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Knowledge of genomic testing among early-stage breast cancer patients

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Abstract

***Background*: Genomic recurrence risk test results now inform clinical decisions about adjuvant treatment for women with early-stage breast cancer. We sought to understand patients' knowledge of these tests and correlates of their knowledge.**

***Methods*: Participants in this cross-sectional study were 78 women, treated for early-stage, estrogen receptor-positive breast cancer with 0–3 positive lymph nodes, whose medical records indicated they received Oncotype DX testing earlier. We mailed a questionnaire that assessed knowledge of genomic recurrence risk testing (13 item scale, alpha = 0.83) and reviewed medical charts of consenting patients.**

***Results*: Knowledge about genomic recurrence risk testing was low (mean knowledge score = 67%, SD = 0.23). Low knowledge scores were more commonly due to responses of 'don't know' than incorrect answers. Most women (91%) clearly understood that test results can aid decisions about chemotherapy, and few (22%) understood that the test's estimate of the chance of metastasis assumes the patient is receiving hormone therapy. Higher knowledge about genomic recurrence risk testing was associated with higher education, reading ability, and numeracy. Knowledge was higher among women who recalled receiving both verbal and printed information about the test and among women who had active roles in deciding about their treatments. Higher knowledge was also associated with having fewer concerns about genomic testing.**

***Discussion*: Among early-stage breast cancer patients who received Oncotype DX, we found low knowledge about many aspects of genomic recurrence risk testing. Research is needed to understand testing information provided to patients and best practices for patient education.**

Keywords: early-stage breast cancer; genomic testing; decision making; recurrence risk; adjuvant therapy

Introduction

While genomic-based tests hold great promise for many areas of medicine, they are already part of the routine clinical care for breast cancer, including aiding adjuvant treatment decisions [1–4]. For example, the genomic test, Oncotype DX (Genomic Health, Redwood City, California), is a clinically validated multigene test designed to predict the risk of recurrence despite endocrine therapy, and to inform adjuvant treatment decisions for stage I and II, node-negative, estrogen receptor-positive breast cancer [4–7], as well as for some node-positive breast cancers [8,9]. Oncotype DX calculates a breast cancer recurrence score based on the expression of 21 genes. The recurrence score is a number from 0 to 100 that corresponds to a likelihood of distant breast cancer recurrence within 10 years of diagnosis, assuming adjuvant hormonal treatment. This risk of recurrence is then further categorized into low, intermediate, or high risk. In patients with node-negative hormone receptor-positive breast cancer, low recurrence risk indicates higher benefit from hormone therapy, such as tamoxifen and lower benefit of chemotherapy, whereas a high recurrence risk indicates a greater benefit from receiving chemotherapy (as opposed to hormone therapy alone) [4].

These new tests raise the question of the extent to which patients are prepared to participate in informed decision making about their care. Studies show that most patients prefer to be involved in medical decisions that affect their care [10,11] and that patients who are active participants in their medical decisions are better adjusted psychologically, report being more satisfied with their

decisions, and are more likely to adhere to their treatment regimens [12–15]. However, we do not know whether patients understand genomic tests and their results adequately to be informed decision makers when using them. A recent US study assessed retention of information about genomic tests among a proxy population of breast cancer patients who had not received Oncotype DX, but who were provided with an oral and written description of the test immediately before completing the survey [16]. Breast cancer patients with lower health literacy had lower genomic test knowledge (76% correct) than women with higher health literacy (90%). Less than half the patients were able to answer all questions about the test correctly, even though they had received the answers minutes before. A study of breast cancer patients in nine European countries found low knowledge about adjuvant hormone therapy, suggesting they lacked adequate information for informed decision making [17]. These studies suggest that some breast cancer patients may not have information they need to make informed decisions about their care.

This study sought to understand knowledge of genomic testing among breast cancer patients who received the Oncotype DX test as well as identify correlates of knowledge, including patient characteristics, experiences with breast cancer treatment, and experiences with genomic testing. Patient characteristics, such as race and education, are associated with a wide variety of cancer outcomes including breast cancer survival, making them important potential correlates [18,19]. Experiences with treatments, including chemotherapy, are potentially important because of the relationship between recurrence risk and treatment decisions. Experiences with Oncotype DX and beliefs about the test are also potentially important. Beliefs and concerns about genomic testing can reduce breast cancer patients' willingness to let the results guide treatment decisions [16]. These concerns include believing that the test had a negative effect on their family, only having the test because other family members wanted them to, or believing that this type of genomic information is better left unknown. Finally, we examined whether different ways of presenting test results was associated with higher knowledge.

Methods

Participants and procedure

Participants were women previously treated for early-stage breast cancer at the University of North Carolina Breast Center (Chapel Hill, NC), whose medical records indicated they received the Oncotype DX test between the time the test was first available in June 2004 and March 2009. We included women diagnosed with stages I or II, node-negative, hormone receptor-positive breast cancer. We also included one woman who was node positive, because the test was clinically useful for node-positive breast cancer that matched her profile [8,9]. We excluded women who did not speak English or who were under the age of 18.

Patients received a mailed questionnaire between December 2008 and June 2009. They had the option to complete a Health Insurance Portability and Accountability Act authorization form to allow a review of their medical records regarding their cancer diagnosis and treatment. Women received $15 incentives for participation. The institutional review board of the University of North Carolina at Chapel Hill approved the study protocol and materials.

Measures

Outcome

The questionnaire assessed knowledge of Oncotype DX using 13 true or false questions, which appear in the Appendix. We awarded one point for each correct answer, summing to create a composite knowledge score for each participant ($\alpha = 0.83$). We counted an answer incorrect if the participant chose the wrong answer, answered 'don't know', or skipped the question ($<2\%$).

Participant characteristics

The questionnaire assessed demographic characteristics and characteristics pertaining to breast cancer (length of time since diagnosis, family and personal history of breast cancer, and treatments received after surgery). The questionnaire assessed numeracy with a 3-item scale [20] (potential ange, 0–3 correct answers). A single item assessed how often respondents need help with written health-related materials, to identify patients who may have limited reading ability, which is a component of health literacy. Response options ranged from 'never' to 'always'. We reverse-coded responses so that higher values indicated a higher reading ability (range 1–5). For patients who consented to medical chart review, we recorded a number of co-morbidities [21], tumor stage, nodal status, menopausal status, recurrence risk based on the Oncotype DX test, and adjuvant treatments received.

Role in treatment decisions

One questionnaire item assessed how women and their doctors decided on breast cancer treatment [22]. The question had the following response options: 'I made the final selection about which treatment I will receive', 'I made the final selection of my treatment after seriously considering my doctor's opinion', 'My doctor and I shared

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responsibility for deciding which treatment is best for me', 'My doctor made the final decision about which treatment will be used but seriously considered my opinion', and 'I left all decisions regarding my treatment to my doctor'. Similar to earlier studies [23,24], we coded the first two responses as 'active decision-making', the third as 'shared decision-making', and the last two as 'passive decision-making'.

Receiving test results

The questionnaire assessed participants' receipt of information about the test, including whether they received printed or verbal information from their doctors as well as whether their doctors described test results using 'numbers' (such as '6% chance'), 'words' (such as 'low risk' or 'high risk'), and 'graphics' (such as a 'chart' or 'other'). Participants reported their perceived understanding of what they were told about the results of the test, using a 5-point response scale ranging from 'nothing at all' to 'everything'.

Perceived consequences of genomic recurrence risk testing

We adapted seven items from the O'Neill scale [25] to form the 'perceived benefits' and 'perceived concerns' subscales. Three items measured concerns about testing ($\alpha = 0.85$) and four items measured perceived benefits ($\alpha = 0.67$). Responses options ranged from 'strongly disagree' to 'strongly agree' (coded as 1–4).

Data analysis

We analyzed data using SPSS statistical analysis software (SPSS 16.0, SPSS Inc., Chicago, IL). We report percentages when analyses are for the entire sample and percentages (n/N) when analyses include only a subsample (typically because of missing data). We examined correlates of knowledge using bivariate linear regression, reporting results as correlation coefficients. Tests were two-tailed with a critical alpha of 0.05.

Results

Of the 104 women invited to participate, 78 completed the survey. All but ten participants gave authorization to review their medical charts (87%). On average, women were 58 years old (range 38–83) (Table 1). Most were Caucasian (81%), married or living as married (74%), had household income of $60 000 or more (60%), and some form of health insurance (92%). Most participants had node-negative (97%, 66/68), stage I breast cancer (79%, 54/68). The average time since diagnosis was 17 months (range 4–54) with the majority of women (78%) receiving a diagnosis within 2 years of study. Over half the women reported they had an active (55%, 42/77) role in their treatment decision making while the remaining were split

Table 1. Association between patient characteristics and knowledge of genomic recurrence risk testing

	n (%)	Mean knowledge score (%)	*r*
Age			−0.40**
Time since diagnosis			−0.36*
Race			0.28**
White	63/78 (81)	70	
Other	15/78 (19)	54	
Marital status			0.41**
Not married	20/78 (26)	51	
Married or living as married	58/78 (74)	73	
Employment			0.36**
Not currently employed	32/75 (43)	57	
Currently employed	43/75 (57)	74	
Annual household income			0.39**
<$60 000	31/78 (40)	55	
⩾$60 000	47/78 (60)	75	
Insurance			0.13
Uninsured	6/78 (8)	56	
Insured	72/78 (92)	68	
Education			0.41**
Not college educated	36/78 (46)	57	
College educated	42/78 (54)	76	
Numeracy			0.42**
Lower (0–2/3 answers correct)	54/78 (69)	62	
Higher (all answers correct)	24/78 (31)	79	
Literacy (reading ability)			0.22*
Often or always need help	16/78 (21)	54	
Never/Rarely/Sometimes need help	62/78 (79)	71	
Nodal status			−0.04
0	66/68 (97)	67	
1–3	2/68 (3)	62	
Breast cancer stage			−0.05
I	54/68 (79)	67	
II	14/68 (21)	66	
Recurrence risk based on Oncotype DX			0.08
Low (⩽11%)	34/68 (50)	66	
Intermediate (12–21%)	25/68 (37)	67	
High (>21%)	9/68 (13)	71	
Menopausal status			−0.24
Premenopausal	19/64 (30)	74	
Currently in menopause	3/64 (5)	77	
Postmenopausal	42/64 (65)	63	
Co-morbidities			−0.51**
Minor	24/68 (35)	80	
Average	22/68 (32)	63	
Major	22/68 (32)	56	
Family history of breast cancer			0.02
No	38/78 (49)	67	
Yes	40/78 (51)	68	
Had other cancer			−0.14
No	63/77 (82)	69	
Yes	14/77 (18)	60	

Note: Analyses are bivariate. Age and time since diagnosis were continuous variables. $^{*}p \leqslant 0.05$; $^{**}p \leqslant 0.001$.

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Table 2. Association between treatment-related variables and knowledge of genomic recurrence risk testing

	n (%)	Mean knowledge score (%)	r
Breast Cancer Treatment			
Radiation			−0.17
No	31/78 (40)	72	
Yes	47/78 (60)	64	
Chemotherapy			0.17
No	53/78 (68)	64	
Yes	25/78 (32)	73	
Hormone therapy			0.12
No	7/78 (9)	58	
Yes	71/78 (91)	68	
Complete or total mastectomy			0.13
No	43/68 (63)	65	
Yes	25/68 (37)	71	
Breast conserving surgery			−0.10
No	24/68 (35)	70	
Yes	44/68 (65)	65	
Had active role in treatment decision			0.25*
No	35/77 (45)	62	
Yes	42/77 (55)	71	
Getting Oncotype DX Test Results			
Understood results when received them			0.30*
Small or moderate amount	23/70 (33)	63	
Large amount or everything	47/70 (67)	73	
Received both verbal and printed information about the test			0.51**
No	13/75 (17)	48	
Yes	62/75 (83)	72	
Doctor used numbers when delivering test results			0.23*
No	9/73 (12)	57	
Yes	64/73 (88)	72	
Attitudes about Oncotype DX			
Perceived benefits			0.07
Concerns			−0.30**

Note: Analyses are bivariate. Attitudes about testing scales were continuous variables. *$p \leqslant 0.05$; **$p \leqslant 0.001$.

between passive and shared roles (22 and 23%, respectively) (Table 2).

Most women (93%, 69/74) recalled discussing their recurrence risk test result with their doctors and half had a low recurrence risk (50%, 34/68). When receiving information about the test from their doctors, the majority of women remembered receiving both verbal and printed information about the test (83%, 62/75), and most women remember their doctors describing the results of the test using numbers (88% 64/73). Most women reported understanding a large amount or all of what their doctor told them about the results of the test (67%, 47/70). A third of the women (33%, 23/70) recalled understanding a moderate or a small amount of what their doctors told them.

Most women reported being satisfied with the test. Most women said that they would have the test if they had to decide again today (96%, 74/77), that they would recommend the test to other women (95%, 73/77), and agreed that having the test gave them a better understanding of their treatment options' chances of success (95%, 73/77). The majority of women thought that their test result could be trusted (77%, 57/74), that it was accurate (71%, 53/75), and that having the test was useful because it could say for sure whether their cancer had a high chance of coming back (76%, 57/75). Few women had concerns about the test: 8% (6/77) of women said that they had the test only because other family members wanted them to, 5% (4/77) said that having the test had a negative effect on their family, and only 3% (2/76) agreed that this information about one's cancer is better left unknown.

Knowledge

Knowledge about the genomic recurrence risk test was low (mean knowledge score = 67%, SD = 0.23). No patients answered all knowledge items correctly, though 15% of patients answered 12 of the 13 items correctly. Women most clearly understood the relationship between genomic recurrence risk testing and chemotherapy. For example, most understood that the test aids decisions about having chemotherapy (91%) and that the results can help some women avoid having chemotherapy (86%) (Figure 1). Fewer women understood the relationship between the test result and chance of metastasis: just over half (53%) the women knew that the test result gives the chance of metastasis and only 22% knew that the test result provides the chance of metastasis assuming additional hormone treatment after surgery (e.g. tamoxifen).

Women chose the 'don't know' option more often than they chose a wrong answer (Figure 1). Only 2 of the 13 knowledge questions yielded a higher proportion of women who reported the wrong answer than selected 'don't know' (Figure 1). These items were, 'The Test gives the chance of metastasis assuming no more treatment after surgery' (48% wrong answer and 30% 'don't know') and 'The Test is done on tissue from the breast' (8% wrong answer and 4% 'don't know'). Women were more likely to answer correctly when the correct answer was true than when it was false (mean correct answers 80% vs 56%, $t = 18$, $p < 0.001$).

Correlates of knowledge

Women with higher knowledge scores were more likely to be younger, white, married, employed, and have a higher household income (Table 1). Women with higher numeracy scores, higher health literacy (reported never, rarely, or sometimes needing help reading), and more education had higher knowledge scores. Another demographic characteristic

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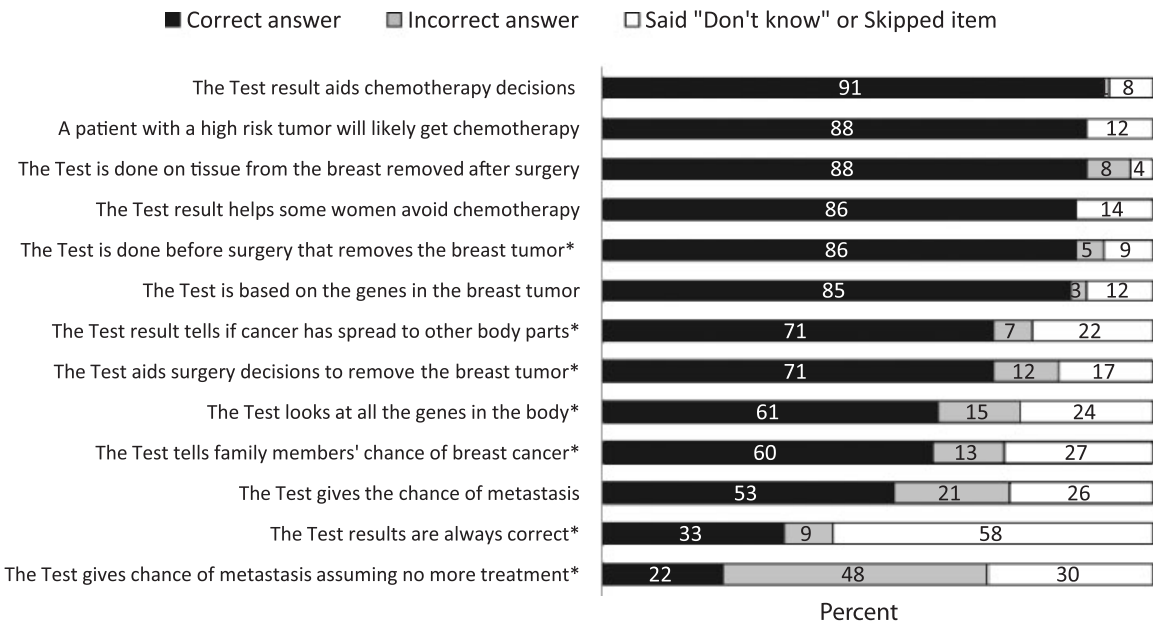

Figure 1. Knowledge of genomic recurrence risk testing. *Correct answer was false.

associated with higher knowledge scores was having less co-morbidity.

Women diagnosed with breast cancer more recently had higher knowledge scores than women whose diagnoses happened longer ago. Women diagnosed in the 12 months before the survey answered 70% of the items correctly, on average, similar to women diagnosed 12–24 months before the survey (68%). Women diagnosed more than 2 years earlier had the lowest knowledge scores (60%). This finding did not appear to be owing to changes in how doctors presented test results to women. A *post hoc* analysis found that time since diagnosis was not associated with receiving results in words, numbers, or graphs (all $p > 0.52$).

Women who had active decision-making roles had higher knowledge scores than women with more passive roles ($p < 0.05$) (Table 2). Women who reported greater understanding of what their doctors told them about their results (i.e. higher perceived knowledge) had higher knowledge of the test. Knowledge scores were higher among women who recalled receiving both verbal and printed information ($p < 0.001$). Women who recalled that their doctors described the results of the test using numbers had higher knowledge scores ($p < 0.05$). While knowledge was not associated with perceived benefits about genomic testing, perhaps owing to restricted range, women who reported fewer concerns about genomic testing had higher knowledge.

Discussion

As use of genomic tests for screening, prevention, and treatment grows, patients' understanding of genomic tests is increasingly important. Among early-stage breast cancer patients who received Oncotype DX, we found low knowledge about many aspects of genomic recurrence risk testing. Most women understood the relationship between the test and chemotherapy (e.g. test aids decisions about chemotherapy) and general test procedures (e.g. it is done after surgery that removes the breast tumor). However, few understood that the test provides the chance of metastasis assuming additional treatment and that the test does not provide information about familial risk for breast cancer. Differences in knowledge of these facts should be interpreted with caution as items with the lowest knowledge also had 'false' as the correct answer, which may have made them harder to answer. This report is among the first to examine knowledge of this genomic test among women who received it.

Though knowledge was low on some topics, women were, to a substantial extent, aware of gaps in their understanding of the tests. Women who did not provide correct answers chose the 'don't know' option more often than they chose the wrong answer for 11 out of 13 of the knowledge questions. Likewise, women who reported greater understanding of what their doctors told them about their results had higher knowledge. This is a positive finding that suggests that educational efforts would address patients, many of whom are aware of gaps in their understanding and, thus, may be receptive to information to address these gaps (Table 2).

Women with higher education, reading ability (which is a component of health literacy), and numeracy had greater knowledge of genomic testing. These findings are consistent with findings

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from an earlier study on genomic testing that found that having higher health literacy and numeracy increases patients' ability to recall information about recurrence risk testing [16], and also with other studies of literacy and numeracy in the context of cancer prevention and treatment [20,26]. These findings have implications for practice. When communicating recurrence risk test information with patients, health professionals and educators should pay attention to patient health literacy and numeracy, and perhaps adjust the delivery of and time spent on risk communication messages with patients. Other patient characteristics associated with lower knowledge, which may help identify women who need additional care when presenting test information, were being older, non-white, unemployed, having a lower household income, and having less co-morbidity. This last finding may be especially concerning as patients with greater co-morbidity typically receive less aggressive and less definitive cancer therapy [27–30], and less definitive cancer therapy and co-morbidity are associated with poorer health outcomes [31].

Knowledge was higher among women who recalled receiving both verbal and printed information about the test and among women who recalled that their doctors described the results of the test using numbers. These findings offer preliminary information on risk communication approaches that may be most effective. However, additional experimental research will be necessary to understand the types of risk formats women prefer and that help them retain the most information.

Knowledge was also higher among women who adopted active decision-making roles in their breast cancer treatment relative to women who reported more passive roles. It is possible that encouraging women to take a more active role in their treatment decisions will increase their overall knowledge about important tests, such as Oncotype DX. Similarly, tools to increase patients' knowledge may facilitate a more active role in decision making. Exploring what the ideal model may be for decision making and knowledge as well as evaluating efforts to increase patient involvement are areas for future research.

Women in this study had few concerns and were satisfied with the test, saying that they would recommend the test to others and that they would still have the test if faced with the decision again today. In general, they perceived more benefits than concerns regarding the test. Even though women had few concerns about the test, these concerns were associated with testing knowledge, such that women who reported fewer concerns had higher knowledge. This finding may reflect more knowledgeable patients being more skeptical or patients who are naturally concerned educating themselves more about the test.

Strengths of the study include its high response rate, that it addresses a clinically relevant topic not covered earlier in literature, and that it offers novel data that can be a basis for further research. A limitation is that some women received their treatment many months before participating in the study. However, it is plausible that patterns of difference in knowledge that we observed may be similar to what would be true in a prospective cohort. While the absolute levels of knowledge may change over time, variations in knowledge by topic and the correlates of knowledge may correspond more closely to what we might see among patients actively deciding about treatment. As noted earlier, some differences in knowledge do coincide with the correct answer being true or false, suggesting caution when interpreting these findings. Nonetheless, we found that knowledge about the test remained low even among women diagnosed within 12 months before the survey. However, instead of focusing on level of knowledge over time, we think it is most important to understand the disparities in knowledge in an effort to best inform future research and intervention planning. The cross-sectional study design limits our ability to draw conclusions regarding causal relationships. As participants were mostly Caucasian, well-educated, and insured women receiving medical care from the same institution, future research will need to establish the generalizability of our findings to other populations of breast cancer patients receiving the test. A last limitation is that we used a single item measure in our assessment of health literacy called the Single Item Literacy Screener. Although this measure has been evaluated and regarded as performing moderately well in the assessment of limited reading ability [32], we recognize that employing a single item measure to assess health literacy is not ideal and that it does not encompass all components of health literacy.

Genomic testing is rapidly moving into routine clinical care and has the potential for far-reaching public health impact. Our study is among the first to describe knowledge of genomic testing from patients who received the test, and opens the door to future efforts to improve patient knowledge. Ensuring that patients have information they need to make informed decisions will require making sure that all patients who receive genomic testing, regardless of age, literacy, or educational level, understand what the test is and how it pertains to their health and treatment. Healthcare professionals should be cognizant of the different informational needs of patients and should tailor their educational efforts accordingly. Little is known about the nature of test result information provided to patients. Understanding what is currently being related to patients would help identify gaps, if any, in these discussions and is a potential area for future research.

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Appendix A

Questionnaire items assessing knowledge of Oncotype DX

	True	False	Don't Know
1. The Test is done before surgery that removes the breast tumor.	☐	☐	☐
2. The Test is done on tissue from the breast that is removed when the woman has surgery.	☐	☐	☐
3. The Test looks at all the genes in a patient's body.	☐	☐	☐
4. The Test result is based on the genes of the breast tumor.	☐	☐	☐
5. The results of the Test are always correct.	☐	☐	☐
6. The Test result tells whether other women in a patient's family have a higher chance of breast cancer.	☐	☐	☐
7. The Test result gives the chance of metastasis (cancer coming back in parts of the body other than the breasts).	☐	☐	☐
8. The Test gives a woman's chance of metastasis assuming she gets no more treatment after surgery.	☐	☐	☐
9. The Test result tells whether cancer cells have already spread to parts of the body other than the breasts.	☐	☐	☐
10. The Test result aids decisions about having chemotherapy.	☐	☐	☐
11. A patient with an 'unfavorable' (or high risk) tumor will be recommended to get chemotherapy.	☐	☐	☐
12. The Test result aids decisions about having surgery to remove the breast tumor.	☐	☐	☐
13. The results of the Test help some women avoid having chemotherapy.	☐	☐	☐

References

1. Morris SR, Carey LA. Gene expression profiling in breast cancer. *Curr Opin Oncol* 2007;**19**:547–551.
2. Henry LR, Stojadinovic A, Swain SM *et al*. The influence of a gene expression profile on breast cancer decisions. *J Surg Oncol* 2009;**99**:319–323.
3. Asad J, Jacobson AF, Estabrook A *et al*. Does oncotype DX recurrence score affect the management of patients with early-stage breast cancer? *Am J Surg* 2008;**196**: 527–529.
4. Oakman C, Bessi S, Zafarana E *et al*. New diagnostics and biological predictors of outcomes in early breast cancer. *Breast Cancer Res* 2009;**11**:205–216.
5. Paik S, Shak S, Tang G *et al*. A multigene assay to predict recurrence of tamoxifen-treated, node-negative brest cancer. *N Engl J Med* 2004;**351**:2817–2826.
6. Wolf I, Baruch NB, Shapira-Frommer R *et al*. Association between standard clinical and pathologic characteristics and the 21-gene recurrence score in breast cancer patients. *Cancer* 2008;**112**:731–736.
7. Paik S, Shak S, Tang G *et al*. Gene expression and benefit of chemotherapy in women with node-negative, estrogen receptor-positive breast cancer. *J Clin Oncol* 2006;**98**:1183–1192.
8. Goldstein LJ, Gray R, Badve S *et al*. Prognostic utility of the 21-gene assay in hormone receptor-positive operable breast cancer compared with classical clinicopathologic features. *J Clin Oncol* 2008;**26**:4063–4071.
9. Albain K, Barlow W, Shak S *et al*. Prognosticand predictive value of the 21-gene recurrence score assay in postmenopausal, nodepositive, ER-positive breast cancer (S8814,INT0100). Presented at the 30th Annual San Antonio Breast Cancer Symposium; 13–16 December 2007, San Antonio, Texas. Abstract 10.
10. Degner LF, Kristjanson LJ, Bowman D *et al*. Information needs and decisional preferences in women with breast cancer. *JAMA* 1997;**277**:1485–1492.
11. Keating KL, Guadagnoli E, Landrum MB *et al*. Treatment decision making in early stage breast cancer: should surgeons match patients' desired level of involvement? *J Clin Oncol* 2002;**20**:1473–1479.
12. Thomas R, Godward S, Makris A *et al*. Giving patients a choice improves quality of life: a multi-centre, investigator-blind, randomised crossover study comparing letrozole with anatrozole. *Clin Oncol* (*R Coll Radiol*) 2004;**16**:485–491.
13. Fallowfield L, Atkins L, Catt S *et al*. Patients' preference for administration of endocrine treatments by injection or tablets: results from a study of women with breast cancer. *Ann Oncol* 2006;**17**:205–210.
14. Partridge AH, Wang PS, Winer EP *et al*. Nonadherence to adjuvant tamoxifen therapy in women with primary breast cancer. *J Clin Oncol* 2003;**21**:602–606.
15. Atkins L, Fallowfield L. Intentional and non-intentional non-adherence to medication amongst breast cancer patients. *Eur J Cancer* 2006;**42**:2271–2276.
16. Lillie SE, Brewer NT, O'Neill SC *et al*. Retention and use of breast cancer recurrence risk information from genomic tests: the role of health literacy. *Cancer Epidemiol Biomarkers Prev* 2007;**16**:249–255.
17. Wengström Y, Aapro M, Leto di Priolo S *et al*. Patients' knowledge and experience of adjuvant endocrine therapy for early breast cancer: a European study. *Breast* 2007;**16**:462–468.

18. Virnig BA, Baxter NN, Habermann EB *et al*. A matter of race: early-versus late-stage cancer diagnosis. *Health Aff* 2009;**28**:160–168.
19. Albano JD, Ward E, Jemal A *et al*. Cancer mortality in the United States by education level and race. *J Natl Cancer Inst* 2007;**99**:1384–1394.
20. Schwartz LM, Woloshin S, Black WC *et al*. The role of numeracy in understanding the benefit of screening mammography. *Ann Intern Med* 1997;**127**:966–973.
21. Charlson ME, Pompei P, Ales KL *et al*. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987;**40**:373–383.
22. Degner LF, Sloan JA, Venkatesh P. The control preferences scale. *Can J Nurs Res* 1997;**29**:21–43.
23. Bruera E, Sweeney C, Calder K *et al*. Patient preferences versus physician perceptions of treatment decisions in cancer care. *J Clin Oncol* 2001;**19**:2883–2885.
24. Grunfeld EA, Maher EJ, Browne S *et al*. Advanced breast cancer patients' perceptions of decision making for palliative chemotherapy. *J Clin Oncol* 2006;**24**:1090–1098.
25. O'Neill SC, Brewer NT, Lillie SE *et al*. Women's interest in gene expression analysis for breast cancer recurrence risk. *J Clin Oncol* 2007;**25**:4628–4634.
26. Harris KA. The informational needs of patients with cancer and their families. *Cancer Pract* 1998;**6**:39–47.
27. Yancik R, Wesley MN, Ries LAG *et al*. Effect of age and comorbidity in postmenopausal breast cancer patients aged 55 years and older. *JAMA* 2001;**285**:885–892.
28. Newschaffer CJ, Penberthy L, Desch CE *et al*. The effect of age and comorbidity in the treatment of elderly women with nonmetastatic breast cancer. *Arch Intern Med* 1996;**156**:85–90.
29. Bergman L, Dekker G, van Kerhoff EH *et al*. Influence of age and comorbidity on treatment choice and survival in elderly patients with breast cancer. *Breast Cancer Res Treat* 1991;**18**:189–198.
30. Piccirillo JF, Feinstein AR. Clinical symptoms and comorbidity: significance for the prognostic classification of cancer. *Cancer* 1996;**77**:834–842.
31. Satariano WA, Silliman RA. Comorbidity: implications for research and practice in geriatric oncology. *Crit Rev Oncol Hemat* 2003;**48**:239–248.
32. Morris NS, MacLean CD, Chew LS *et al*. The single item literacy screener: evaluation of a brief instrument to identify limited reading ability. *BMC Fam Pract* 2006;**7**:21.

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