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Educational intervention to improve patient understanding of breast density

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EDUCATIONAL INTERVENTION TO IMPROVE PATIENT UNDERSTANDING OF BREAST DENSITY

by

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ABSTRACT

Breast cancer is the most common cancer among women worldwide and has been a major public health concern for years. The main focus for improving breast cancer related outcomes has been on prevention and early detection. A mammogram, 2-D x-ray of the breasts, is the preferred screening tool for breast cancer. In the U.S., there is some controversy as to when screening mammograms should begin, however, all organizations agree that screening is important for prevention and early detection of breast cancer.

In recent years there has been a question as to how effective mammograms are as a screening tool in women with dense breasts. Normal breast tissue is composed of fibrous, glandular, or adipose tissue. Dense breast is defined as the presence of large areas of fibrous or glandular tissue. The presence of fibrous and glandular tissue makes it more difficult to detect lesions due to lack of contrast. Dense breasts not only make it difficult to detect lesions but it is also in itself a risk factor for developing breast cancer.

Given the difficulty in detecting lesions on mammogram and increased risk factor for breast cancer there has been a nationwide movement amongst advocacy groups to inform women of whether or not they have dense breasts. Many states have enacted legislation requiring that mammogram results include whether or not women have dense breasts. Current research has shown that although women may be more familiar with the term breast density, many are still not entirely show what breast density is and how it

relates to screening mammograms and breast cancer. In this proposed project we will focus on pre- and post-intervention questionnaire results following an educational intervention about breast density. The educational intervention will be a 45-minute lecture dividing into three sections: 1. General information about breast density 2. Breast Density and Breast Cancer 3. Supplemental Screening Recommendations. The 45-minute lecture will then be followed by a 15-minute question-answer period. This study will attempt to address the knowledge gap for women have received dense breast notifications.

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LIST OF ABBREVIATIONS

ACR ..... American College of Radiology

BCSC ..... Breast Cancer Surveillance Consortium

BD ..... Breast Density

BI-RADS ..... Breast Imaging-Reporting and Data System

BMI ..... Body Mass Index

BMC ..... Boston Medical Center

BSE ..... Breast Imaging-Reporting and Data System

CBE ..... Clinical Breast Exam

DBN ..... Dense Breast Notification

DBT ..... Digital Breast Tomosynthesis

DCIS ..... Ductal carcinoma in situ

ER ..... Estrogen Receptor

HER2 ..... Human Epidermal Growth Factor Receptor 2

IDC ..... Invasive Ductal Carcinoma

ILC ..... Invasive Lobular Carcinoma

LCIS ..... Lobular Carcinoma In Situ

MRI ..... Magnetic Resonance Imaging

NCCN ..... National Comprehensive Cancer Network

POMS-SF ..... Profile Of Mood States-Short Form

PR ..... Progesterone Receptor

TPB ..... Theory of Planned Behavior

US .....Ultrasound

USPSTF .....United States Preventive Services Task Force

INTRODUCTION

Background

Breast cancer is the most common cancer in women worldwide and continues to be a major public health concern.[1] The World Health Organization estimates that nearly 2.1 million are impacted each year and in 2018 breast cancer was responsible for an estimated 627,000 deaths.[2] Given its impact on the public, it has been heavily studied and known risk factors include: age, *BRCA1* or *BRCA2* mutation, family history of breast cancer, chest radiation therapy, hormone replacement therapy, lifestyle behaviors, and dense breasts.[2]

The main focus for improving breast cancer related outcomes has been on prevention and early detection. In the 1980s, the United States implemented screening guidelines that women between the ages of 40-74 should receive biennial mammograms, an x-ray of the breast.[3,4] The goal of this was to detect lesions at an earlier stage. The implementation of breast screening has successfully decreased breast cancer related mortality by at least 20 percent.[4] However, in recent years more attention has been placed on the effectiveness of mammograms as a screening tool in women who have dense breasts.

Breasts are composed of 3 types of tissue: fibrous, glandular, and adipose tissue.[5] Adipose tissue appears dark on a mammogram, whereas fibrous and glandular tissue appear white. The three different types of tissue are normal findings on a mammogram. Dense breast is defined as having large areas of fibrous and glandular tissue present on a mammogram. The goal of a radiologist is to identify the lesions on a mammogram as

early as possible, however, when women have dense breast detecting lesions becomes more difficult. This is because fibrous tissue and glandular tissue appear white, similar to most breast cancer lesions.[6] The presence of large areas of dense breast tissue can make it difficult to detect these lesions due to lack of contrast between the lesions and normal fibroglandular tissue. Dense breast tissue not only makes it difficult to detect lesions, but dense breast tissue in itself is an increased risk factor for breast cancer. Although dense breast tissue has been a known risk factor for breast cancer for women, few women are aware of this fact.[7]

Statement of the Problem

Women with extremely dense breast have a four to six time increased risk for breast cancer when compared to women with little or no fibroglandular tissue.[8] Despite being a known risk factor, women are not aware of what dense breasts are nor that it increases the risk of getting breast cancer.[7]

In recent years, breast density has gained significant attention through advocacy groups. The most notable activist was Nancy Capello, who was diagnosed with late stage breast cancer after being told she had a “normal” mammogram. She later discovered that she had dense breasts yet it was never communicated to her nor that its presence increased her risk for breast cancer.[9] Due to growing dissatisfaction with the lack of complete communication about mammogram results, several states across the U.S have enacted dense breast notification (DBN) legislation. DBN legislation requires that a radiologist indicate the presence of dense breasts on a mammogram report.[10] Although now the presence of dense breasts is being communicated to women, there is no

standardized memo for this notification. Despite the lack of a standardized memo for DBN, organizations such as the American College of Radiology have attempted to educate women about breast density by making a brochure to explain the topic.[11] One other important factor to note and inform women about is that the assessment of breast density on mammogram is subjective. Radiologists estimate the amount of dense breast tissue present on mammogram and studies have found that there is a lot of variability among the readers.[12] Techniques for automated breast density assessment have been developed but not in wide use currently.

Many recent studies have found that, despite being told they have dense breasts, some women do not understand what dense breasts are nor do they realize it is a risk factor for breast cancer.[13] The miscommunication and lack of complete explanation has also resulted in increased in anxiety among women.[14]

While many studies have analyzed the aftereffects of DBN legislation, no current study has attempted to implement methods to improve patient understanding. Despite this gap in research, a few studies have laid the groundwork by identifying key factors in improving patient understanding. For example, Gunn et al. conducted a study among women at a safety net hospital who identified they would prefer for their results to be communicated to them verbally using simple language along with visual images.[13]

Hypothesis

Implementing a 1-hour educational intervention for patients will result in increased knowledge and decreased anxiety surrounding their notification of having dense breasts.

Objectives and specific aims

The main purpose of this study is to implement a patient educational intervention to increase patient understanding and comfort after receiving a dense breast notification. Patients from Boston Medical Center will be scheduled to participate in a 1-hour lecture about breast density. This will allow time for patient education and to address any questions the patient may have following completion of the lecture. This study has three specific aims:

- To compare pre- and post-intervention scores of patient knowledge about dense breasts
- To compare pre- and post-intervention scores of patient anxiety about dense breasts
- To assess patient opinions of and suggestions for better educational intervention methods

REVIEW OF THE LITERATURE

Overview

Breast Cancer

Breast cancer is the most common cancer in women worldwide.[15] About 1 in 8 women in the United States will develop breast cancer over the course of their lifetime.[16] Between 2006 and 2015, breast cancer incidence increased by 0.4% per year.[17] In 2019, it is estimated that there were will be 271,270 new cases of breast cancer. Breast cancer is the second most common cause of cancer death in women in the U.S. with about 42,260 estimated deaths expected in 2019. The death rate reached 33.2 per 100,000 in 1989 and has declined by 40% from 1989 to 2016 likely due to screening and better treatment options.[18]

Risk factors for breast cancer can be divided into modifiable and non-modifiable factors. Modifiable risk factors include: weight, exercise, alcohol consumption, smoking, exposure to estrogen, recent oral contraceptive use, stress, and anxiety. Nonmodifiable risk factors include: female gender, older age, family history of breast cancer, personal history of breast cancer, race/ethnicity, radiation therapy to the face or chest, diethylstilbestrol exposure, and increased breast density.[15] Among the numerous risk factors for breast cancer, older age and female gender are the strongest.[17]

Breast cancer can be classified based on its invasiveness into surrounding tissue, as well as into molecular subtypes. Non-invasive breast cancer is a cancer that has not extended into tissue surrounding the lobule or ducts where the cancerous lesion originated.[19] The two types of noninvasive breast cancer are ductal carcinoma in situ

(DCIS) and lobular carcinoma in situ (LCIS). Invasive breast cancer is when atypical cells have spread from the lobules or ducts into surrounding tissue. The different types of invasive cancer are: infiltrating lobular carcinoma (ILC), infiltrating ductal carcinoma (IDC), medullary carcinoma, mucinous carcinoma, and tubular carcinoma.[19] Other rare forms of breast cancer include inflammatory breast cancer and Paget's disease of the breast. Molecular subtypes of breast cancer include: luminal A, luminal B, HER2 over-expression, triple-negative/basal-like, and normal-like (Table 1).[20] The molecular subtypes of breast cancer are based on the genes the cancer expresses which include: ER, PR, HER2, and KI67.[21]

Table 1. Molecular subtypes of Breast Cancer. Adapted from Dai et al.[20]

Molecular subtype	Gene expression	Prevalence
Luminal A	ER+, PR+, HER2-, KI67-	23.7%
Luminal B	ER+, PR+, HER2-, KI67+	38.8%
HER2 over-expression	ER-, PR-, HER2+	11.2%
Triple-negative/Basal-like	ER-, PR-, HER2-, basal marker +	12.3%
Normal-like	ER+, PR+, HER2-, KI67-	7.8%

Treatment options for breast cancer range from local treatment to systemic treatment.[22] Local treatment options include surgery or radiation, whereas systemic treatment options include chemotherapy, hormone therapy, and targeted therapy. Therapy is usually decided with a multidisciplinary team while taking molecular subtype, tumor invasiveness, and patient's desires into consideration.[23] Although there have been

improvements in treatment options and earlier detection, breast cancer still remains one of the top causes of cancer related deaths in women.[16]

Breast Cancer screening

Breast Cancer screening entails evaluating a woman's breasts for malignancy before there are any clinical signs or symptoms of the disease.[24] Methods of breast cancer screening include: clinical breast exam (CBE), breast self-examination (BSE), mammography, tomosynthesis, and magnetic resonance imaging.[25] A CBE is a physical exam done by a trained healthcare provider.[26] The sensitivity of CBE is 88% for lesions greater than 1 cm and between 34-44% for lesions smaller than 1 cm.[25] BSE is when a woman examines her own breast visually and physically for any abnormalities.[27] BSE has an overall sensitivity of 26 percent.[25] Mammography is an x-ray of the breast and is the current recommended screening method by the United States Preventive Services Task Force (USPSTF).[3] Tomosynthesis is a 3-D mammography in which the x-ray tube moves in an arc over the breast tissue. The Oslo Tomosynthesis Screening Trial demonstrated that the sensitivity for detecting lesions improved significantly from 54.1% to 70.5% when tomosynthesis was added as a screening method.[28] MRI uses magnetic fields to produce cross-sectional images of the breast. Prior to capturing the images a contrast dye is injected in the vein to improve the quality and details in the image.[29] The USPSTF and American Cancer Society recommend against teaching BSE.[3,29] The USPSTF states that the current evidence for CBE and MRI is insufficient to assess benefits and harms of these additional screening methods. However, the American

Cancer Society no longer recommends CBE and they have recommended MRI screening for women with a high lifetime risk greater than 20 percent beginning at the age of 30.[29]

Breast cancer screening with mammography became a widespread practice in the U.S. in the 1980s, which has resulted in a steady decrease in breast cancer mortality.[4] Randomized control trials have demonstrated that screening with mammography can decrease mortality by at least twenty percent.[4] Screening guidelines for breast cancer were implemented in the hopes of detecting breast cancer at an earlier stage, which could allow for better treatment options and outcomes. Currently, there is controversary among various organizations as to when screening should begin and the frequency of screening.[30]

The United States Preventive Services Task Force recommends that women between the ages of 50 to 74 years get a screening mammography every two years. For women between the ages of 40 to 49 the guidelines state that the decision to get a screening mammography should be discussed with a healthcare professional. The final decision to get a mammogram should always be an individual one based on the person's preferences and risk factors.[3] The UPSTSF does not recommend women between the ages of 40-49 with below average risk for breast cancer to get mammography. Mammography in this age group can lead to an increased number of false-positive results leading to unnecessary interventions. For example, a provider may biopsy or treat a cancer that would not have otherwise progressed or become apparent in that person's lifetime.[3] It is important to note that these recommendations are for asymptomatic women over the age of 40 who do not have the following risk factors: personal history of breast

cancer, previous history of high-risk breast lesion, *BRCA1* or *BRCA2* gene mutation, or history of chest radiation at a young age.[3]

However, the National Comprehensive Cancer Network (NCCN) recommends that women begin annual screening mammograms at the age of 40 even for women who are at average risk. The difference in screening recommendations among various organizations is due to differing opinions on the importance of the benefit of mammography versus the risks described above.[30] The NCCN's position is that the benefit of mammograms outweighs the risk of recall, breast needle biopsy, or over-diagnosed cancer. Despite controversy on when women should start getting screening mammograms and the frequency, all organizations agree that screening mammograms are important for breast cancer prevention and early detection.

Breast Density Overview

John Wolfe was the first to identify breast density as a risk factor for breast cancer in a retrospective study published in 1976.[31] As previously mentioned dense breasts are considered a moderate risk factor for breast cancer.[32] Data from the Breast Cancer Surveillance Consortium (BCSC) indicates that women between the ages of 50-64 with dense breast have a relative risk (RR) of 1.29 for developing cancer compared to women with average density. Women between the ages of 65 to 74 have a RR of 1.30.[33] The increased risk of for breast cancer due to dense breast is two-fold: breast density inherently increases the risk of breast cancer and it makes it difficult to detect lesions on mammograms, as will be discussed. Breast density is an established risk factor for all breast cancer subtypes, however, the exact mechanism for increased risk is unclear.[25,34]

Normal breasts are composed of 3 types of tissues: glandular epithelium, fibrous connective tissue, and adipose tissue.[5] Breast density is determined by the amount of fibrous and glandular tissue present in the breasts. [35]

Breast density cannot be determined from a physical exam. Rather, a patient's breast density is determined by visual inspection of a mammogram by a radiologist (Figure 1). There are four systems that have been used to classify breast density: Wolfe's grading, Tabar, Breast Imaging Reporting and Data System (BI-RADS), and visual estimation. [10] The most common method used in the U.S is BI-RADS, developed by the American College of Radiology**.** The BI-RADS categories for breast density are labeled with letters a-d, whereas the BI-RADS assessment categories and management recommendations following mammograms are numbered one through six (Table 2). There are four categories of breast composition (Table 3) with the last two categories falling into what is classified as dense breast.[35] When the breasts have differing densities, the breast with the higher density is used to categorize breast density. The most recent edition of BI-RADS no longer has percentage brackets for the four different breast density categories. The committee is awaiting the publication of data using validated percentage quartiles before adding it back into the categories. They are encouraging providers to continue using subjective interpretation as they were trained initially.[35]

Figure 1. Example of categories of breast density on mammogram.[36]

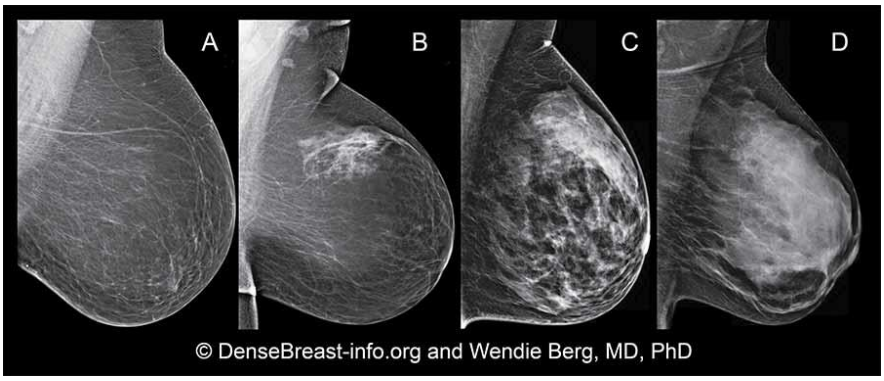

Table 2. BI-RADS Assessment and Management Categories (Adapted from ACR BI-RADS Atlas 2013).[35]

Assessment	Management
Category 0: Incomplete	Recall for additional imaging
Category 1: Negative	Routine mammography screening
Category 2: Benign	Routine mammography screening
Category 3: Probably Benign	6-month follow up or continued surveillance mammography
Category 4: Suspicious	Tissue diagnosis needed
Category 5: Highly suggestive of Malignancy	Tissue diagnosis needed
Category 6: Known Biopsy-Proven Malignancy	Surgical excision required

Table 3. Breast Composition Categories (Adapted from ACR BI-RADS Atlas 2013)[35]

Breast Composition Categories
a. Breasts are almost entirely fatty
b. Scattered areas of fibroglandular density
c. Breasts are heterogeneously dense
d. Breasts are extremely dense

Higher degrees of breast density make it more difficult for a radiologist to detect a lesion because fatty breast tissue appears radiopaque (black) on an x-ray, whereas fibrous or glandular tissue appear radiolucent (white). The increased presence of radiolucent areas make it harder to visualize a lesion, since lesions also typically appear white on a mammogram.

Additionally, when a woman's breast is deemed extremely dense, the sensitivity of a mammogram for detecting lesions is significantly decreased.[35] Prior research has shown that dense breasts decreases the sensitivity of a mammogram from 85.7-88.8% to 62.2-68.1% in women with extremely dense breasts.[31] Breast density also decreases the specificity of mammograms from 93.5% to 88.7% for women between the ages of 40-49.[37] Nearly 50% of women fall into the heterogeneously dense or extremely dense categories.[38]

Breast density itself can be influenced by a variety of factors. It decreases with older age and higher body mass index (BMI) and increases with hormone replacement therapy.[39] A study by the BCSC found that of the estimated 27.6 million women with dense breasts about 45% of the women were between the ages of 40-49.[37] The same study by the BCSC found that only 2 percent of women with a BMI >30 had dense breasts, 40 percent of women with a BMI between 25.0 to 29.9 had dense breasts, and 58 percent of women with a normal BMI had dense breasts.[37] Hormone replacement therapy is an established risk factor for breast cancer, but is still commonly used for the treatment of symptoms in menopause.[40] Greendale et al stated that estrogen use alone for 2 years resulted in a nonsignificant increase in breast density. Combined hormone replacement

with estrogen and progestin resulted in a significant increase of 3-5 percent of breast density compared to the placebo and estrogen only groups.[41]

Dense breast may also have an impact on other prognostic factors for breast cancer survival. Common tumor prognostic factors include estrogen receptor (ER) status, grade, and size.[42] Roubidoux et al sought to investigate the relationship between common tumor prognostic factors and breast density. The researchers recruited 121 women who had negative mammogram results and were later diagnosed with invasive breast cancer. Results showed significant findings for age, tumor size, stage, and ER positivity as it relates to BI-RADS breast density categories a through d (Table 4 and Table 5). The mean age for women decreased as the breast density category increased. The mean size of the tumor detected increased as the breast density category increased. The number of tumors with estrogen receptor positivity decreased as density increased. Higher degree of tumor stage was significantly associated with increased breast density. In conclusion, increasing breast density was significantly associated with younger age, larger tumor size, higher tumor stage, and negative estrogen receptor status, all of which are negative prognostic factors in women who are diagnosed with breast cancer.[42]

Table 4. Tumor Prognostic Factors and Breast Density Category (Adapted from Roubidoux et al.)[42]

Factor	Category a	Category b	Category c	Category d	Overall
Number of patients	15	41	49	16	**121**
Mean age	67.8	63.3	58.9	50.4	**60.1**
Mean Tumor size (mm)	11.3	13.0	14.7	19.7	**14.7**
Estrogen receptor positivity	15	32	37	8	**92**

Table 5. Tumor Stage and Breast Density Category (Adapted from Roubidoux et al)[42]

Tumor stage	Category a	Category b	Category c	Category d
I	10	25	28	5
II	5	16	18	8
III	0	0	3	2
IV	0	0	0	1

Breast Density Notification Legislation

The increased risk of breast cancer and the lower sensitivity of mammograms in women with dense breasts has led to changes in legislation by many states in the U.S.[43] The movement for change was led by Nancy Capello, who was diagnosed with stage IIIC breast cancer 6 weeks after being told she had a normal mammogram.[9] Prior to her cancer diagnosis, she was unaware that she had dense breasts and that it was a risk factor for breast cancer. She was shocked that her healthcare providers were familiar with these

topics yet never disclosed this information to her, so she began advocating for women in Connecticut.

In 2009, Connecticut was the first state to enact a dense breast notification law and there are now 34 states that require some sort of dense breast notification for patients.[44,45] The goal of DBN legislation is to provide patients with direct notification of their mammography findings to increase awareness, which could potentially lead to increased discussions with healthcare providers about breast cancer, dense breasts, and associated risk factors.

In Massachusetts the DBN legislation currently requires the letter to include the following information: 1) that dense breast tissue was found on the mammogram; 2) the degree of density present with an explanation; 3) that dense breast tissue is a common and normal finding but has an associated increased risk of cancer; 4) that the presence of dense breast tissue makes it more difficult to find cancer on a mammogram; 5) the potential need for additional testing or screening which should be discussed with a healthcare provider; 6) that the report of the mammogram has been sent to the referring physician and will become a part of the patient's medical record; and 7) where to find additional information.[46]

Supplemental Screening

The need for supplemental screening has been heavily discussed given the increased risk for breast cancer and decreased sensitivity and specificity of mammograms for women who have been classified as having dense breasts. The supplemental screening options

include: ultrasound (US), digital breast tomosynthesis (DBT), MRI, and molecular breast imaging.[6]

Ultrasound is the most commonly used additional screening method for women with dense breast who have had a negative mammogram. US is able to detect 2-4 cancers per 1000 screens.[6] Some positive aspects of US are that it does not require any radiation and costs are similar to screening mammography. However, many imaging centers do not offer screening with US. This may due to studies showing that screening with US had low specificity and positive predictive values when compared with mammography.[6] One review found that in women with a high risk for developing breast cancer there is not sufficient evidence showing that mammogram with adjunct US was more sensitive than mammogram alone. In fact, using US increased the number of false-positive findings which led to unnecessary breast biopsies.[47]

MRI has been offered to women with an elevated lifetime risk of breast cancer over 20 percent.[29] The sensitivity and specificity of an MRI are 94.3% and 24.4% respectively. MRI is able to detect 14+ cancers per 1000 screens following a mammogram. Despite the high sensitivity for detecting cancer, barriers to use of MRI as an additional screening method include high cost, concern for side effects from contrast injection, and lack of availability. An additional factor limiting MRI use for women with dense breast is the lack of randomized control trials comparing the effectives of MRI and mammography in women with dense breasts.[6]

Tomosynthesis is a 3-dimensional mammography that reconstructs a 3-d image of the breast using multiple thin slices.[29] This method of supplemental screening has

increased sensitivity and specificity for all breast densities. However, tomosynthesis has only been shown to detect 1-2 cancers per 1000 screens following a mammogram.[6] While all three supplemental screening methods have positive features for the detection of breast cancer in women with dense breast, data is still lacking on which method is superior.[6] Given the lack of conclusive evidence for methods of supplemental screening in women with dense breasts there are still no guidelines on how to best guide patients who have been diagnosed with dense breasts.[37] Some researchers suggest that while there are no official guidelines for supplemental screening it should be addressed on a case-by-case basis while taking into consideration additional risk factors besides breast density.[37] This is concerning given that DBN legislation requires that women be informed of additional screening options.

Existing research

Prior to analyzing how DBN legislation has impacted women's knowledge regarding dense breasts, it is important to establish a baseline of knowledge for women who have not received a DBN. Manning et al conducted a study in Michigan in 2013 when at the time only two states, Connecticut and Texas, had mandated reporting.[7] Participants included women who had previously participated in a breast density (BD) imaging study with ultrasound. Researchers mailed 236 surveys and they received 77 responses. Women were asked "Do you know what breast density is?" and responded on a scale from 1 (I have never heard about it) to 5 (I know exactly what it is). They were also asked if they were aware of the density of their own breast and, if they answered yes, they were further prompted to disclose their breast density category. They were asked to

define breast density in their own words. Three experts graded the responses on a scale from 1 (not correct at all) to 4 (quite accurate for a lay person). Finally, women's knowledge of breast density as a risk factor was assessed using an agreement statement. They were asked "Women with more dense breasts are at a greater risk for getting breast cancer" and asked to rate this on a scale from 1 (I strongly disagree) to 5 (I strongly agree). Results indicated that women generally perceived that they knew what breast density was (M= 3.64, SD =1.29). The accuracy of their BD definitions were determined to be neither highly accurate nor highly inaccurate (M=2.42, SD = 0.97). Within the sample, only 33.8% of women responded that they were aware of their own breast density. Women were only slightly aware that breast density was a risk factor for breast cancer (M =3.26, SD=1.19).[7] The results of this study indicate that though women perceive that they know what the definition of dense breast is their definitions are not always accurate. Despite possibly knowing the definition of dense breast about two-thirds of participants were not aware of their own breast density. This is concerning in that knowledge of breast density does not necessarily correlate with personal knowledge of one's own breast density. Given that breast density is an established risk factor for breast cancer, it is important for women to not only be aware of breast density as a topic, but to also be aware of their personal breast density since it can negatively affect their health.

Although this study was conducted in a state that did not require DBN legislation, it is relevant for discussion in that, despite women's perceptions of their own knowledge about dense breasts, many of them lacked thorough knowledge of the topic. The participants did not have the most accurate definitions, were unaware of their own breast

density, and were not aware that dense breasts are a risk factor for cancer. Women who are currently receiving DBNs may have similar outcomes seen in this study in that, though they may be aware of the topic of dense breasts following DBN legislation, their knowledge may not be robust enough to make important decisions surrounding their health. One limitation of this study is that the participant knowledge was assessed using a questionnaire which could have led to a response bias. The order of the questions from BD knowledge to BD as a risk factor could have led more participants to answer correctly that BD is a risk factor than would have been anticipated.

O'Neill et al was one of the first studies that assessed patient awareness of breast density as a risk factor and as a personal risk factor in patients who had received a recent mammogram with benign results. Participants were between the ages of 35-50, English speaking, and with no prior history of cancer or breast abnormality. This study was unique in that it included participants who were younger than the recommended age of screening of 40 in an attempt to include participants who were potentially receiving an early screening exam due to an increased risk of breast cancer. The sample was predominantly of white race (68%, 24% African American, 4% Asian American, 2% Native American/Pacific Islander, 2% identified as more than one race). 93% of the sample identified as non-Latina and only 7% identified as Latina. Results indicated that 62% of the sample (N=213) were aware of breast density as a risk factor. Of the 213 that were aware of breast density as a risk factor and 112 had spoken to a provider about breast density. Patient awareness was highest among white women when compared to all other racial groups collectively (OR = 2.22, $p < .050$), those of older age (OR= 1.07, $p <$

.10), and those with an affected first-degree relative (OR = 4.04, p<.05). One of the limitations of this study is that it did not identify how women were aware of the various questions associated with breast density. One of the hypotheses was that women were likely aware of breast density due to media coverage of DBN legislation in Virginia that aired in Washington D.C., where the study was conducted. However, media coverage does not guarantee that the DBN legislation served its purpose of increasing breast density awareness. Future studies will need to ensure that women have received DBNs as part of their inclusion criteria in order to assess the effectiveness of this new legislation on awareness and knowledge. Another limitation is that the sample was predominantly white, potentially making the study's conclusions less generalizable.

In 2016 a study was performed that focused on the content of dense breast notifications across 24 states and how well patients understood the letter they received about their dense breasts.[48] The researchers used the Flesch-Kincaid grade level (range: -3.4 to no upper bound) and the Dale-Chall readability tests (range: ≤ 4 to ≥16) to assess for the level of reading difficulty in the notification. The level of understanding for the participants in this study was assessed by the Patient Education Materials Assessment Tool (range: 1% to 100%).[48] The results of this study showed that the Flesch-Kincaid readability levels ranged from grades 7 to 19.4 and all DBNs scored low on patient's ability to understand the content.[48] While the recommended reading grade level for DBNs is between 7 and 8, this study found the readability levels were higher than this in many states. The purpose of DBNs was to increase patient awareness and understanding of breast density, but the results of this study indicate that there is still a lack of

receptiveness in the content of DBNs. This study highlights the need for methods to improve patient understanding whether it be modification of DBNs across the U.S. or patient education.

Yeh et al. reported on the impact a DBN could potentially have on women. In this study, the participants' perceived risk, anxiety, and intentions for future screening were assessed before and after receiving a hypothetical DBN.[14] The participants in this study were who were recruited did not necessarily have dense breast thus they received a hypothetical DBN. The participants were asked to rate their perceived lifetime risk of getting breast cancer on a scale from 0 to 100%. The anxiety level among the participants was assessed using the Short Form of the Profile of Mood States (POMS-SF).[14] Data was analyzed using a dependent sample t-test to assess the difference between perceived lifetime risk and intention for future screening prior to and after receiving a DBN. The results indicated that women reported a greater perceived risk after reading a DBN (M=27.82, SE =1.53) than prior to reading a DBN (M= 19.79, SE =1.29), ($p<.001$, $d= 0.67$). The participants also had greater intentions for getting a mammograms after reading a DBN (M= 12.17, SE=.30) than prior to reading a DBN (M =11.35, SE=.35), $t(183)= -3.29$, $p= .001$, $d=0.25$. The study also showed that higher anxiety levels among women resulted in greater perceived risk and stronger intention for additional screening.[14] The results in this study highlight the importance of monitoring anxiety levels in patients who receive DBNs since it mediates the relationship of perceived lifetime risk of breast cancer and intention for additional screening. One limitation of this study is that the women who were included did not necessarily have dense breasts. The impact of actually

having dense breasts may increase the effect of receiving a DBN on anxiety level and intentions for future screening.

Guterbock et al. performed a population survey about dense breasts among women in Virginia. DBN legislation in Virginia went into effect in July 2012, a year prior to the study, and this study's goal was to assess what women knew about dense breasts following enactment of legislation. Patients were assessed using a questionnaire that included questions surrounding: family experience with breast cancer, current breast cancer screening practices, participant's perceived risk for breast cancer, understanding of breast density, understanding of current screening guidelines, willingness to change screen practices, and where to look for other sources for information.[32] The participants were asked to list any risk factors that they were aware of for breast cancer and only 0.8% listed breast density as a risk factor. [32] When specifically asked about their familiarity with breast density, 51.8% of women who had had a mammogram within the year prior to the study stated they were informed by a healthcare provider. Virginia only requires that women with heterogeneously or extremely dense breast be notified of their breast density. 50 percent of woman who receive mammograms fall into these two breast density categories, so the results of this study were as expected for women who receive DBNs.[32] However, among the women who recalled being informed about having dense breasts, only 53% of them were aware of the relationship between dense breasts and breast cancer.[32] The results of this study indicate that DBN legislation seems to be slightly effective since more than half of the women in this study were aware of breast density, similar to the number of women in the U.S. who have dense breasts. However,

awareness of one's own breast density did not necessarily indicate that patients were aware of how breast density affects their personal risk for breast cancer. This highlights the need for further interventions to aid with patient education and understanding beyond awareness of breast density. A limitation of this study was that the researchers did not verify what percentage of participants actually received a DBN. If receiving a DBN would have been taken into consideration, it would allow for better analysis of the relationship between DBNs and patient understanding of breast density. Another weakness is that the survey was conducted in Virginia making the conclusions less generalizable across the U.S especially, since DBNs vary from state to state.

A similar study to the one conducted by Guterbrock et al. was performed in a Massachusetts hospital that serves vulnerable populations. This was a qualitative study to assess patients' perceptions and actual participation in follow-up care, such as discussion with a provider or additional screening, after receiving a DBN. [13] Participants (N=58) were screened for the following criteria: English speaking women between the ages 40-75, who had a mammogram at Boston Medical center, and had received a DBN. Participants were then asked questions about their DBN and their understanding of the content. 81% of the participants recalled receiving the DBN and of this group all recalled that the letter informed them that they had dense breasts. However, the amount of recall in the content of the letter varied among the participants (Table 5).[13] Although all of the participants were able to recall that they have dense breasts, many were unable to remember that it has increased risk for breast cancer and that it can cause masking on mammograms. This is another study that emphasizes the need for further education

beyond just awareness of breast density to include implications for the finding. One useful result of this study was that the participants in this study expressed that they wished the material had been presented to them in clearer language with less clinical jargon and many would have preferred verbal communication of results. The feedback from these participants can be used to tailor a more effective method of giving patients important information. One strength of this study is that the inclusion criteria required that women had received a DBN. This allows for a more accurate analysis of the relationship between DBNs and patient understanding of breast density. A limitation of this study is that it was conducted at a single hospital with a small sample size making the results less generalizable. The women who were included were only English-speaking as well.

Table 6. Recall of notification content. (Adapted from Gunn 2018)[13]

Content	Percent of participants who recalled specific information
Presence of dense breasts	100%
Increase in breast cancer risk	10%
Masking bias	28%
Recommendation to talk to a provider	34%
Possible benefits of additional screening	31%

Manning et al wanted to assess how knowledge about breast density impacted health decision-making. Researchers in this study recruited 67 African Americans and 71 European-Americans and randomly assigned them to one of four groups: no information, only BD information, only imaging modality information, or both BD and imaging

modality information. They used the theory of planned behavior (TPB) to measure the effect of knowledge about breast density and imaging modalities on breast cancer screening decision-making. TPB predicts that knowledge, attitudes, and intentions are useful in the prediction of actual behaviors.[26] The authors predicted that having information about BD and new imaging modalities would increase the women's intention to discuss breast cancer screening with their physician. Researchers used a 2 by 2 full-factorial MANOVA to examine experimental effects. They found that BD information had a significant impact on intentions of having a discussion with a provider about breast cancer screening ($F_{1,130} = 14.04$, $p < .01$, $\eta^2 = .10$).[49] One strength of this study is that it highlighted the importance of patient education in increasing the frequency of positive behaviors. However, the researchers focused on intentions and not actual behaviors, which could possibly show different results in real life situations.

Prior research has shown that about 50% of primary care providers in states with DBNs were aware of breast and density. Casas et al. performed a study on breast health providers in an attempt to address the lack of understanding among providers. Participants were clinicians who educate women about breast health at Boston Medical Center (BMC). Clinicians included were internal medicine providers in primary care, internal medicine residents in primary care, and radiology residents. A total of 14 participants were included in this study In this study, the researchers developed an educational workshop that included a sample DBN and a PowerPoint presentation that covered topics about breast density. The efficacy of the workshop was assessed by surveys prior to the intervention, immediately after the intervention, and 3 months after

the intervention. The survey included questions about demographics, practice behavior, knowledge about breast density, and attitudes of the participants.[50] To assess change in knowledge the participants were given 10 questions and then paired t-tests were used to analyze scores at following the workshop. The results indicated that participants were more knowledgeable about breast density on the postintervention survey (2.00 points, $p<.0001$). At the 3-month follow-up survey, there was no statistically significant change from the postintervention score (0.87 points, $p=.06$). The results of this study demonstrated the effectiveness of the workshop at leading to retention of knowledge surrounding breast density postintervention and at 3 months. One limitations of this study is the small sample size. Another limitation is that retention of information was not analyzed past 3 months. While this study provides information on provider knowledge and comfort after educational interventions, there is lack of research on patient knowledge and comfort after an educational intervention. Given the success of an educational intervention on provider knowledge around breast density, it is important to assess if similar methods could improve patient knowledge.

Prior research has focused on breast density awareness, knowledge, and reactions following DBN legislation. Studies have shown that while women may have heard of dense breast many are still unsure of what it exactly means and its relationship with breast cancer. There have been efforts to improve provider knowledge about breast density, which seems to be promising, however, research is lacking on how to improve patient's knowledge. Current legislation in Massachusetts requires that a DBN encourage women to speak with their provider for any further questions, however, as studies have

shown some providers may still be unfamiliar with this topic. While new research shows promising results for provider education interventions it would be helpful to develop alternative methods to educate patients about breast density.

METHODS

Study design

A pretest-posttest design will be used to evaluate the effect of an educational intervention on patient awareness, knowledge, and emotions in regards to breast density. Participants will attend a 45-minute lecture with educational materials provided about breast density followed by a 15-minute question-answer period. The aim of this study is to improve patient understanding and comfort surrounding the topic of breast density as it relates to breast cancer.

Study population and sampling

Individuals who will be invited for participation in this study are women who have had a routine screening mammogram at BMC and have received a DBN stating that they have either heterogeneous or extremely dense breast. Women will be contacted via phone or email after HIPAA waiver authorization has been obtained. The patients eligible for this study will be English-speaking women between the ages of 40 to 74 with at least a 5th grade reading level who have had a routine screening mammogram at BMC within the last year. The age criteria were made in concordance with the screening recommendations provided by the USPTF, NCCN, and ACR. Exclusion criteria include: 1) women with prior diagnosis of breast cancer and 2) previous or current enrollment in a breast density awareness study.

A sample size of 31 participants is needed to have a power of 80% to detect an effect size of 0.5 standard deviations in the paired t test at an alpha of 0.05.

Intervention

Participants will meet with a moderator in a lecture room. The intervention in this study will be a 1 hour lecture with 45 minutes of teaching followed by a 15 minute question-answer period. The lecture material provided will be in the format of a PowerPoint accompanied by images. The material included will be approved by a knowledgeable breast health provider and a radiologist. The goal of this study is to improve patient understanding about breast density and decrease anxiety after receiving a DBN letter following a screening mammogram.

The lecture material will be divided into the following three sections: 1. General Information about Breast Density; 2. Breast Density; and Breast Cancer 3. Supplemental Screening Recommendations. The subsections included are outlined below.

Topics

1. General information about Breast Density (25 minutes)
    a. Normal Breast Composition
    b. Definition of Dense Breasts
    c. Method of identifying Breast density
    d. Categories of Breast Density
    e. Frequency of Dense Breasts
2. Breast Density and Breast Cancer (10 minutes)
    a. Effect of Breast Density on detecting Breast Cancer
    b. Increased Risk for Breast Cancer
3. Final Recommendations (10 minutes)

a. Tips for discussion with health provider
    i. Personal risk assessment
    ii. Additional Screening options: Tomosynthesis and MRI

Study variables and measures

Participants will complete a pre- and postintervention questionnaire in order to determine the effects of the educational intervention on knowledge of breast density and anxiety level. The preintervention questionnaire will include a question portion about demographics including: age, race, ethnicity, highest education level, income, and family history of breast cancer The pre- and posttest questionnaire will be identical in order to measure the success of the presentation. There will be 10 questions that address breast density knowledge and will cover topics discussed during the 45 minute presentation. There is no validated survey for breast density knowledge so the 10 question assessment was done to mimic a similar study that was conducted by Casas et al.[50] Since there is no validated survey researchers will need to pilot the survey used in this study. This will be done with patients from BMC who meet the same inclusion criteria as the participants in this study. The questions regarding anxiety level of the participants will be included on the same questionnaire and are derived from the validated Short Form of the Profile of Mood States.[28] POMS-SF is a 37 item questionnaire that assesses total mood disturbance based on a 5-point Likert Scale from 0 meaning not at all to 4 meaning extremely. Prior studies have POMS-SF has comparable accuracy of results as when POMS is used with the advantage of POMS-SF taking less time to administer.[51] Surveys will be administered at 3 months and 6 months postintervention to assess for duration of the intervention.

Given that this is a new area of research, there will also be a space provided at the end of the postintervention questionnaire for participants to give feedback on the presentation and an area for suggestions for improvement. The goal of this question is to allow for participant feedback in order to improve patient educational interventions for women with dense breasts.

Recruitment

Recruitment will take approximately 1 week with the knowledge that about 60 women get a mammogram per day at the Belkin Breast Health Center with approximately 50% having dense breast and a 20% response rate. The research assistant will obtain a list of women who have had a screening mammogram at the Belkin Breast Health Center after a HIPAA waiver authorization has been approved. The women will be contacted via phone or email and invited to participate in this study. They will be screened with the following questions in order to determine eligibility: 1. Have you ever been diagnosed with breast cancer?; and 2. Have you ever or are you currently participating in a breast density awareness study? After eligibility has been determined the women will be offered an opportunity to attend a dense breast lecture with a chance to win a $30 Visa gift card. Eligible participants will then be given a date and time to attend the lecture session.

Data collection

Participants will be given a questionnaire in multiple choice format prior to the start of the lecture. Participants will be asked to write the last 5 digits of their phone number on the top of the pre- and post-questionnaire in order to keep the data linked. At the 3 and 6 month marks participants will receive the questionnaires via the same method of delivery

of their DBN. They will also input the 5 digit code on these questionnaires to link them with the prior results. The data will then be transferred from the questionnaire onto a spreadsheet by an undergraduate assistant.

The postintervention questionnaire will be given at the conclusion of the question-answer period. Data will be transferred and stored in the same method described for the preintervention questionnaire. However, the open-ended portion of the postintervention questionnaire for participant feedback will be transferred onto a word document.

Data analysis

At the conclusion of the study, the data acquired will be entered into an excel spreadsheet or word document as appropriate. For the knowledge based portion of the questionnaire, correct answers will be given a score of 1 and an incorrect answer will be given a score of zero. The range for knowledge-based score will be from a minimum of 0 to a maximum of 10. Given a sample size of 31 participants and analysis of a continuous variable, a paired t-test will be used to evaluate the effectiveness of the educational intervention on pre- and post- knowledge scores as well as for pre and post- POMS-SF scores. Total mood disturbance will be determined from the POMS-SF by adding all of the items then subtracting the vigor/activity subscale. The range for total mood disturbance score is -24 to 124 with a more positive score reflecting a higher Total Mood Disturbance.

The short answer portion of the questionnaire will be logged onto a word document and then grouped based on recurring themes. This portion will aid the

researchers in tailoring educational interventions to be more effective in the future. This is an important step given there are no other studies similar to one the being conducted.

Timeline and resources

The project will require the assistance of a primary investigator, a research assistant, an undergraduate student worker, a breast health provider, and a radiologist. The primary investigator will be responsible for developing the lecture material this will likely take a week. The lecture material will then be approved by both a breast health provider and radiologist to ensure accuracy of the data being presented. Following approval of the lecture material a lecturer will need to be hired and trained to present the data in the PowerPoint. It will most likely take a week for the lecturer to become comfortable with the material. The research assistant will be responsible for obtaining a list of potentially eligible women from the Belkin Breast Health Center. Both the research and undergraduate assistant will be responsible for contacting and scheduling eligible participants which will take 8 weeks, as discussed previously.

Researchers will need access to a Boston University School of Medicine or BMC lecture room large enough to hold 31 participants and a lecturer. The lecture room must also have a computer, projector, and screen to display the lecture material. The student worker will collect the surveys and transfer the data to a spreadsheet or word document as appropriate which will be done at the conclusion of each lecture. Data analysis will be completed by the primary investigator and research assistant which will likely take a week. In conclusion, it will take a total of 14 weeks from recruitment to completion of the postintervention data analysis. The study will not officially be complete until the 6 month

survey has been collected. Participants will be given 2 weeks to complete the survey at the 3 month and 6 month mark. Thus, from initial recruitment to data analysis of the 6 month survey a total of about 10 months is needed.

Institutional Review Board

This study protocol will be submitted to The Boston University Medical Center Institutional Review Board for exempt review. The research being conducted in this study is the effectiveness of an instructional technique, which falls under exempt categories defined by the Common Rule in the Code of Federal Regulations Title 45 Part 46. This study offers minimal risk to the subjects that will be included.

CONCLUSION

Discussion

This study has the potential to make a positive impact on women who have been classified as having dense breasts on their mammograms. This study would be one of the firsts attempts to address the knowledge gap of breast density in patients following enactment of DBN legislation. Another strength of this study is that it allows for patient feedback in recognition of the need for modifications in educational interventions that are better suited for patients.

While the study could benefit women, it also has several limitations that should be considered. First, the sample included may not be generalizable. BMC serves a diverse patient population with patients who speak 84 languages, however, the participants in this study will be English speaking only. Another possible limitation is sampling bias. Participants will be selected nonrandomly and offered a $30 Visa gift card as an incentive. Although it would be ideal to have random selection of participants, the exclusion criteria of participation in prior or current breast density awareness makes it necessary for a researcher to contact the participant for screening. Also, the uncertainty of the length of time of recruitment period could negatively impact results. Women who are recruited close to the time of the intervention could have greater understanding of breast density given recent reading of a DBN which would confound results. Another aspect to consider is the method used for assessment of knowledge of breast density. The 10 questions given for knowledge assessment has not been validated in prior studies. Given the study design causal inferences cannot be determined since there was no comparison

group. Depending on the results of this study future studies will need to be conducted to strengthen the reliability of the findings seen here. A potential study would be one where the participants recruited would be divided into intervention and non-intervention groups and then administered the same questionnaires as the present study.

Summary

In 2015, Massachusetts enacted a law that required radiologists to notify women if they had dense breasts on their screening mammogram. This legislation was enacted in an effort to increase awareness among women who may have not have known that they had dense breasts and that dense breasts is a risk factor for breast cancer. Those in favor of this legislation believed that women had the right to know whether they were at an increased risk for breast cancer so that they could have the appropriate conversations with their providers. Opponents of this legislation were concerned that it would cause increased distress among patients, especially considering there were no guidelines in place for additional screening for women who do have dense breasts. Regardless, the legislation has been in place for a few years and current studies have focused on how women are reacting to these notifications.

Current studies demonstrate that, although women may be aware of dense breasts, many do not know what this finding entails in regards to breast cancer. Additionally, lack of complete knowledge about breast density tends to provoke anxiety in women. There has been an effort to improve provider knowledge about breast density, however, no such research exists for patients. Given the current climate surrounding this topic, this study

will attempt to address the knowledge gap for women who have received dense breast notifications.

Public health significance

This study would be one of the first to offer an educational intervention to women who have received a DBN in the state of Massachusetts. It would benefit women by offering an opportunity to learn more about breast density and could help alleviate distress that can be caused by receiving a DBN. This would allow for more productive conversations with healthcare providers drawing attention away from explaining what breast density is and putting the focus on whether or not additional screening is necessary. Although there are no current guidelines for supplemental screening, researchers have encouraged providers to assess the need for additional screening based on a personal risk assessment. Personal risk assessment can be a timely and difficult conversation. It would be helpful to empower women with knowledge regarding breast density so they can make appropriate decisions for their health regarding supplemental screening.

LIST OF JOURNAL ABBREVIATIONS

Am J Cancer Res	The American Journal of Cancer Research
Ann Intern Med	Annals of Internal Medicine
Ann Surg Oncol	Annals of Surgical Oncology
Biol Res	Biological Research
Breast Cancer Res Treat	Breast Cancer Research and Treatment
Cell Biochem Biophys	Cell Biochemistry and Biophysics
Eur Radiol	European Radiology
Genes Dis	Genes and Diseases
JAMA	The Journal of American Medical Association
J Am Coll Radiol	The Journal of the American College of Radiology
J Cancer Educ Off J AM Assoc Cancer Educ	The Journal of the American Association for Cancer Education
J Med Imaging	The Journal of Medical Imaging
JNCI J Natl Cancer Inst	The Journal of the National Cancer Institute
J Natl Compr Canc Netw	The Journal of the National Comprehensive Cancer Network
Med Clin North AM	Medical Clinics of North America
N Engl J Med	The New England Journal of Medicine
Patient Educ Couns	Patient Education and Counseling
Radiol Clin North Am	Radiologic Clinics of North America

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