recruitment

Recruitment sites included two hospital systems to diversify the patient and provide study population: Cook County Health and Hospital System (CCHHS) in Chicago, Illinois, and the Froedtert Hospital (FH) at the Medical College of Wisconsin in Milwaukee, Wisconsin. CCHHS is a large public health care system and serves as the major safety-net specialty care center in the region. FH is an academic medical center in a suburban setting that also draws from the Milwaukee metropolitan region.

Inclusion criteria were English- and Spanish-speaking women with a new diagnosis of stage 0, 1, 2, or 3 breast cancer diagnosed between February 2015 and October 2015. Exclusion criteria included cognitive impairment as determined by chart review. Consecutive patients who met eligibility criteria, had received their breast cancer diagnosis, and had pending treatment consultations were identified by the breast cancer clinic teams. Study information sheets were placed in their education packet. Interested patients were contacted and, if eligible, offered study enrollment as were their clinicians. Participants were compensated for their time with a $50 incentive. Informed consent was obtained from the patients, clinicians, and other partners, family, or friends present in the consultation.

Study protocol

Clinician education about the study was provided through conferences and presentations delivered by email in advance of study enrollment. At conferences, study investigators discussed the role of heath numeracy in cancer communication, the CAT-NUMi intervention, and the study design and protocol. A self-guided power point presentation covered similar topics. Providers were shown a clinician report for a hypothetical patient and recommended numeric formats for the patient's level of health numeracy.

The CAT-NUMi was administered at a baseline visit and a CAT-NUMi report given to the clinician before the consultation. Consultations were audio-recorded. A 1-week follow-up patient telephone survey and a postconsultation clinician

survey were administered. The study protocol was entered into ClinicalTrials.gov, NCT01879189.

Development and validity assessment of the computer adaptive test of health numeracy

The NUMi was developed in English and Spanish using item response theory (IRT). Items were written in a multiple-choice, closed-ended format. Details regarding the development of the item bank and the paper version of the NUMi have been previously published.[7] The computer adapted test (CAT-NUMi) uses an algorithm for selection from the item bank based on the estimated numeracy skill of each respondent. This approach increases precision by selecting items that provide the optimal level of information from each respondent, minimizing respondent burden and the administration of items that are too easy or difficult for the respondent.[26] For example, if an examinee responds incorrectly, an easier item is administered. This process continues until minimal information is provided with additional items (Fig. 1).

Scores on the CAT-NUMi indicate the level of numeracy skill was determined by an IRT model and range from −3.0 (low) to +3.0 (high). We divided scores into three categories based on scores in our validation cohort: <1 standard deviation (SD) below the mean (low), between 1 SD below and 1 SD above the mean (medium), and >1 SD above the mean (high).[27]

Simulation studies were conducted to determine the precision of the CAT-NUMi (with an item limit of 5, 10, 15, or 20 items), assuming a positively skewed, normal, and negatively skewed underlying ability distribution of health numeracy in the test population. Administrating 10 items resulted in adequate reliability with an acceptable standard error of measurement (Supplementary Table S1; Supplementary Figs. S1–S3).

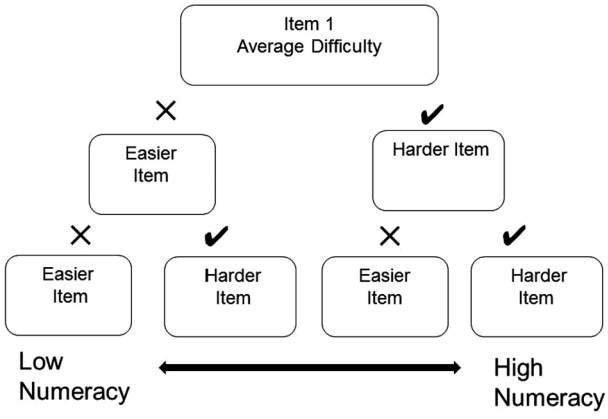

FIG. 1. Flow diagram for item selection in the computer adaptive test. This diagram illustrates the item selection for the computer-administered test. An average difficulty item is administered first. The difficulty level of subsequent items depends on whether a respondent correctly responds to each item. Items range in difficulty across the spectrum from easiest to hardest. The test ends when a specified level of precision for health numeracy is reached based on the item-level difficulty and discrimination parameters or the test reaches the maximum number of items allowed. The maximum length of the test is based on simulation studies.

The content validity of items used in the CAT-NUMi and construct validity for the paper and pencil versions of the NUMi have been previously published.[7] The construct validity of the CAT-NUMi was supported by correlating scores on the CAT-NUMi to level of education and health literacy as measured by the Short Test of Functional Health Literacy in Adults (S-TOFHLA), among the 50 study participants. Divergent validity was established by weak correlations between CAT-NUMi scores, with scores on the decisional conflict scale (DCS) and the state anxiety index (Table 1).

The CAT-NUMi clinician report

A clinician report was developed to convey patient health numeracy level with content and format informed by interviews with surgical oncologists, radiation oncologists, and medical oncologists who care for breast cancer patients. The report includes the patient's category of health numeracy (low, medium, or high) and recommended numeric formats for patients at a given level of health numeracy. The report also recommends using the teach-back technique, an approach to ensure patient comprehension by asking the patient to explain, in their own words, information that was conveyed (Fig. 2 and Supplementary Figs. S4 and S5).[28]

Baseline and outcome measures

Surveys were administered in the primary language of the participant (English or Spanish). Demographic data (age, gender, education, race/ethnicity, and numeracy), print literacy as measured by the S-TOFHLA,[29] primary language, state anxiety using the State Trait Anxiety Inventory,[30] and knowledge about stage of disease and risk of recurrence were assessed at baseline before use of the CAT-NUMi and consultation. Postconsultation patient outcomes were assessed following the CAT-NUMi test (feasibility and usability measure) and 1 week postconsultation (interpersonal processes of care [IPC], DCS, and knowledge).

We assessed postconsultation knowledge of stage of disease and risk of recurrence, two domains pertinent to the construct of prognosis. The 18-item IPC measure assessed patient centeredness of communication across six domains: lack of clarity, elicited concerns, explained results, compassionate/respectful, discrimination due to race/ethnicity, and disrespectful office staff.[31] For the domains of lack of clarity, discriminated against, and disrespectful office staff, lower scores (range 1–5) indicated higher levels of IPC. For the domains of explained results, elicited concerns, decided together, and compassionate, higher scores (range 1–5) indicated higher levels of IPC.[32]

Decisional conflict was assessed with the 16-item DCS.[33] The DCS measures personal perceptions of (1) uncertainty in choosing options, (2) feeling uninformed, (3) unclear about personal values, (4) unsupported in decision making, and (5) effective decision making such as feeling the choice is informed, value based, likely to be implemented, and expressing satisfaction with the choice. The DCS total and subdomain scores range from 0 to 100 with higher scores indicating greater decisional conflict. Persons scoring <25 on the DCS are more likely to follow-through with decisions made.[34]

Postconsultation clinician outcomes were assessed within 1 week of the consultation and included usability of the CAT-NUMi physician report, self-report of communication strategies used in the consultation, and patient cancer stage

Table 1. Evidence for Validity of the Computer Adapted Test of Numeracy Understanding in Medicine Instrument

Measure	*Distribution*	*Numeracy*	*Statistical significance*	*Evidence*
Education level				
Up to high school	36%	–0.81		
Some college	32%	–0.03	ANOVA: $p<0.00001$	Convergent validity
College degree	32%	0.76		
Health literacy (S-TOFHLA), range 0–36	Mean 32.86 SD 4.45	Mean – 0.59 SD 1.08	Spearman correlation: 0.62, $p<0.00001$	Convergent validity
Decisional conflict scale, (0–100)	Mean 17.45 SD 13.33	Mean – 0.59 SD 1.08	Spearman correlation: 0.02, $p=0.89$	Divergent validity
State anxiety index, (20–80)	Mean 40.35 SD 12.21	Mean – 0.59 SD 1.08	Spearman correlation; 0.08, $p=0.58$	Divergent validity

Scores on the CAT-NUMi is based on an Item Response Theory model with a typical range of –3.0 (lowest level skill) to +3.0 (highest level of skill).

CAT-NUMi, Computer Adapted Test of Numeracy Understanding in Medicine Instrument; SD, standard deviation; ANOVA, analysis of variance; S-TOFHLA, Short Test of Functional Health Literacy in Adults.

and treatment options. Clinicians also provided comments regarding the modifications they made in communication, feedback regarding the CAT-NUMi report, methods used to communicate risk information, and integrating the CAT NUMi report into the cancer consultation.

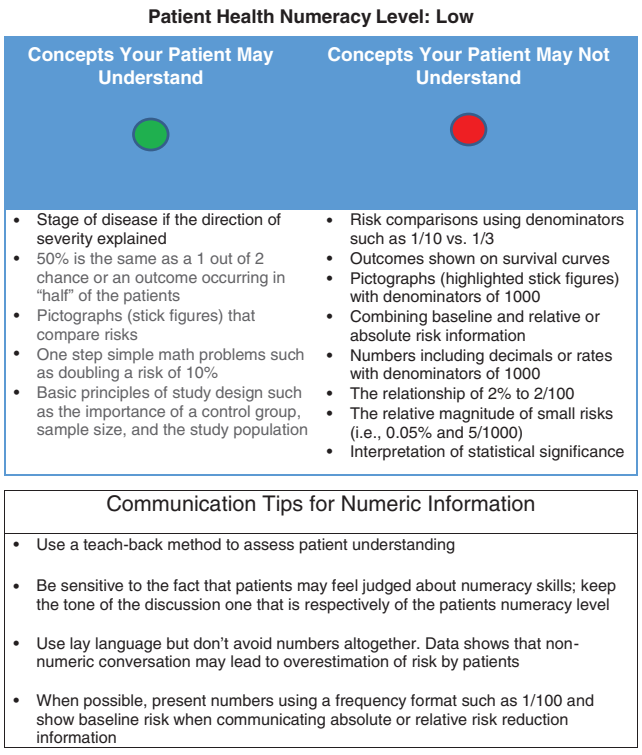

FIG. 2. CAT-NUMi Report for a Patient with Low Health Numeracy

The clinician is given the following description of health numeracy with the report: Health numeracy reflects a person s ability to understand and use numbers in taking care of their health. Your patient has taken a test of health numeracy. The test consisted of questions that assessed his/her ability to use 1) basic math skills, 2) tables and graphs, 3) basic probability concepts and 4) statistics used in risk communication and medical decision making. This patient has a Low Health Numeracy level.

Qualitative analysis of the consultation transcripts

The Spanish transcripts were translated into English. All transcripts (English and Spanish) were then transcribed verbatim and entered into NVivo for analysis.[35] Using an inductive approach, a coding scheme was developed for clinician communication to identify numeric formats and constructs used when talking about prognosis. Prognostic talk was defined as clinician talk coded as pertaining to survival or risk of recurrence. Clinician communication was also coded for use of the teach-back technique during the consultation. We identified whether it was used by the clinician at least one time during a given consultation.

Two investigators independently coded 10% of the transcripts (M.S. and A.F.) with disagreements resolved by consensus and leading to clarification of coding instructions with the remainder coded by one of the two coders (A.F.). We explored association between the patient scores on the CAT-NUMi report and (1) numeric information used by the clinician to convey prognosis and (2) clinician use of the teach-back technique, an approach of communication recommended for persons of low general health literacy or health numeracy.

Statistical analysis

We used descriptive statistics to summarize baseline demographic, clinical factors, health numeracy, and patient and provider usability ratings. We described IPC and DCS scores as well as patient knowledge of stage of disease before and after the consultation. An *a priori* primary outcome of interest was the clarity of communication as indicated by the lack of clarity domain of the IPC.

The accuracy of postconsultation patient-perceived risk of recurrence was determined in comparison to the clinician's estimate. We defined perceived risk of recurrence as accurate if patient estimates were ±10% absolute risk of recurrence provided by their clinician, to reflect the proportion of patients who had a gist of their level of risk for recurrence. We also determined the median and interquartile range (IQR) of differences in risk perception between patients and clinicians. We used a Kruskal-Wallis test to evaluate the association of health numeracy level with the clinicians' use of the following numeric format to communicate prognosis: whole

numbers, proportions, percent, statistics, statistical uncertainty, and calculations.

Results

Study population

Fifty patient participants were enrolled in the study. Of the 50 consultations, 49 (98%) patient follow-up surveys were completed and 49 (98%) clinician follow-up surveys were completed. Thirty-five (70%) of the patient participants were English speaking and 15 (30%) were Spanish speaking. Four ($n=4$) did not have recorded transcripts due to technical reasons, leaving 46 transcripts for analysis. Twelve ($n=12$) clinicians who specialize in breast cancer treatment participated in the study from the fields of surgical oncology ($n=3$), radiation oncology ($n=3$), and medical oncology ($n=6$). One patient who identified Spanish as their primary language spoke English during the consultation, while the remaining used Spanish with an interpreter. Additional characteristics of the patient population and provider specialty of consultation visits are presented in Table 2.

Patient outcomes

Of the 48 patients reporting a DCS score, 33 (68.75%) had a score below the threshold of 25, indicating a level associated with greater likelihood of adhering to a treatment decision.[34] The mean (SD) of the DCS score among the total cohort was 17.4 (13.3). High scores in the IPC domains of explained results, elicited concerns, decided together, and compassionate/respectful, and low scores in the IPC domains of lack of clarity, discriminated against for race/ethnicity, and disrespectful office staff indicated strong patient centeredness of communication (Table 3). The overall experience of taking the CAT-NUMi was rated as very good or excellent by 65% of patient participants, fair by 33%, and poor by 2%. Additional usability measures are presented in Table 3.

Clinician outcomes

Clinicians received the CAT-NUMi report before the visit in 47 out of 49 responses on the postvisit survey. Of respondents, the clarity of the report was rated as excellent or very good in 98% and fair in 2% and helpfulness as excellent or very good in 40%, fair in 54%, and poor or very poor in 6% of the consultations. Clinicians reported modifying their communication approach somewhat or quite a bit based upon the CAT-NUMi report in 33% of the consultations, and not at all in 67%. Additional usability outcomes are presented in Table 4.

Clinicians provided qualitative feedback on their experience with the CAT-NUMi intervention. Self-reported modifications made in their communication approach included the use of simple percentages or proportions, avoiding numbers and focusing on simple concepts such as what is cancer, using lower denominators, and incorporating the teach-back technique in the consultation. Some stated that the CAT-NUMi report was most helpful when identifying patients with a low level of numeracy. Others indicated they used more complex numeric information, ''My discussion was at a higher level in terms of language used and analysis made.'' Clinicians identified communication strategies, including sharing mammogram images with patients, focusing on the purpose and goals of treatment, and drawing pictures or diagrams (Table 5).

Table 2. Patient Baseline Characteristics

Participant characteristics	*Total cohort* (n = *50*) n *(%)*
Race/Ethnicity	
Non-Hispanic black	21 (42)
Non-Hispanic white	12 (24)
Hispanic	17 (34)
Preferred language	
English	35 (70)
Spanish	15 (30)
Age (median, interquartile range)	51.0 (46–61)
Education level	
≤HS/GED	18 (36)
Some college	16 (32)
College degree or greater	16 (32)
State Trait Anxiety Index ($n=49$)	40.2 (12.2)
Numeracy level (Measured by the CAT-NUMi)	
Low	18 (36)
Medium	18 (36)
High	14 (28)
CAT-NUMI numeracy scores (mean, SD, range)	–0.059 (1.09), –2.25 to 1.94
Print literacy score (S-TOFHLA)	
Low	1 (2)
Marginal	2 (4)
Adequate	47 (94)
Stage of disease	
0	3 (6)
1	15 (30)
2	12 (24)
3	8 (16)
Unknown	4 (8)
Missing	8 (16)
Type of consultation for study visit	
Surgical oncology	16 (30)
Radiation oncology	12 (20)
Medical oncology	22 (44)

The S-TOFHLA is scored from 0 to 36 as follows: 0–16 (Inadequate functional health literacy), 17–22 (Marginal functional health literacy), and 23–36 (Adequate health literacy). The S-TOFHLA has also been validated in Spanish.[29] The CAT-NUMi scores indicate ability level and are determined by the IRT statistical model. The scores have a hypothetical range from –3.0 (low numeracy) to 3.0 (high numeracy). Clinicians were asked to identify the stage of breast cancer in the Tumor Nodes Metastasis (TNM) system with options provided of 0 or *in situ*, Stage 1a, Stage 1b, Stage 2a, Stage 2b, Stage 3a, Stage 3b, Stage 3c, or ''I don't know.'' In this table, the Stage categories were collapsed to 0 or *in situ*, 1, 2, or 3. The State Anxiety Inventory Score ranges from 20 to 80 with increasing scores indicating increasing levels of anxiety.

IRT, item response theory; HS, High School; GED, General Educational Development.

Patient knowledge regarding stage of disease and risk of recurrence

Among the 41 consultations where the clinician and patient both reported stage of disease, 12/41 (29%) of patients reported the same stage of disease preconsultation as the clinician. Concordance increased to 23/41 (56%) postconsultation.

TABLE 3. PATIENT OUTCOMES

Measure	*Total* n	n *(%)*	*Time of assessment*
Decisional conflict (0–100) Mean (SD)			1 Week postconsultation
Total	48	17.4 (13.3)	
Informed subscale	49	18.2 (13.5)	
Clarity about value subscale	48	16.8 (13.1)	
Support subscale	49	14.2 (13.2)	
Uncertainty subscale	49	24.0 (20.9)	
Effective decision-making subscale	48	16.1 (16.3)	
Interpersonal processes of care (1–5) mean (SD)			1 Week postconsultation
Explained results	50	4.64 (0.72)	
Lack of clarity	49	1.70 (0.71)	
Elicited concerns	50	4.62 (0.55)	
Decided together	47	4.14 (1.17)	
Compassionate, respectful	48	4.77 (0.44)	
Discriminated against due to race/ethnicity	49	1.04 (0.14)	
Disrespectful office staff	49	1.23 (0.55)	
How much experience have you had using computers in the past? *n* (%)	49	12 (25)	Preconsultation
A lot		9 (18)	
Very much		17 (35)	
Somewhat		9 (18)	
Very little		2 (4)	
None			
How comfortable are you with using a computer? *n* (%)	48		Preconsultation
Very comfortable		17 (35)	
Somewhat comfortable		18 (38)	
Neither comfortable or uncomfortable		6 (14)	
Somewhat uncomfortable		7 (15)	
Very uncomfortable		1 (2)	
How clearly was the purpose of the test described? *n* (%)	49		Preconsultation
Excellent		19 (39)	
Very good		19 (39)	
Fair		10 (20)	
Poor		0	
Very poor		1 (2)	
How would you describe your experience interacting with the computer today? *n* (%)	49		Preconsultation
Excellent		17 (35)	
Very good		18 (37)	
Fair		12 (25)	
Poor		2 (4)	
Very poor		0	
How easy was it to move from screen to screen? *n* (%)	49		Preconsultation
Very easy		26 (53)	
Easy		15 (31)	
Fairly easy		7 (14)	
Difficult		1 (2)	
Very difficult		0	
How would you describe the clarity of the questions? *n* (%)	49		Preconsultation
Excellent		7 (14)	
Very good		23 (47)	
Fair		17 (35)	
Poor		2 (4)	
Very poor		0	
How would you describe your overall experience in taking this test?	49		
Excellent		9 (18)	
Very good		23 (47)	
Fair		16 (33)	
Poor		1 (2)	
Very poor		0	

Patient Decisional Conflict Scale scores range from 0 to 100. Scores <25 indicate low levels of decisional conflict with persons more likely to follow-through with decisions made.[34] The Interpersonal Processes of Care scores range from 1 to 5 with higher scores indicating higher frequency of the construct measured.[32]

Table 4. Clinician Responses on Feasibility/Usability of the Computer Adapted Test of Numeracy Understanding in Medicine Instrument in Consultations

Question	n *(Consultations)*	n *(% of Consultations)*
Did you receive the health numeracy report of your patient before your consult?	49	
Yes		47 (96)
No		2 (4)
How would you rate the clarity of the patient health numeracy report?	48	
Excellent		19 (40)
Very good		27 (57)
Fair		2 (4)
Poor		0
Very poor		0
How would you rate the helpfulness of the health numeracy report?	48	
Excellent		9 (19)
Very good		10 (21)
Fair		26 (54)
Poor		1 (2)
Very poor		2 (4)
How satisfied were you with the process of integrating this numeracy test in the patient visit?	48	
Extremely satisfied		5 (10)
Very satisfied		12 (25)
Neutral		30 (63)
Dissatisfied		1 (2)
Very dissatisfied		0
How much did you modify your communication approach based upon the numeracy test result	49	
Significantly		0
Quite a bit		5 (10)
Somewhat		11 (23)
Not at all		33 (67)

Measures were obtained within 1 week after the consultation. The reasons for not having received the CAT-NUMi report before the consultation were not known. One qualitative comment indicated that they did not receive the report in time to review before the consultation. Clinicians in all consultations were eligible to respond to the feasibility/usability questions whether or not they received the report before the consultation.

Among 10 consultations where both patients and clinicians provided estimates of risk of recurrence postconsultation, 2 patients (20%) were accurate. Overall, patients overestimated their 10-year risk of recurrence by a median of 12.5% (IQR: 0%–35%) in comparison to clinician's estimates (Fig. 3).

Use of numeric formats to communicate prognosis

Clinicians discussed prognosis in 89% of transcripts. Clinicians were more likely to use a percentage when describing prognosis to patients if they had higher levels of health numeracy as determined by the Kruskal-Wallis test (Table 6). The use of a teach-back technique was observed at least one time by clinicians in 12/46 (26%) of the consultations. In those consultations in which teach-back technique was used, the median (range) of times a teach-back statement was coded in the consultation was 1 (0–9).

Discussion

We conducted a prospective cohort study as a proof of concept that a brief and valid test of patient health numeracy combined with a clinician facing report could inform tailored communication in the breast cancer treatment consultation. The majority of patients found the CAT-NUMi easy to use and reported a positive experience when taking the test. However, fewer clinicians rated the report's helpfulness as very good or excellent, or modified their approach to communication based on the report. Examples of communication modifications reported by clinicians included the use of simpler percentages or proportions when discussing numeric outcomes with patients. A review of the transcripts revealed that the use of percentage as a format to convey prognostic information was more likely in consultations for patients with a high level of health numeracy.

Our intervention was designed to improve the quality of cancer treatment consultation. Prior studies have demonstrated that women with a diagnosis of breast cancer lack knowledge regarding the stage of disease, with disparities in knowledge across race and ethnic groups. In a survey study of 1118 white, black, or Hispanic women who underwent surgery for stage 0–3 breast cancer diagnosis from 2010 to 2011, only 20%–58% correctly reported tumor characteristics, with black and Hispanic women less likely than white women to know their stage of disease estrogen receptor (ER) status, and human epidermal growth factor receptor 2 (HER2) status.[36] Stage of disease is a numeric construct and persons of low numeracy may not understand the implications of higher versus lower stage of disease as easily as those with higher levels of numeracy.[37,38]

Decision aids (DAs) designed for women with breast cancer can augment the cancer consultation and improve the treatment decision-making process.[39] However, numeric information conveyed in DAs is often complex, including risk and probability estimates as recommended by the International Patient Decision Aid Standards.[17,40,41]

Persons of low numeracy have greater difficulty in completing DAs.[8,42] In a qualitative study of 22 surgeons, factors believed to facilitate DA use included exposure to this approach during training and the perceived need for a systematic approach to communicate risk and benefits, while barriers included high confidence in their verbal communication skills and the perception that patients already understood the conveyed information.[14] Clinicians' knowledge of patient health numeracy has the potential to inform their recommendations for use of decision support that aligns with the patient's comfort level regarding numeric information.[19,20]

In our study, we report increased numeric-based knowledge among patient study participants from preconsultation to postconsultation regarding the stage of disease. We found some evidence that the numeric formats used to communicate prognosis varied by level of health numeracy conveyed in the

Table 5. Qualitative Feedback from Clinicians Participating in the Study

Modifications in communication based on the CAT-NUMi report
I think I generally speak to patients assuming a ''medium level'' of comprehension/numeracy.
Tried to incorporate ''teach-back.'' She seemed to underestimate her risk, said she has a small cancer in the breast.
I tried to avoid numbers, tried to focus on basic concepts, that is, what is cancer, what do we know about it.
Would not have changed my approach.
I used only simple numerical concepts like $\sim 1/2$.
Tried to use very simple percentages (1/2 or 50%).
More conscious of how I used numbers basic discussion was the same.
Did not use numbers much at all. I was not able to get her to ''say back'' to me what she had understood. I should have asked her directly to tell me what she understood.
My discussion was at a higher level in terms of language used and analysis made.
Only a minimal modification.
I changed explanation of risk level to small denominators.
Lower denominator.
I provided more specific percentages.
Feedback on the CAT-NUMi report content
I think I would likely find this system helpful for patients that don't necessarily have a high ''numeracy level.''
I use the same approach for every patient that is simple and uses diagrams. I have found that even the most educated people have trouble understanding medical concepts so I simplify my discussions for everyone.
It would be nice to receive this report more in advance of the patient encounter.
I like the pictograph but I need one that I can fill in and use. I don't need a pdf. I would like one that is a reliable electronic format.
Asking the patient how much they want to participate in decisions/choices or whether they feel it is the ''doctor's job'' to tell them ''what they recommend.''
I did not feel confident that the patient and her boyfriend could understand all of the information I gave to them, but they seemed to understand the treatment plan.
Need more than numeracy ideas, need basic education of what cancer is, why chemotherapy is given (the purpose of chemo), what other treatments are needed, the goal of the treatment, that is, curative vs. exclusively survival or palliative.
Integrating the CAT-NUMi in the cancer consultation
Not finding very useful.
I am not sure how much I used my own bias/intuition/reading patient's facial expressions, *etc.* vs. how much the numeracy information influenced my discussion. I should have tried to press more for the ''teach-back'' method to make sure she understood what was explained.
I think the ''teach-back'' is helpful, I was surprised to hear patient seemed to underestimate her risk when she told me she had a ''small'' cancer, tumor in the breast.
I felt the report was helpful for ''Low'' results because I tried to keep the conversations more simplified from the very beginning. Even though I tried to keep it simple, I am not sure how much was understood, when I tried ''teach-back'' I think my question was misunderstood and I should have reworked it.
I think that more team members are needed to communicate risk and reasons/goal for therapy.
Patient's main concern seemed to be whether she needed chemotherapy and if it should be given before or after surgery, *etc.* I focused more on that.
I gave my standard discussion for patients who are about to become pre-op. (chemotherapy who are not potential candidates for NABPB-51 or alliance A011202.
Methods used by clinicians to communicate risk information in the consultation
Tried to example the purpose of each treatment (Chemotherapy, hormonal therapy, surgery, *etc.*) tried to convey to her that the hormonal therapy may have the greater impact on her cancer but because of the positive nodes, chemotherapy would also benefit her.
Direct viewing of imaging studies.
Wrote out the outcomes on paper for the patient for risk of recurrence, pathology results, *etc.*
Pictures
Review of imaging studies.
This was a very well informed patient. She has a mutation that increases her risk of breast cancer. She had questions about surgery, but guidelines/data to specifically answer her questions (of lateral mastectomy) do not exist.
Draw pictures and diagrams
I have found that using teach-back method can sometimes be difficult to get the patient to be able to describe what I just told them.
Told her what the ''goal'' of treatment will be (*i.e.*, to cure her if possible).
I spoke in general terms, avoided numbers patient did not ask questions, she was somewhat withdrawn. She seemed to understand the overall purpose of the treatment.
Sharing mammogram image with mass and calcifications.
I think the teach-back method is a great choice. I think I am sometimes afraid to ''insult'' patients if I ask too many times if they understand or if I ''Talk back'' to them.
Try to tell her what the purpose of the treatment is, weather it is curative or not, why we will give the chemotherapy.

These verbatim quotations report all qualitative feedback provided by the 12 participating clinicians. Clinicians had the opportunity to provide feedback for each patent of theirs, who was enrolled in the study.

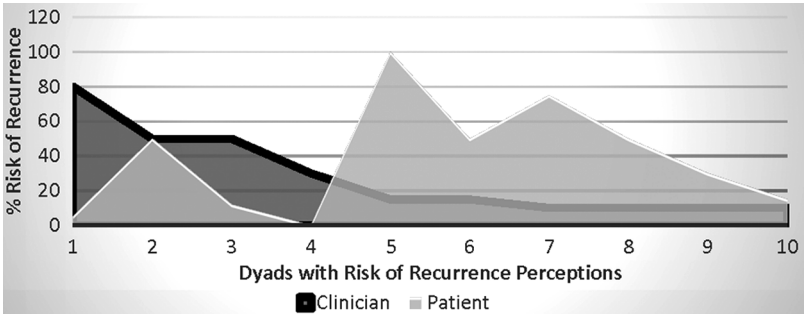

FIG. 3. This figure demonstrates difference in clinician- and patient-perceived risk of recurrence following the cancer treatment consultation. The *darker gray* area represents clinician perceptions, which are lower than patient perceptions in most cases.

CAT-NUMi report. We also find support that the perceived clarity was not decreased as an unintended consequence with IPC-perceived clarity scores similar to historical control in breast cancer populations. In addition, qualitative comments from clinicians indicate that some were considering health numeracy in their cancer communication approach.

Despite indicators that the intervention had an impact on communication, in a majority of consultations, clinicians stated that they did not change their communication style based on the intervention. Some stated that they have established a set approach to communication. Others commented that they prioritize communicating a basic understanding of cancer and the nature of treatment, rather than a discussion of prognosis and outcomes. Indeed, studies indicate that patients have multiple expectations, seeking not only knowledge but also judgments about treatment implications, evaluative comments, and clues about what information signifies.[2,13] Recognizing the competing goals and time limitations in the clinical visit, the CAT-NUMi report was designed to be clear, brief, and specific in guidance provided.

Qualitative comments indicate that clinicians may selectively use the CAT-NUMi report, with some using as simple numeric formats as possible and others communicating at a higher level. However, clinicians may not accurately assess a patient's level of health numeracy based on general knowledge about a patient's education.[7,43] Therefore, an objective measure of health numeracy may have value in guiding the level of discussion involving numeric information.

The CAT-NUMi clinician report recommends the use of a teach-back technique to confirm patient understanding of information. Our analysis found that this approach was used at least once in 25% of the consultations. In a systematic review of the teach-back method on adherence and self-management among people with chronic disease, this approach was found to increase disease-specific knowledge, adherence, and self-efficacy.[44] Its efficacy in cancer consultation is not known. Communication guidance to use the teach-back technique in cancer treatment consultations may address some barriers to the use of numeric information as clinicians can assess the degree of patient understanding.

We sought to measure the impact of the intervention on clear communication through use of the IPC measure, with a focus on the clarity of information provided. Our study found a similar quality of communication as previously reported in a breast cancer cohort, with the exception of perceived discrimination from office staff, a finding that warrants evaluation in future studies. A study of 1885 women diagnosed with breast cancer in 2006–2011, eight months following diagnosis, reported a lack of clarity score of 1.72 (range 1–5), with higher scores among Hispanic and Asian compared to white women.[45] The lack of clarity score in our study was comparable to this larger cohort, despite the timing of the consultation when the information presented may be most overwhelming and complex.

We report increased knowledge about stage of disease following the consultation, although gaps in knowledge persisted. Only 41% correctly identified stage of disease after the consultation, and among patient–clinician dyad respondents, only 20% estimated risk of recurrence accurately. These results could indicate lack of communication regarding these numeric outcomes, poor understanding, or limited recall of information. Further research is needed to determine if this approach improves clarity of information and patient knowledge of prognosis.

Table 6. Use of Quantitative Format or Concept to Convey Prognosis in Consultations Overall and Stratified by Numeracy Level ($n=46$)

Quantitative format or concept	*Total* *Median (range)* n = *46*	*Low* *Median (range)* n = *18*	*Medium* *Median (range)* n = *15*	*High* *Median (range)* n = *13*	p-*Value*
Whole numbers	25.5 (1–52)	36 (1–51)	31.5 (3–52)	17 (8–31)	0.08
Proportion	0 (0–8)	0 (0–8)	0 (0–5)	0 (0–3)	0.67
Percent	0.5 (0–8)	0 (0–2)	1 (0–7)	2 (0–8)	0.04
Decimals	00	0	0	0	—
Statistics	0 (0–9)	0 (0–1)	0 (0–3)	1 (0–9)	0.06
Statistical Uncertainty	0 (0–5)	0 (0–1)	0 (0–3)	0 (0–5)	0.40
Mental calculations	1 (0–4)	1 (0–4)	1 (0–4)	0 (0–3)	0.86

Kruskal-Wallis test for association with nonparametric measures used to test for association of numeracy with use of quantitative terms in transcripts when discussing prognosis. These data show the median number of times in each consultation the format or concept was used. The *p*-value indicates whether there was a significant difference between the three groups.

This study has several limitations. First, this was a pilot study with a small sample size and although we attempted to enroll a consecutive sample of eligible patients, we lack data on participation rates, limiting the generalizability of findings. Second, the study did not use a randomized design, limiting inferences that the information provided by the CAT-NUMi report lead to changes in communication strategies. Third, 94% of patients had adequate general literacy. However, there was a wide distribution of health numeracy, the focus of our intervention. Finally, the intervention included both numeracy-specific communication guidance and general guidance to use the teach-back technique, limiting our ability to discern the independent effect of these components.

Despite limitations, this study has several strengths. These include a strong conceptual model, integration of the intervention in a clinical setting, the use of mixed methods to assess feasibility, and diversity of the sample with respect to education, numeracy level, inclusion of Spanish- and English-speaking patients, and providers across a range of disciplines involved in breast cancer care.

In conclusion, in this pilot study, we evaluated the use of a computer-based test of health numeracy, together with a clinician-facing report as a strategy to support patient-centered communication in cancer treatment consultation. The health numeracy assessment used modern psychometric methods to create a computer adaptive test and minimize respondent burden. The intervention was well accepted by patients, with patient- and clinician-reported outcomes indicating potential benefit on the quality of communication in the cancer consultation. Furthermore, there was no indication of adverse impact on communication in the consultation. However, the impact of the CAT-NUMi report could increase with greater clinician experience. Also, the expanding use and capabilities of health information technology could better support tailoring of clinician communication to patient-level factors.

This study does not definitely answer the question of whether universal precautions or tailored approaches to providing numeric information in the cancer consultation are optimal. A future study that uses a randomized design and is adequately powered to evaluate the causal effect of CAT-NUMi on the efficacy of cancer communication is needed to answer this question. Given the growing complexity of cancer care, communication strategies that adapt to the patients' level of health numeracy have the potential to increase patient centeredness and effectiveness of cancer treatment consultation.

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Author Disclosure Statement

No competing financial interests exist.

Supplementary Material

Supplementary Figure S1
Supplementary Figure S2
Supplementary Figure S3
Supplementary Figure S4
Supplementary Figure S5
Supplementary Table S1

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