Pressure Pain Phenotypes in Women Before Breast Cancer Treatment

Grace A. Kanzawa-Lee, BSN, RN, Steven E. Harte, PhD, Celia M. Bridges, BA, BSN, RN, Chad Brummett, MD, Daniel J. Clauw, MD, David A. Williams, PhD, Robert Knoerl, PhD, RN, and Ellen M. Lavoie Smith, PhD, APRN, AOCN®, FAAN

OBJECTIVES: To explore associations between quantitative sensory testing (QST) and pretreatment pain, physical, and psychological characteristics in women with breast cancer.

SAMPLE & SETTING: 41 women with treatment-naive stage 0–III breast cancer at the University of Michigan Comprehensive Cancer Center in Ann Arbor.

METHODS & VARIABLES: Participants completed self-report surveys and QST within the month before breast surgery. Pressure pain thresholds (PPTs) were measured bilaterally at each trapezius with a manual QST algometer. PPT values were split, yielding low, moderate, and high pain sensitivity subgroups. Subgroup self-reported characteristics were compared using Spearman's correlation, chi-square, and one-way analysis of variance.

RESULTS: Lower PPT (higher sensitivity) was associated with higher levels of pain interference and maladaptive pain cognitions. The high-sensitivity group reported higher pain severities, interference, and catastrophizing and lower belief in internal locus of pain control than the low-sensitivity group.

IMPLICATIONS FOR NURSING: Individualized interventions for maladaptive pain cognitions before surgery may reduce pain sensitivity and the severity of chronic pain developed after surgery.

KEYWORDS pain; pressure pain sensitivity; breast; cancer; quantitative sensory testing

***ONF, 45*(4), 483–495.**

DOI 10.1188/18.ONF.483-495

About 25% of women diagnosed with invasive breast cancer experience cancer treatment–related chronic neuropathic pain (Andersen, Duriaud, Jensen, Kroman, & Kehlet, 2015; Belfer et al., 2013; Bruce et al., 2014). Chronic neuropathic pain is often poorly managed, in part because of the complexity of its assessment. Challenges in assessment include the following (Baron, 2009):

- Its presentation varies despite identical underlying mechanisms.
- It may be widespread or referred to body sites unrelated to the area of primary nerve injury, making pain location a poor indicator of true injury site.
- It can be difficult to differentiate from other acute neuropathic or nociceptive pain conditions.

Improper assessment may result in inappropriate, ineffective, and costly treatment or in analgesic or psychotropic abuse, which negatively affect the patient (Chiu et al., 2014; Macdonald, Bruce, Scott, Smith, & Chambers, 2005; Tevaarwerk et al., 2013).

Because current treatments for cancer-related chronic neuropathic pain (e.g., antidepressants, anticonvulsants) are inconsistently effective (Greco et al., 2014; Phimolsarnti & Waikakul, 2015), National Comprehensive Care Network (2018) guidelines recommend individualized and comprehensive treatment for chronic neuropathic pain. Individualization may be based on disease characteristics, genotype, symptom clusters, comorbidities, biopsychosocial and demographic risk factors, and/or pain profiles (Ahmedzai, 2013; Cherkin et al., 2016). Experimental pain testing, or quantitative sensory testing (QST), has been used to determine pain profiles in patients with chronic pain (Cardoso et al., 2016; Coronado, Bialosky, Robinson, & George, 2014; Frey-Law, 2016; Vaegter & Graven-Nielsen, 2016) and to titrate individualized interventions for women with breast cancer (Axelsson, Ballegaard, Karpatschof, & Schousen, 2014). However, research

that focuses on identifying high-risk patients with cancer before surgery and intervening early to reduce development of chronic neuropathic pain after cancer treatment is lacking. In addition, few studies have investigated QST approaches for identifying pain sensitivity profiles before treatment in patients with cancer.

The purpose of this cross-sectional study was to explore self-reported pain and physical and psychological characteristics of QST-determined pain sensitivity subgroups in a pretreatment cohort of women with stage 0–III breast cancer. The aims were as follows:

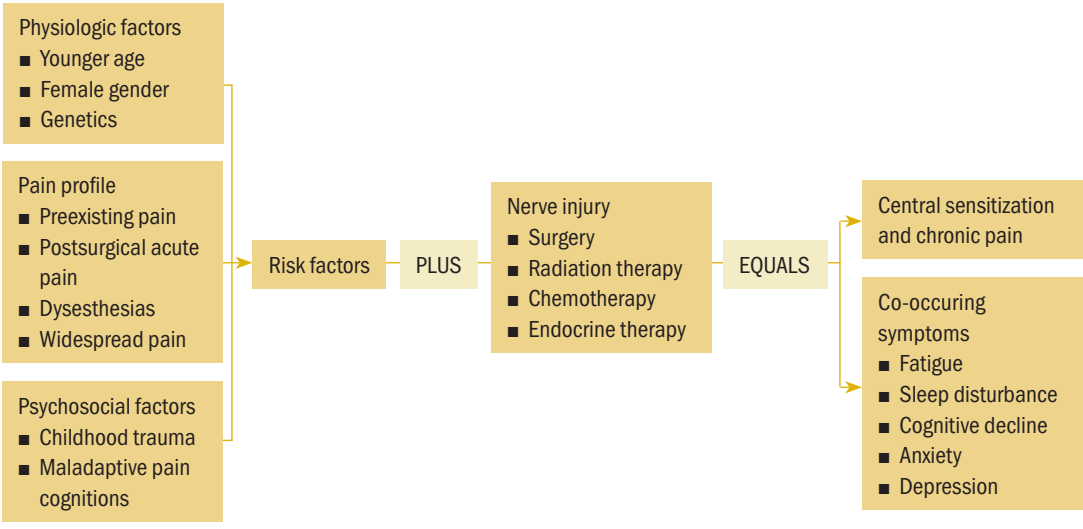
- To describe evoked pain sensitivity and self-reported pain severity and interference, anxiety, fatigue, sleep–wake disturbance, cognitive difficulty, pain catastrophizing, beliefs in pain control, and childhood trauma within the cohort
- To explore and compare self-reported variables in and across QST-determined pain sensitivity subgroups

Conceptual Framework

The aims were guided by a conceptual framework (see Figure 1), an evidence-based adaptation of the Theory of Unpleasant Symptoms (Lenz, Pugh, Milligan, Gift, & Suppe, 1997). This framework proposes that physiologic, psychological, and situational factors influence the symptom experience (symptom intensity, quality, distress, timing). The framework also suggests that co-occurring symptoms interact, potentially contributing to heightened pain sensitivity through shared central nervous system pathways.

Among patients with cancer, symptoms known to correlate with or predict chronic pain include sleep disturbance, fatigue, depression, and anxiety (Miaskowski et al., 2014). Physiologic factors, such as younger age, female gender, and genetics, also correlate with or predict chronic pain (Andersen et al., 2015; Fernández-de-las-Peñas et al., 2012; Gärtner et al., 2009; Langford et al., 2015; Wang et al., 2016). Psychosocial factors influencing chronic pain severity may include childhood trauma (Häuser, Kosseva, Üceyler, Klose, & Sommer, 2011; Jones, Power, & Macfarlane, 2009; Yeung, Davis, & Ciaramitaro, 2016) and maladaptive pain cognitions (Edwards et al., 2013; Higgins, Bailey, LaChapelle, Harman, & Hadjistavropoulos, 2015). Childhood trauma linked with chronic pain refers primarily to experiences of physical abuse, sexual abuse, and neglect prior to age 17 years. Maladaptive pain cognitions may include pain catastrophizing (hypernegative pain outlook) and unempowered belief in loci of pain control (belief that external factors or chance, rather than oneself, control one's pain). Chronic pain severity is also associated with dysesthesias (hyperalgesia/

FIGURE 1. Conceptual Framework of Risk Factors for the Development of Chronic Pain After Breast Cancer Treatment



Note. These major evidence-based risk factors can interact with an injurious procedure or agent, such as those used for breast cancer treatment, and cause sensitization of central and peripheral nerves, leading to more severe chronic pain.
Note. Based on information from Lenz et al., 1997.

pain hypersensitivity, allodynia, and hypoesthesia) and pre- and immediately postsurgical pain intensity, neuropathic quality, and widespread distribution (Boogaard et al., 2015; Schou Bredal, Smeby, Ottesen, Warncke, & Schlichting, 2014; Wang et al., 2016). Surgical factors (e.g., axillary lymph node dissection) and other adjuvant cancer treatments may also predict chronic pain severity (Andersen et al., 2015; De Oliveira et al., 2014; Schou Bredal et al., 2014; Wang et al., 2016). Because of the pilot nature and limited power of the current study, some potential influencing factors (e.g., genetic markers) were not evaluated.

Methods

The study was approved by the University of Michigan Institutional Review Board, and all participants provided written informed consent. A nurse coordinator identified eligible patients after breast cancer tumor board case discussions. Those deemed eligible were approached at their initial surgical consultation. Research staff explained the study and obtained written informed consent if the patient wished to participate. Within the month prior to surgery, patients completed QST and questionnaires at the Michigan Medicine Chronic Pain and Fatigue Research Center in Ann Arbor. Research assistants collected cancer treatment information from the medical record.

Sample and Setting

A convenience sample of 41 women with breast cancer from the University of Michigan Comprehensive Cancer Center in Ann Arbor completed the full set of assessments. Patients were eligible if they were women aged 25 years or older who were newly diagnosed with stage 0–III breast cancer, scheduled for breast cancer surgery, and able to read and speak English. Main exclusion criteria were planned neoadjuvant chemotherapy; preexisting carpal/tarsal tunnel syndrome, diabetic neuropathy, or arthritis affecting the hands and/or feet; or psychiatric illness that might interfere with the individual's ability to participate fully.

Measures

A manual pressure algometer was used to measure pressure pain threshold (PPT), but the remaining measures in the current study were done using validated paper-and-pencil self-report questionnaires. A standardized self-report form was used to collect demographic information and analgesic and psychotropic medications taken within 24 hours before the study examinations. Cancer stage and treatment data were obtained from the electronic health record.

Pain sensitivity: Obtained via standard QST techniques, PPT indicates pressure pain sensitivity. A manual pressure algometer was applied with increasing pressure to the patient's trapezius at a rate of 0.5 kg/cm^2 per second to a maximum pressure of 10 kg/cm^2. Participants were instructed to indicate verbally when the sensation of pressure became painful. The pressure intensity at the moment of first pain sensation was recorded as the PPT. Each trapezius was tested three times with 20 seconds between each trial; all six trials were averaged for analysis. A higher PPT indicates lower pain sensitivity, and a lower PPT indicates higher pain sensitivity.

Pain severity: The 15-item Brief Pain Inventory-Short Form (BPI-SF) quantifies overall pain severity and interference on a scale of 0 (no pain, does not interfere) to 10 (pain as bad as you can imagine, completely interferes). Pain severity is the average of patients' ratings of their pain at its least, worst, average, and right now. Pain interference is an average of seven items asking how much, in the past 24 hours, pain has interfered with mood, enjoyment of life, and five daily activities. The BPI-SF has demonstrated strong internal consistency (alpha = 0.8–0.92), stability (test-retest reliability range = 0.78–0.98), and validity in cancer populations (Cleeland, 2009; Ham, Kang, Teng, Lee, & Im, 2015). Evidence supports face, expert content, construct (factor analysis), and criterion-related validity.

Chronic widespread pain: The Michigan Body Map (MBM) measures the number of sites on a patient's body at which pain has persisted for at least three months. It is an outline of a person in the anatomical position, labeled with check boxes at 35 body sites and a "no pain" check box. The MBM has demonstrated internal consistency (alpha = 0.91) and construct (test-retest reliability = 85%–100%) and discriminant validity (face validity established) for various populations (Brummett et al., 2016; Wolfe, 2003).

Neuropathic pain: The 12-item PainDETECT questionnaire (range = –1 to 38) assesses the severity, patterns, and neuropathic qualities (e.g., numbness, tingling, burning, radiating) of any painful sites indicated by the patient. A score of 12 or less indicates likely nociceptive pain, and a score of 19 or greater indicates likely neuropathic pain (Freynhagen, Baron, Gockel, & Tölle, 2006). Scores of 13–18 indicate ambiguity. Evidence supports the construct validity and stability of this questionnaire. Sensitivity values range from 53%–85%, and specificity ranges from 77%–80% (Jones & Backonja, 2013).

Co-occurring symptoms: The Patient-Reported Outcomes Measurement Information System

(PROMIS) short forms measure symptoms of fatigue (seven items), sleep disturbance (eight items), and sleep-related impairment (eight items). Each PROMIS item is rated from 1 (never/not at all) to 5 (always/very much); item ratings are summed to give raw scores ranging from 7–35 for fatigue and 8–40 for sleep disturbance and sleep-related impairment. The scores are transformed linearly to t scores for analysis. The 16-item Multiple Ability Self-Report Questionnaire (MASQ) measures cognitive difficulty; MASQ item scores are summed, yielding five subscales: visual perceptual ability (range = 6–30), language (range = 8–40), verbal memory (range = 8–40), visual–spatial memory (range = 8–40), and attention concentration (range = 8–40). The 10-item State Trait Anxiety Inventory Y-2Ax (STAI Y-2Ax) responses range from 1 (almost never) to 4 (almost always), and the total score ranges from 10–40. For all these measures, higher scores indicate worse symptoms. Abundant evidence supports the validity and reliability of the PROMIS instruments (supported by literature, expert, and patient review) (Cella et al., 2010; Fries, Bruce, & Cella, 2005), MASQ (Cronbach alpha = 0.92–0.93, test-retest reliability = 0.71) (Seidenberg, Haltiner, Taylor, Hermann, & Wyler, 1994; Williams & Arnold, 2011), and STAI Y-2Ax (Cronbach alpha = 0.79–0.94, test-rest reliability = 0.62–0.84) (Spielberger, 1983; Stanley, Beck, & Zebb, 1996).

Maladaptive pain cognitions: The 13-item Pain Catastrophizing Scale (PCS) measures various cognitions regarding the experience of pain. Items are rated from 0 (not at all) to 4 (all the time). The summed score ranges from 0–52, and it has three subscales: rumination (range = 0–16), magnification (range = 0–12), and helplessness (range = 0–24). Higher scores indicate greater pain catastrophizing (Lamé, Peters, Kessels, Van Kleef, & Patijn, 2008; Osman et al., 2000; Sullivan, Bishop, & Pivik, 1995). Studies have demonstrated sufficient validity and reliability of the PCS (Cronbach alpha = 0.75–0.95) (Osman et al., 2000; Sullivan et al., 1995; Van Damme, Crombez, Bijttebier, Goubert, & Van Houdenhove, 2002).

The Beliefs in Pain Control Questionnaire (BPCQ) measures how much participants agree that pain is controlled by one's own actions, external medical treatment, and chance happenings. Select items are summed to create three subscales: beliefs in internal locus of pain control (five items, range = 5–30), beliefs in external locus of pain control from powerful doctors (four items, range = 4–24), and beliefs in external locus of pain control from chance happenings (four items, range = 4–24). Higher scores indicate stronger beliefs in the locus of pain control being measured (Skevington, 1990). Studies have demonstrated sufficient validity (supported by factor analysis) and reliability (Cronbach alpha = 0.56–0.82, test-retest reliability = 0.56) of the BPCQ (Czerw, Religioni, Deptała, & Fronczak, 2016; Skevington, 1990).

Childhood trauma: The six-item Childhood Traumatic Events Scale (CTES) (Pennebaker & Susman, 1988) measures trauma experienced before age 17 years because of the death of a family member or friend, parental upheaval, illness, violence, sexual abuse, and other self-reported types of trauma. Participants were asked to rate how traumatic each event was on a scale from 1 (not at all traumatic) to 7 (extremely traumatic) and to what degree they confided in others on a scale from 1 (not at all) to 7 (a great deal). Based on their responses, trauma experience was coded as 0 (no trauma), 1 (trauma with confiding), or 2 (trauma without confiding). The validity of the CTES has been supported by psychosocial experimentation (Pennebaker & Susman, 1988) and is widely used in current research. Convergent validity of the CTES has been supported in comparison with cortisol levels (Butler, Klaus, Edwards, & Pennington, 2017; Cărnuţă, Crişan, Vulturar, Opre, & Miu, 2015) and self-reported chronic pain (Nicol et al., 2016), emotional regulation, psychological distress, anxiety, poorer mood, and symptom burden (Lai, Morgan, Vetter, & Andriole, 2016). Each item has demonstrated a content validity index of 0.75 or greater based on unpublished reviews from four experts (two nursing PhDs, a pain and health psychologist with experience using the CTES, and a pain clinic social worker). Established content validity evaluation methods were used (Lynn, 1986).

Statistical Analysis

No power analysis was conducted for this pilot study. Pain sensitivity subgroups were formed via a tertile split of PPT values, yielding high (lowest PPT; n = 14), moderate (n = 13), and low (highest PPT; n = 14) pain sensitivity tertiles. The authors used descriptive statistics to characterize the sample and Spearman's rho bivariate correlations to examine the relationships between PPTs and self-reported pain and symptom severities. Clinical variables and self-reported pain, physical, and psychological characteristics were further compared across PPT tertiles by one-way analysis of variance with Tukey's Honest Significant Difference post-hoc tests, Pearson's chi-squared test, and independent t tests. A two-sided p value of 0.05 or less was considered significant. All data analyses were conducted using IBM SPSS Statistics, version 22.0.

TABLE 1. Sample Characteristics by PS Subgroup

Characteristic	High PS (N = 14) n	Moderate PS (N = 13) n	Low PS (N = 14) n	p
Marital status				0.318
Married	7	8	10	
Separated or divorced	3	2	–	
Other	4	3	4	
Education				0.461
Associate's degree or less	6	6	5	
Bachelor's degree or higher	8	7	9	
Race				0.536
Caucasian	12	12	13	
African American	1	–	1	
Other	1	1	–	
Breast cancer stage				0.65
0	1	–	–	
I	7	5	9	
II	5	8	4	
III	1	–	1	
Childhood trauma				0.581
No trauma	6	5	7	
Trauma without confiding	8	8	5	
Death of close friend or family				0.483
No trauma	12	12	9	
Trauma without confiding	1	2	3	
Parental upheaval				0.645
No trauma	10	11	10	
Trauma without confiding	4	2	2	
Sexual abuse				0.362
No trauma	11	12	12	
Trauma without confiding	2	1	–	
Victim of violence				0.78
No trauma	11	12	11	
Trauma without confiding	2	1	1	
Extreme illness or injury				0.535
No trauma	13	11	11	
Trauma with confiding	–	1	–	
Trauma without confiding	–	1	1	
Other trauma				0.161
No trauma	8	9	10	
Trauma with confiding	–	2	1	
Trauma without confiding	6	2	1	

PS—pain sensitivity
Note. Some data are missing because not all participants responded to all questions.

Results

Sample Characteristics

Forty-four participants completed assessments, but 41 participants provided near-complete PPT and survey data and were used as the study sample (see Table 1). Participants were aged 56 years (SD = 11.3, range = 31–82) on average for the total group. Participants were aged an average of 60.1 years (SD = 10.2, range =

TABLE 2. Pain Characteristics by PS Subgroup

	High PS (N = 14)			Moderate PS (N = 13)			Low PS (N = 14)				
Characteristic	$\bar{X}$	**SD**	**Range**	$\bar{X}$	**SD**	**Range**	$\bar{X}$	**SD**	**Range**	**F**	**p**
QST											
PPT (kg/cm^2)[a, b, c]	1.78	0.37	1.1–2.2	2.84	0.56	2.2–3.3	5.41	1.68	3.7–7.98	52.545	0.00
Self-reported items											
Pain severity[a, b]	2.61	2.73	0–8.5	0.63	0.89	0–2	0.63	0.89	0–3	7.006	0.003
Pain interference[a, b]	2.74	2.82	0–8.14	0.39	0.6	0–1.71	0.22	0.49	0–1.71	9.32	0.001
Neuropathic pain severity[a, b]	10.71	11.19	0–32	4.57	4.64	0–15	3.5	4.7	0–16	3.768	0.032
Widespread pain	6	6.07	–	3.89	3.82	–	2.7	2.95	–	1.412	0.261
Anxiety	22.08	4.57	–	22	1.52	–	20.79	1.72	–	0.861	0.431
Fatigue	49.66	9.01	–	52.66	7.61	–	46.16	8.04	–	2.259	0.127
Sleep disturbance	52.19	8.19	–	52.79	14.81	–	49.28	7.91	–	0.701	0.657
Wake disturbance	16.79	9.85	–	19.14	7.75	–	14.36	4.8	–	1.335	0.275
Cognitive difficulty											
Language	14	3.44	–	13.43	3.48	–	13	2.83	–	0.331	0.72
Visual perceptual ability	11.79	3.24	–	11.43	4.7	–	9.64	2.47	–	1.431	0.251
Verbal memory	16	4.74	–	17	3.14	–	16	5.26	–	0.233	0.793
Visual–spatial memory	14.5	4.03	–	14.86	3.08	–	14.07	4.67	–	0.137	0.873
Attention concentration	15.64	3.59	–	15.79	3.66	–	15.36	4.48	–	0.043	0.953
Maladaptive pain cognitions											
Pain catastrophizing[a, b]	14.21	10.77	–	6.14	5.96	–	6.14	6.1	–	4.832	0.013
Helplessness[a, b]	5.71	5.48	–	2.21	2.04	–	1.93	2.43	–	4.647	0.015
Magnification	2.71	1.64	–	1.29	1.94	–	1.79	1.48	–	2.56	0.09
Rumination	5.79	4.93	–	2.64	3.3	–	2.43	2.98	–	3.366	0.045
Beliefs in pain control											
Internal[a, b]	14.29	4.05	–	17.93	4.94	–	18.14	2.63	–	4.141	0.023
External	10.57	3.69	–	8.93	2.46	–	8.29	3.17	–	1.959	0.155
Powerful doctors	11.43	3.76	–	10.36	3.08	–	10.5	4.5	–	0.324	0.725

[a] Significant difference between the high and low PS subgroups
[b] Significant difference between the high and moderate PS subgroups
[c] Significant difference between the moderate and low PS subgroups
PPT—pressure pain threshold; PS—pain sensitivity; QST—quantitative sensory testing
Note. The instrument score ranges are defined as follows: PPT (0–10); pain severity (0–10), pain interference (0–10), neuropathic pain severity (–1 to 38), widespread pain (0–35), anxiety (10–40), fatigue (7–35), and sleep–wake disturbance (8–40); cognitive difficulty language (8–40), visual perceptual ability (6–30), verbal memory (8–40), visual–spatial memory (8–40), and attention concentration (8–40) subscales; pain catastrophizing helplessness (0–24), magnification (0–12), and rumination (0–16) subscales; and beliefs in pain control internal (5–30), external (4–24), and powerful doctors (4–24) subscales. Higher PPT indicates lower pressure pain sensitivity. Higher self-reported item scores indicate worse symptoms (more painful sites for the widespread pain variable). Higher cognitive difficulty, pain catastrophizing, and beliefs in pain control scores indicate higher perceived cognitive difficulty, pain catastrophizing, and beliefs in the indicated locus of control, respectively.

47–82) in the high pain sensitivity subgroup, 53.9 years (SD = 11, range = 36–71) in the moderate pain sensitivity subgroup, and 53.8 years (SD = 12.5, range = 31–67) in the low pain sensitivity subgroup ($F = 1.713$, $p = 0.243$). Most had stage I or II breast cancer, were married and Caucasian, and held at least a bachelor's degree. No demographic or clinical differences were found among the three pain sensitivity groups.

Pain and Symptom Profiles

The descriptive statistics (i.e., mean, SD, and range) in Table 2 illustrate the pain and symptom profiles for the entire sample and by pain sensitivity subgroup. Mean PPTs (pain sensitivity) ranged from 1.78–5.41 kg/cm^2, (SD = 0.37–1.68). Across all subgroups, the mean pain severity and interference scores were 2.74 or less (SD = 2.82) on a scale from 0–10; mean neuropathic pain severity was 10.71 or less (SD = 11.19) on a scale from –1 to 38.

The high-sensitivity group reported significantly higher pain severity ($p \leq 0.01$), interference ($p \leq 0.002$), and catastrophizing ($p = 0.027$) (specifically, feelings of helplessness [$p \leq 0.04$]) than the low- and moderate-sensitivity subgroups. In addition, the high-sensitivity group reported lower belief in internal locus of pain control than the other two groups ($p \leq 0.052$). Compared to the low-sensitivity group alone, the high-sensitivity group reported higher neuropathic pain severity ($p = 0.039$) and a trend toward higher levels of pain rumination ($p = 0.065$).

Relationships Among Quantitative Sensory Testing and Self-Reported Symptoms

PPT showed moderate negative correlations with self-reported pain interference ($r = –0.417$, $p = 0.007$), belief in external locus of pain control ($r = –0.329$, $p = 0.033$), overall pain catastrophizing ($r = –0.471$, $p = 0.002$), and the three pain catastrophizing subscales of rumination ($r = –0.402$, $p = 0.008$), magnification ($r = –0.345$, $p = 0.025$), and helplessness ($r = –0.403$, $p = 0.008$). Moderate positive correlations were found between PPT and belief in internal locus of pain control ($r = 0.461$, $p = 0.002$). Although nonsignificant, negative correlations were found between PPT and pain severity ($r = –0.287$, $p = 0.066$), neuropathic pain severity ($r = –0.276$, $p = 0.077$), and the number of painful body sites ($r = –0.31$, $p = 0.096$).

Discussion

Based on QST and self-reported variables, this pilot study characterized pretreatment pain and co-occurring symptoms among women with breast cancer. The authors found distinct pretreatment pain, symptom, and pain cognition profiles among the three QST-identified pain sensitivity subgroups. Two key findings emerged:

- Prior to breast cancer surgery, women demonstrated a wide range of evoked pain sensitivity but generally reported low pain severity.
- Lower PPT was associated with increased pain severity, interference, catastrophizing, neuropathic pain, and belief in external locus of pain control, but with lower belief in internal locus of pain control.

These findings partially align with the current conceptual framework and the literature on factors associated with chronic pain. Specifically, the findings support the conceptual framework's links between pain sensitivity and self-reported pain severity and self-reported maladaptive pain cognitions in women before breast cancer treatment. These associations have also been reported among individuals who are post–cancer treatment or who have other types of chronic pain (Belfer et al., 2013; Cardoso et al., 2016; Edwards et al., 2013; Miaskowski et al., 2014; Poulin et al., 2016; Terry, Moeschler, Hoelzer, & Hooten, 2016; Walton et al., 2017). Therefore, the current study contributes to the literature by identifying these associations among individuals prior to cancer treatment.

Contrary to published literature, this study did not find associations between pain sensitivity and age, race, cancer stage, anxiety, fatigue, sleep–wake disturbance, cognitive difficulty, childhood trauma experience, or widespread pain (El Tumi, Johnson, Dantas, Maynard, & Tashani, 2017; Tesarz, Eich, Treede, & Gerhardt, 2016; Vaegter & Graven-Nielsen, 2016). The evidence of associations between pain sensitivity and age, socioeconomic factors, and neuropathic pain presence and severity has been inconsistent and is inconclusive (El Tumi et al., 2017; Martinez et al., 2015; Vaegter & Graven-Nielsen, 2016; Vollert et al., 2016). Although evidence suggests that many symptoms share common central nervous system–mediated pathways and contribute to processes that increase pain sensitivity (Burnstock, 2015; Campbell et al., 2015; Clauw & Chrousos, 1997; Goesling, Clauw, & Hassett, 2013), the current study may have been unable to detect symptom associations found in prior studies because of the small sample size or low symptom severities in the presurgical sample. The inconsistent results in the literature, including in the current study, may also be because of differences in pain mechanisms in individuals with different pain sensitivities. For example, women who display high pain sensitivity prior to treatment may already have altered pain processing

mechanisms and more comorbid symptoms that predispose them to developing worse chronic pain after breast cancer treatment.

Maladaptive pain cognitions (e.g., locus of control, catastrophizing) may increase the complexity of pain relationships by influencing the development and/or perception of pain severity and sensitivity and by interacting centrally with other symptoms, such as anxiety and fatigue (Campbell et al., 2015; Kjøgx et al., 2016; Yeung et al., 2016). Belief in pain control is an important factor associated with an individual's cognitive processing and report of pain, coping, help-seeking behavior, compliance to pain treatment, and expectations and perceptions of treatment efficacy (Ang et al., 2010; Higgins et al., 2015; Oliveira et al., 2009; Shen, Redd, Winkel, & Badr, 2014). Pain catastrophizing has also been shown to predict chronic pain severity and interference in individuals with lung cancer (Dalton, Higgins, Miller, Keefe, & Khuri, 2015) and may mediate the relationship between chronic pain and evoked pain sensitivity after breast cancer surgery (Edwards et al., 2013). Because of the complex nature of pain and pain sensitivity, individualized interventions that target maladaptive pain cognition may be required for optimal pain management.

Some studies in other chronic pain populations support the individualization of pain treatment based on QST indicators of abnormal pain-processing mechanisms (Rabey, Slater, O'Sullivan, Beales, & Smith, 2015; Vollert et al., 2016). Other literature suggests tailoring interventions based on genotype, self-reported symptom clusters, comorbidities, and pain severity and catastrophizing (Ahmedzai, 2013; Cherkin et al., 2016; Hill et al., 2011). However, research is needed in understudied (e.g., cancer) populations to evaluate QST-based pain interventions and QST predictors of response to pain interventions.

The current study supports the utility of a simple, brief algometry QST method to identify women with high pain sensitivity. Although the expensive, complex, and time-consuming procedures of other QST methods limit their use in research and clinical practice, QST has the potential to aid in identifying women who may benefit from additional tailored educational materials, motivational interviewing, and/or cognitive behavioral therapies to address maladaptive pain cognitions. However, further testing is needed to evaluate the impact of QST-based pretreatment interventions on chronic pain outcomes after cancer treatment.

Limitations

This article presents exploratory results intended to generate hypotheses for further study in larger samples; therefore, none of the findings are conclusive. This pilot study may not have been powered to detect some factors associated with pain sensitivity and, because of its exploratory nature, some of the findings may have been because of chance or biased by missing data. Participants completed several questionnaires and could have experienced respondent fatigue, leading to missing or less accurate data. Some variables that may be relevant were not evaluated; data on preexisting chronic pain conditions were not collected, and depression was not evaluated because of missing data.

The low self-reported pain and symptom severities may have limited the ability to detect significant associations. Because no current evidence-based cutoff point identifies individuals with high versus low pain sensitivity, the authors created the subgroups by categorizing participants based on high, middle, and low PPT tertiles. Cluster analysis techniques may have been more informative, but the authors were not powered for this. In addition, convenience sampling techniques were used, and the sample was composed primarily of well-educated Caucasian women drawn from patients at one comprehensive cancer center; therefore, the results may only be generalizable to patients in university communities within the United States.

Other extraneous variables, including genetics and medications, could have influenced the results. Specifically, the authors did not evaluate other factors that correlate with pain sensitivity and chronic pain in non-cancer populations, including BMI, sex hormones, inflammatory markers, and psychosocial factors (Attal et al., 2009; Axelsson et al., 2014; Campbell et al., 2016; Fernández-Lao et al., 2012; Sutton, Pukall, & Chamberlain, 2009; Velasco et al., 2015; Walton et al., 2017). Further research is needed in diverse patient populations before and after cancer treatment to explore predictors of pain.

KNOWLEDGE TRANSLATION

- Individuals with higher pain sensitivity may have greater pain severity and interference and more maladaptive pain cognitions.
- Some individuals may exhibit heightened pain sensitivity before cancer treatment but report low pain levels.
- Quantitative sensory testing for pressure pain thresholds may aid in identifying high-risk individuals who could benefit from interventions, such as pain-coping skills training, before and during treatment to reduce chronic pain development after cancer treatment.

Implications for Nursing

Because pain is typically addressed only after it has developed, nurses usually do not assess pretreatment risk factors that predispose women to chronic pain after breast cancer treatment. In addition, the current practice of prescribing treatment according to pain symptoms has often led to ineffective management and costly analgesic abuse ("Relieving Pain in America," 2016). Even when pain manifests with similar symptomology, the underlying mechanism of pain may differ among patients. Therefore, developing a comprehensive pain and symptom profile for each patient is essential to tailor interventions that target the factors underlying each individual's pain.

Conclusion

The current findings suggest that QST-measured pain sensitivity may be an important piece of a comprehensive pain assessment and useful in directing a patient's plan of care to prevent the development of severe chronic pain after breast cancer treatment. Because women may self-report low presurgical pain severity despite a wide range of evoked pain sensitivity, QST may be a better indicator than pain severity to proactively identify individuals at high risk for chronic pain after breast cancer treatment. In addition, QST may serve as a marker of other modifiable pain risk factors, such as maladaptive pain cognitions, which may be amenable to early interventions (e.g., motivational interviewing, cognitive behavioral therapies). Despite the simplicity and potential utility of algometry QST, insufficient evidence to support its use, lack of clinician expertise, and the current inaccessibility of algometers in the clinical setting are barriers to clinical implementation. Earlier assessment and proactive nursing interventions before and during breast cancer treatment may lead to significant decreases in post-treatment chronic pain, a complex problem for which few efficacious interventions are available.

Grace A. Kanzawa-Lee, BSN, RN, is a doctoral student in the School of Nursing; **Steven E. Harte, PhD,** is an assistant research scientist in the Department of Anesthesiology and the Department of Internal Medicine/Rheumatology; **Celia M. Bridges, BA, BSN, RN,** is a clinical research project manager in the School of Nursing; **Chad Brummett, MD,** is an assistant professor in the Department of Anesthesiology; and **Daniel J. Clauw, MD,** and **David A. Williams, PhD,** are professors in the Department of Anesthesiology, the Department of Internal Medicine/Rheumatology, and the Department of Psychiatry, all at the University of Michigan in Ann Arbor; **Robert Knoerl, PhD, RN,** is a postdoctoral research fellow in the Phyllis F. Cantor Center for Research in Nursing and Patient Care Services at the Dana-Farber Cancer Institute in Boston, MA; and **Ellen M. Lavoie Smith, PhD, APRN, AOCN®, FAAN,** is an associate professor in the School of Nursing and the PhD program director at the University of Michigan. Kanzawa-Lee can be reached at gracekan@umich.edu, with copy to ONFEditor@ons.org. (Submitted August 2017. Accepted February 7, 2018.)

Harte has previously consulted for Analgesic Solutions, deCODE Genetics, Aptinyx, and the Society of Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction, and has received additional funding support from the National Institutes of Health, Aptinyx, Eli Lilly and Company, Cerephex Corporation, and the American Cancer Society. During the writing of this article, Brummett was supported by research funding from the National Institutes of Health (under award numbers US-17-PAF02680 [R01 DA042859-05], 16-PAF06270 [R01 HD088712-05], 16 PAF07628 [R01 NR017096-05], K23 DA038718-04, P50 AR070600-05, and R01 DA038261-05), the National Institute on Drug Abuse, the Michigan Department of Health and Human Services, the University of Michigan Genomics Initiative, and Neuros Medical, Inc. Clauw has previously consulted for Abbott Pharmaceuticals, Aptinyx, Cerephex Corporation, Daiichi Sankyo, Pfizer, Samumed, Theravance Biopharma, Tonix Pharmaceuticals, has served on speakers bureaus for Pierre Fabre, has participated in advisory or review activities for Abbott Laboratories, Astellas Pharma, Cerephex Corporation, Pfizer, and Zynerba Pharmaceuticals, and has received additional support from Aptinyx, Cerephex Corporation, and Pfizer. Williams is president of the American Pain Society and has previously consulted for Pfizer. During the writing of this article, Lavoie Smith was supported by funding from Genentech. Lavoie Smith has previously consulted for the American Society of Clinical Oncology and has served on speakers bureaus for Mahidol University.

Harte, Bridges, Brummett, Clauw, Williams, and Lavoie Smith contributed to the conceptualization and design. Kanzawa-Lee, Bridges, and Brummett completed the data collection. Kanzawa-Lee provided statistical support. Kanzawa-Lee, Harte, Williams, and Lavoie Smith provided the analysis. All authors contributed to the manuscript preparation.

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