Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Melford Lazarte, MSN, APRN-Rx, AGACNP-BC, ACNPC-AG, CNOR

University of Hawai‘i at Hilo

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Committee Chair:

Joan Thompson-Pagan, PhD, APRN, RNC, CNE

Committee Member:

Joyce Norris-Taylor, DNP, NP-C, APRN-Rx
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To the higher spiritual being, thank you for guiding my path and giving me shining stars.

Dedications

To my dad in heaven. You raised me to be the change I need to be, to work hard, to always do good and be kind to other people, and to love wholeheartedly.

To my love, Kyle, also in heaven. Wherever you are in time and space, I also dedicate this to you. You are another shining star that I wake up to every morning. Like you said, I will continue to seek out an answer to what is not right in front of me through books, connections, hands-on experience, passed down knowledge, and more!
Abstract

Breast cancer is a common cancer diagnosis in women. Management generally includes chemotherapy, radiation, and or surgery. The surgical option involves the removal of a suspicious or cancerous lump, based on diagnostic imaging or a needle core biopsy, respectively. The decision for surgery then takes place. Surgery could mean lumpectomy or mastectomy, with sentinel node biopsy or full axillary dissection. Although the option for bilateral mastectomies is not required, it is discussed openly in addition to clinical history, personal risks, and recurrences. After any combination of recommended management is accomplished, the risk for breast-cancer-related lymphedema (BCRL) is increased. The use of bioimpedance spectroscopy (BIS), a non-invasive tool similar to standing on a weighing scale, is approved by the U.S. Food and Drug Administration (FDA) as a safe screening method for BCRL. Like other available screening measures, BIS should be adopted into clinical practice. Adoption carries the possibility to improve the quality of routine breast cancer care. **Purpose:** To bring awareness of early BCRL screening with the use of BIS and encourage its adoption. **Conceptual Framework:** Population, Intervention, Comparison, and Outcome (PICO) format. **Theoretical Framework:** The Diffusion of Innovation (DOI) theory. **Method and Instrument:** Anonymous survey via Survey Monkey or Word document based on participant preference. The survey contained 22 simple questionnaires in the form of categorical, nominal, dichotomous, ordinal, or rank-order data. After one month of data collection, data from all 22 questionnaires were extrapolated into Excel spreadsheets. **Participants:** \( n = 12 \) clinics/providers through non-probability or convenience sampling of practice settings located in widespread areas of Maui. **Research Design:** Non-experimental, descriptive, cross-sectional research at a single point in time. **Statistical Analyses:** Chi-square \((x^2)\) test – which included a null \((H_0)\) hypothesis, alternative \((H_a)\) hypothesis, degree of freedom \((df)\), probability value \((p-value)\) or alpha \((\alpha)\) value set at 0.05 – and 95% confidence interval \((CI)\) in select data of 22 questionnaires. **Results and Discussions:** Specific characteristics of participants were
identified and paralleled current literature. This Practice Inquiry Project (PIP) needed to delineate the type of clinic, define the term “future,” and ask the type of adopter explicitly. The $x^2$ test determined possible associations, but could not anticipate or quantify variability. Statistically, participants were not ready or not likely to adopt BIS in the future, yet BIS was recommended. There was $n = 1$ participant that had the BIS device. Also supported by statistics, barriers existed. The two common barriers were organizational/institutional and insurance/financial. Implications: Clinical diagnosis became apparent as the most commonly utilized method to screen or diagnose BCRL. BIS was statistically recommended. The adoption of BIS was associated with variability, again, which was not anticipated and could not be quantified. Such variability was recognized later as relative advantage, compatibility, complexity, triability, and observability – all of which was an essential part of the DOI theory. Due to the small sample size ($n = 12$), there was inherent sharing or overlap of patients within each practice that was also not foreseen. The specific characteristics and barriers that were determined could be pivotal not only in coming up with strategies for adoption but also for primary prevention. Recommendations: The $n = 1$ participant could become a leading innovator and be a part of an extensive future study – to establish clinical information surrounding BCRL from screening, to diagnosis, management, costs, insurance coverage, and challenges, even patient experiences. Instead of an online survey, attending or presenting in a staff meeting would be considered. The timeframe and research design could be modified respectively, for a few months and be retrospective or prospective. Such $n = 1$ participant would be the target population and identify a sample population within it based upon specific characteristics found in this PIP. By extension, the inherent sharing or overlap of patients could be circumvented. The PICO and DOI frameworks may be kept. The type of clinic, type of adopter, and range of time for adoption must be investigated explicitly. Variability should also be addressed. More rank-order data might be warranted to apply not only the $x^2$ test but also the 95% CI in select data. Conclusion: Statistically, participants were not likely to adopt but
recommend the use of BIS in early BCRL screening. Barriers go hand in hand with any changes in clinical practice; thus, they need to be addressed with practical or individualized strategies ahead of time. Perhaps then, the momentum for adoption and method of primary prevention would be gained. Even more, the quality of routine breast cancer care could be elevated not just in one clinic or Maui but throughout the Hawai‘i state at large.

Keywords: Breast; Cancer; Lymphedema; Screening; Bioimpedance; Spectroscopy; Clinics; Providers
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Chapter One: Statement of the Problem

Bioimpedance spectroscopy (BIS) should be integrated as part of routine breast cancer care. Breast-cancer-related lymphedema (BCRL) is a complication that can occur after removal of a suspicious breast lump, removal of the breast itself, or both breasts, along with axillary lymph node dissection (Fu, 2014; Shah, Vicini, & Arthur, 2016). Radiation to the regional area or systemic therapy is yet another factor that increases the risk for BCRL (Fu, 2014; Shah et al., 2016). If the lymphatic system, which distributes fluid throughout the arm, is inherently compromised due to any type of cancer intervention, then the risk of BCRL is lifelong (Fu, 2014; Shah et al., 2016).

Once BCRL is detected, there is an increased risk of subsequent complications like skin changes, infection, pain issues, the chance of having the affected arm not return to baseline, or psychological impact (Fu, 2014; Shah et al., 2016). Although physical therapy is a beneficial part of conservative therapy, management remains a continuous challenge (Fu, 2014; Shah et al., 2016). The need for an established screening program for BCRL is paramount (Fu, 2014; Shah et al., 2016). The BIS screening tool can be used with a focus on early assessment, prevention, and the proactive institution of management (Fu, 2014; Shah et al., 2016).

BIS is a non-invasive technique that provides an objective measurement of the resistance of current flow in the body (Impedimed, 2017). A comparison of read-out value is made between the affected and non-affected limb (Impedimed, 2017). Early lymphedema exists if a result falls outside of the normal range, which is -10 to 10, or if there is an increase of +10 from the baseline read-out (Impedimed, 2017). The result trends, along with other clinical risk factors such as obesity or inadequate physical activity, play a crucial role in the overall evaluation (Fu, 2014; Shah et al., 2016).

Background

Breast cancer is the most common cancer diagnosis that affects women. It will develop in one of eight women in the United States (Wells, DiPiro, Schwinghammer, & DiPiro, 2012;
Doherty, 2015; Papadakis & McPhee, 2017). An estimated case rate of 234,190, including 40,730 deaths, was observed in 2015 (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). A significant risk factor for breast cancer is advancing age (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). The risk for a woman rises dramatically at the age of 60, peaks at age 70, and declines after the age of 70 (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). Family history associated with breast cancer and ovarian cancer must also be taken into consideration (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). If genetic testing fails to reveal a predisposition, a strong familial background remains an essential piece of information (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017).

Early breast cancer detection is critical (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). Clinical breast examination with yearly screening mammogram helps detect breast cancer before it spreads to lymph nodes (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). Ultrasound and magnetic resonance imaging are considered for women who are at high risk given a personal history, family history, genetic predisposition, and lifestyle habits (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). The primary complaint of approximately 70% of women is typically a painless lump (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). A biopsy or cytology for analysis helps provide a breast cancer diagnosis (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017).

Treatment modality for breast cancer varies. Possible curative management may be advised to breast cancer clinical stage I, II, or III (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). Local tumor advancement more than 5 centimeters (cm) and direct extension to the chest wall or skin benefits from a multimodality therapy (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). Palliative care can be added to the treatment plan in metastatic disease (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017).

Primary therapy is dependent on the tumor and its aggressiveness of breast cancer (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). On the other hand, systemic
therapy such as a hormone-modulating drug, cytotoxic chemotherapy, HER2-targeted agent, kills cancer cells that might have escaped the breast and axillary lymph node (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). The use of any treatment before surgical resection helps to gain a sense of future response or sensitivity to chemotherapy (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017).

Tumor size aids in the determination of breast conservation; however, axillary lymph node assists in cancer staging and plan for radiation and or systemic therapy (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). A modified radical mastectomy involves the removal of the “entire breast, overlying skin, nipple, and areolar complex usually with underlying fascia” as well as axillary lymph nodes (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017). The chief benefit of mastectomy is that radiation may not be necessary if the lymph node is without cancer or if the primary tumor is less than 5 cm (Wells et al., 2012; Doherty, 2015; Papadakis & McPhee, 2017).

**Problem Statement**

BCRL is a commonly feared complication following mastectomy with axillary node dissection (Soran et al., 2006; Sierla, Lee, Black, & Kilbreath, 2013). BCRL is 11.67 times more likely to occur with a 95% CI of 1.45 to 93.65 where axillary lymph node dissection is performed (Bulley et al., 2013). BCRL occurs in one of every five breast cancer survivors (Soran et al., 2006; Sierla, Lee, Black, & Kilbreath, 2013). An estimated 120,000 to 600,000 of more than 2.5 million breast cancer patients will suffer from BCRL, which makes it an additional serious health problem to address (Soran et al., 2006; Sierla et al., 2013). Such complication can result in psychosocial problems related to disfigurement and discomfort in addition to mobility issues, infection, and pain among others (Soran et al., 2006; Vicini et al., 2016). BCRL occurs when interstitial fluid accumulates in the affected limb or limbs (in the case of a double mastectomy) (Bulley et al., 2013). The incidence rate varies from 6% to 30% but decreases with early
diagnosis and surgical technique (Soran et al., 2006; Sierla et al., 2013; Soran, Meneske, Girgis, DeGore, & Johnson, 2016).

There is currently no definitive treatment once BCRL is diagnosed. There are only ways to manage BCRL symptoms such as weight reduction, multiple sessions of physical therapy, manual massage, and compression garment (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014). Early screening for BCRL should be integrated into the plan of care for prompt detection, the immediate institution of symptom management, avoid progression of symptoms, and eliminate possible complications (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014; Impedimed, 2017). BIS, which is a non-invasive tool as simple as standing on a weighing scale, can assist in early screening (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014; Impedimed, 2017). BIS provides a measurement of fluid change in the affected limb or limbs (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014; Impedimed, 2017). The BIS measurement can be utilized to trend individualized results over time (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014; Impedimed, 2017).

BIS is part of a prospective method of surveillance (Stout et al., 2012). The cost of this surveillance, which includes early education, identification, objective examination, and management, is about $600 (Stout et al., 2012). On the contrary, the cost of the traditional care model such as circumference measurement, water displacement, or self-assessment, is more than $3,000 (Stout et al., 2012). Each traditional care model is associated with the lack of a standardized point in the arm to measure, inconsistency, and variability (Shah et al., 2012; Bulley et al., 2013). The quality of patient care and the cost of prospective surveillance are thus superior to that of the traditional care model (Stout et al., 2012; Bulley et al., 2013).

Early screening with BIS, too, carries relevance to reduce physical limitation, decrease medical cost, enhance patient safety, and improve quality of life (QOL) in the long run (Dominick et al., 2012; Soran et al., 2016). An insurance claim may be helpful to estimate the overall financial burden, about $14,000 to $23,000 per physical treatment course (Shih et al., 2009;
Quirion, 2010). A more challenging to quantify is the cost related to detrimental impacts on QOL because of the risk of having the affected limb or limbs never return to baseline, depression, stigma, sense of disfigurement, negative health image, and body dissatisfaction (Quirion, 2010; Sierla, Mun Lee, Black, & Kilbreath, 2013; Burckhardt, Berg, & Fleischer, 2014). There is a notable decrease in QOL with BCRL, and if BRCL is left undermanaged (Quirion, 2010; Sierla et al., 2013; Burckhardt et al., 2014).

The integration of BIS for early BCRL screening will aid in prompt detection, help reduce physical limitations or complications, decrease medical cost, enhance patient safety, expand routine breast cancer care, and improve quality of life (Dominick et al., 2012; Soran et al., 2016; Vicini et al. 2016).

**Significance of the Problem**

The National Comprehensive Cancer Network (NCCN) highly recommends the inclusion of routine BCRL education, surveillance, and management during follow-up (Soran et al., 2016; Vicini et al., 2016). Such evidence-based guidelines are essential as there is not a well-defined treatment for BCRL at this time (Sierla et al., 2013; Soran et al., 2016; Vicini et al., 2016). Since 2010, BIS is an FDA-approved measurement to help identify even a sub-clinical form of lymphedema (Soran et al., 2016; Vicini et al., 2016). Through non-invasive electrical flow impedance, similar to standing on a weighing scale, BIS detects fluid volume difference (Soran et al., 2016). BIS sends a harmless and low strength electrical signal in the affected and non-affected limbs, then provides a comparison (Impedimed, 2017). If there is lymphedema, the electrical signal travels quickly through the arm (Impedimed, 2017). With such testing, there is an associated high specificity and sensitivity compared to a traditional care modality like arm circumference or water displacement (Shah et al., 2012; Soran et al., 2016).

There is a certain level of difficulty in diagnosing BCRL immediately after breast cancer treatment because of inflammatory changes that can occur in the body. Detrimental health consequences exist if BCRL remains undetected (Vignes et al., 2007). The duration of BCRL
progresses in severity due to increasing volume over time (Vignes et al., 2007). Tissue alteration, like cellulitis, can occur (Vignes et al., 2007). Lymph stasis, an accumulation of proteins or metabolites in the extracellular space aiding in the increase of colloid osmotic pressure within the tissues, may become chronic (Vignes et al., 2007). Such physiological body changes stimulate the cascade of inflammatory markers and the production of collagen; in turn, subcutaneous fibrosis eventually develops (Vignes et al., 2007).

Once BCRL is present, conservative management is the main goal (Sierla et al., 2013; Soran et al., 2016; Vicini et al., 2016). Physical therapy and exercise are advantageous (Vignes et al., 2007). Decongestive treatment with the use of low stretch bandage is beneficial, too (Vignes et al., 2007). Manual lymph drainage may be potentiated as well (Vignes et al., 2007). Appropriate skincare will need to be added as part of such management (Vignes et al., 2007). As there is not a curative treatment at this time, the focus should be on early screening with the use of BIS, to improve the overall quality of life of a breast cancer survivor after treatment (Vignes et al., 2007; Pusic et al., 2013).

**Aims and Objectives**

BCRL is a lifelong complication after breast cancer treatment, particularly if lymph node removal is performed or after local radiation. The overarching purpose of this Practice Inquiry Project (PIP) is to provide anticipatory guidance on BCRL, bring awareness to early screening using BIS, and stimulate adoption of BIS into clinical practice. **Table 1** outlines the aims and objective of this PIP:
Table 1. Aims and objectives

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<th>Aims</th>
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| Aim #1. Determine the current method of BCRL screening of n = 12 participants. | 1. Partner with n = 12 participants of various specialties.  
2. Identify a key stakeholder as a point of contact.  
3. Establish rapport and open communication with key stakeholders through phone or email.  
4. Incorporate the survey, both online via Survey Monkey and Word document versions. |
| Aim #2. Disseminate information about early BCRL screening using BIS to n = 12 participants. | 1. Create a survey, which includes the purpose of this PIP and brief yet concise information about BIS for early BCRL screening. The survey will serve as a health communication tool.  
2. Email the survey to different n = 12 participants.  
3. Establish a timeline for survey dissemination and collection. |
| Aim #3. Determine the interest of n = 12 in adopting BIS for early BCRL screening as part of prospective surveillance and routine breast cancer care. | 1. Collect the survey from key stakeholders. Anonymous online survey from Survey Monkey or Word attachment accessed through a password-secured account.  
2. Analyze the collected data from the survey.  
3. Based on analyzed data, disseminate findings via HOKU, the University of Hawai‘i at Hilo (UHH) institutional repository. |

Chapter Two: Literature Review

The most common cancer that affects women is breast cancer (Papadakis & McPhee, 2012). The lifetime risk increased from one in 11 in the 1970s and peaked around the year 2000 (National Comprehensive Cancer Network [NCCN], 2015). There was a decrease in risk in 2013 due to variation among racial and socioeconomic groups (NCCN, 2015). Caucasian women ages 40 and older historically had the highest incidence rate, but now converging among African American women particularly between 50 and 59 years old (NCCN, 2015). Increasing age is yet another risk factor (Papadakis & McPhee, 2012; NCCN, 2015). Mortality
has been declining over the last few decades, which suggests the benefits of early detection in combination with effective treatment (NCCN, 2015).

**Breast Cancer Treatment**

Current treatments for breast cancer are complex. They can include surgical intervention, radiation, and or chemotherapy (McPhee, 2012; NCCN, 2015). Endocrine drugs may also be used (McPhee, 2012; NCCN, 2015). The selection of any of these therapies is just as complicated, but generally based on prognosis and determination of predictive factors (McPhee, 2012; NCCN, 2015). These predictive factors are established with histology and pathology (NCCN, 2015). The excised lesions or tumors, from the primary sites or other sites such as axillary lymph nodes, are analyzed by pathologists to determine characteristics, morphology, and staging, to name a few (NCCN, 2015).

The laboratory result determines the next course of clinical action, particularly from a surgical standpoint. If the result shows a negative margin, full excision of the lump itself is an option (Papadakis & McPhee, 2012; NCCN, 2015). Otherwise, if the result comes back with a positive margin, then removal of the affected breast or mastectomy is warranted (Papadakis & McPhee, 2012; NCCN, 2015). The decision to remove the unaffected breast at this point can serve as prophylaxis to significantly reduce the risk of breast cancer (Papadakis & McPhee, 2012; NCCN, 2015). Removal of both breasts is known as bilateral mastectomies. Mastectomy, in general, is vital for local control of breast cancer (NCCN, 2015).

Surgical axillary staging is clinically essential but carries possible complications of lymphedema (Papadakis & McPhee, 2012; NCCN, 2015). Obtaining a sample in the axilla, or armpit, in the setting of a negative or positive margin will play an enormous role in determining a breast cancer stage (Papadakis & McPhee, 2012; NCCN, 2015). The sample, too, may involve taking a biopsy alone or entirely removing an axillary lymph node (Papadakis & McPhee, 2012; NCCN, 2015).
The purpose of the lymphatic system is to distribute fluid throughout the body adequately (Shi, 2009; McPhee, 2012; International Lymphoedema Framework [ILF], 2015; International Society of Lymphology [ISL], 2016). Such bodily function is disrupted if an axillary lymph node gets entirely removed; as a result, swelling in the affected arm, or both arms depending on the surgical invention done, can occur (Shi, 2009; McPhee, 2012; ILN, 2015; ISL, 2016). This swelling is a condition known as BCRL (Shi, 2009; Papadakis & McPhee, 2012; ILN, 2015; ISL, 2016). BCRL is a common complication of local and regional treatment for breast cancer (Shi, 2009; Papadakis & McPhee, 2012; ILN, 2015; ISL, 2016). Other complications of BCRL if undetected can include pain, immobility, contracture, sensory loss, and psychological impact among others (Shi, 2009; Papadakis & McPhee, 2012; ILN, 2015; ISL, 2016).

Summary of PIP Aims

The specific aim of this PIP is to increase the clinical use of early screening for BCRL through the use of BIS. BCRL is a lifelong risk mainly associated with local irradiation therapy and after mastectomy with axillary lymph node dissection (National Lymphedema Network [NLN], 2011; O’Toole et al., 2013). There is currently no definitive treatment for BCRL (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014). Once BCRL is detected, there are only conservative strategies to manage symptoms including weeks of physical therapy, exercise, compression sleeve, self-massage, and weight loss (Sierla et al., 2012).

Early BCRL screening should be given more emphasis, and BIS can assist in the process as part of prospective surveillance (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014; Impedimed, 2017). BIS, a machine similar to a weighing scale, can provide a measurement of fluid change in the affected limb or limbs (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014; Impedimed, 2017). The BIS measurement can be utilized to trend individualized results over time, in turn, enhances preventative measures, patient outcomes, and risk stratification (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014). Patient education and awareness of physical manifestations will also aid in surveillance (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014).
Healthcare providers can perform an objective measurement with BIS, before and after treatment for baseline information and comparison of results (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014). The use of BIS is becoming well known (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014). BIS is a non-invasive tool that can detect early BCRL, even a subclinical form (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014). Early screening through BIS should be integrated into routine breast cancer care (NLN, 2011; O’Toole et al., 2013). This PIP aims to improve the quality of breast cancer care, in particular, early screening for BCRL through the use of BIS in the same manner blood pressure is measured routinely during a clinic visit. This proposed change will further enhance the quality of care and safety.

**Review of Literature on BCRL**

After a breast cancer patient undergoes necessary local irradiation therapy or mastectomy with axillary lymph node dissection, BCRL becomes a lifelong risk (ILF, 2015; NCCN, 2015; ISL, 2016). In the process, appropriate fluid distribution as a central function of the lymphatic system gets inherently disrupted (ILF, 2015; NCCN, 2015; ISL, 2016). Fluid containing other cells and proteins then accumulate; in turn, this manifests as swelling in the at-risk or affected limb (ILF, 2015; NCCN, 2015; ISL, 2016). Fluid formation exceeds the capacity for lymphatic drainage (ILF, 2015; NCCN, 2015; ISL, 2016). If underrecognized, BCRL can lead to pain, discomfort, infection, contraction, immobility, and or psychological impacts (Armer & Stewart, 2010; Hayes et al., 2011; O’Toole et al., 2013; ILF, 2015; ISL, 2016).

BCRL is considered the most common but secondary complication after breast cancer treatment (Armer & Stewart, 2010; Hayes et al., 2011; O’Toole et al., 2013). It can occur as early as two months or as late as two years, and for a lifetime (Dominick, Madlensky, Natarajan, & Pierce, 2012; Soran, Menekse, Girgis, DeGore, & Johnson, 2016). The reported incidence rate ranges between 4% to 56% but will increase over time (Shi et al., 2009; Armer & Stewart, 2010). It can develop in about 20% to 40% of breast cancer survivors, in which there are an
estimated 2.8 million in the United States (Armer & Stewart, 2010; Hayes et al., 2011; O’Toole et al., 2013).

Some literature asserts that BCRL can occur anywhere between 5% to 6%, while others approximate 15% to 20% of the entire breast cancer population (Shi et al., 2009; Armer & Stewart, 2010). Regardless, the number of survivors affected or will be affected with BCRL over a lifetime is staggering, not to mention the high medical cost for symptom control (Armer & Stewart, 2010). The incidence rate does not significantly vary among Caucasian and African American populations (Armer & Stewart, 2010). However, the assessment of true incidence rate is difficult; discrepancy in percentage lies in measurement or diagnosis, even follow-up (Armer & Stewart, 2010; Hayes et al., 2011; O’Toole et al., 2013).

Lymph node excision is the primary risk factor along with tumor stage, treatment modality of radiation or chemotherapy, poor hygiene, or body mass index (BMI), even age (Dominick et al., 2012). The Women’s Healthy Eating and Living (WHEL) study examined other potential predictors of early BCRL (Dominick et al., 2012). A unique dataset was collected, particularly after the completion of treatment, then analyzed through univariate and multivariate logistic regression (Dominick et al., 2012). Categorical and continuous variables were analyzed differently, with the use of the $\chi^2$ test and T-test and Wilcoxon rank-sum test, respectively (Dominick et al., 2012). Logistic regression was used to determine the possible association between self-reporting of lymphedema and participant characteristics (Dominick et al., 2012).

A total of 3,088 women were enrolled in the WHEL cohort study (Dominick et al., 2012). These women were diagnosed with stage I, II, or III breast cancer within four years (Dominick et al., 2012). They were recruited in multiple states such as “California, Arizona, Oregon, and Texas” from March of 1995 through November of 2000 (Dominick et al., 2012, p. 116). The median years of follow-up were “7.3” (Dominick et al., 2012, p. 116). Limitations included demographic differences, variable definitions, percentages of women with breast surgery, and those who received radiation, and classification of diagnosis (Dominick et al., 2012).
The results showed that surgery with radiation (p-value of <0.01), removal of lymph nodes (p-value <0.01), and body mass index (BMI) (p-value of <0.01) were significantly associated with the development of BCRL (Dominick et al., 2012). In any quantitative study, a p-value of less than 0.05 yields a statistically significant result; otherwise, if the p-value is more than 0.05, then there is no statistical significance (Bangdiwala, 2016). BCRL was increased two-folds with mastectomy plus radiation (Dominick et al., 2012).

The findings of Dominick et al. (2012) confirmed, too, that excision of axillary lymph nodes (ALNs) was an independent risk factor of BCRL. Removal of 16 or more ALNs had “1.65 higher odds” of BCRL compared to 10 or fewer ALNs (p. 121). Regardless of how many ALNs were removed, their study also found that BMI of more than 30 (“odds ratio of 2.08”) was associated with higher odds of BCRL compared to less than 25 (“odds ratio of 1.00”) (p. 121). In quantitative studies, the odds ratio of less than one means that the exposure is associated with lower odds of outcome (Szumilas, 2010). If the odds ratio is equal to one, then no associations at all (Szumilas, 2010). If the odds ratio is higher than one, then the exposure is associated with higher odds of outcome (Szumilas, 2010).

The research findings of Dominick et al. (2012) support the aims of this PIP, particularly early screening for BCRL because of higher odds when axillary lymph node dissection is performed in addition to having a BMI higher than 30. Routine screening through BIS should be done before and after breast cancer treatment, then routinely at every clinic visit (Dominick et al., 2012; Shah et al., 2012).

**BIS**

The implementation of BIS in clinical practice can serve as an objective tool in the detection of BCRL. BIS can detect BCRL, even its subclinical form, as early as four months than a traditional modality (NLN, 2011; Shah et al., 2012; O’Toole et al., 2013; Otsby et al., 2014). There is a considerable shift trending away from a conventional method such as water displacement or arm circumference because of interobserver variability (Shah, Vicini, & Arthur,
Early Screening for BCRL Using BIS

2016). With BIS, there is an associated decrease in the rate of inter-or-intraobserver variability and an increase in sensitivity (Shah et al., 2016).

BIS works by sending a non-invasive, low electrical current to measure fluid volume in the affected or at-risk arm (Shah et al., 2016; Impedimed, 2017). The device can compare the ratio of fluid differences between the affected arm and the control, which is a “normal range of limb impedance ratio” in a healthy population (Shah et al., 2016, p. 647). This capacity is “matched for limb dominance and gender” (Shah et al., 2016, p. 647). The result is expressed in a numerical score, which, in turn, serves as an overall quantitative measurement (Shah et al., 2016).

As an example, a female patient comes in for BIS testing because of left mastectomy with axillary lymph node dissection. If her “measured impedance ratio is equal to the mean ratio of the equivalent healthy population,” then her score is 0 (Shah et al., 2016, p. 647). If her score is higher than three standard deviations (SD) from the equivalent healthy population,” then that score is said to be higher than 10, meaning an early sign of BCRL (NLN, 2011; Shah et al., 2016, p. 647). The reference score is between -10 to 10; thus, a value outside of this range can indicate BCRL (NLN, 2011; Impedimed, 2017). A comparison of scores – between the pre-and-postoperative as well as routine scores – is essential for clinical evaluation and the overall trend of results (NLN, 2011; Dominick et al., 2012; Shah et al., 2012; Shah et al., 2016).

Proposed Intervention

The proposed intervention of this PIP is the routine use of BIS as part of early screening for BCRL. BCRL can occur as early as two months or as late as two years, and for a lifetime (Dominick et al., 2012; Soran et al., 2016). Therefore, BIS measurement should be done before treatment and after treatment, then routinely at every clinic visit (Dominick et al., 2012; Soran et al., 2016). Patient education will play a crucial role throughout the entire process; this strategy will reinforce information about BCRL, what clinical manifestation to look for, and to discover any possible psychological impact among others (NLN, 2011; O’Toole et al., 2013; Otsby et al.,
As there is currently no definitive treatment for BCRL, early screening through BIS provides more prospective surveillance (Dominick et al., 2012; Soran et al., 2016).

BIS should be incorporated into routine breast cancer care and in a standardized manner. BIS, along with individual patient risk factors, adds substance to the overall detection of BCRL (Dominick et al., 2012; Soran et al., 2016). Since 2010, BIS has been approved by the Food and Safety Drug Administration (Soran et al., 2016). There is an associated high specificity and sensitivity (Shah et al., 2016; Soran et al., 2016). Applicability can be akin to the process of standing on a weighing scale, the convenience of blood pressure measurement, or routine vital signs.

The National Lymphedema Network (NLN) recommends pre-and-postoperative measurements (NLN, 2011). The NLN (2011) supports that a score of more than 10, for example, warrants immediate referral for further evaluation and management of BCRL. Once again, as there is no definitive treatment for BCRL at this time, early routine BIS screening is paramount (NLN, 2011; Dominick et al., 2012; O’Toole et al., 2013; Otsby et al., 2014; Soran et al., 2016; Impedimed, 2017). This PIP aims to change, or add to, the routine breast cancer care.

According to Runowicz et al. (2016), Sayegh et al. (2017), and the NLN (n.d.) position papers, many of the current recommendations for prevention and management of BCRL revolve around individualized patient education. Such patient education can be achieved through anticipatory guidance, which takes into consideration multiple factors that contribute to BCRL. Interventions may be different between patients and should be tailored accordingly. Actions and precautions involve routine medical check-ups, reporting of physical changes, skincare, maintaining normal body weight, healthy diet and exercise, compression garments, and physical therapy.

Additional research studies are warranted on BCRL treatment, including longer follow-up time to evaluate both sensitivity and specificity of a modern technique like BIS. Early education
and awareness, prompt identification, and the institution of management utilizing current recommendations are critical to control costs, improve patient health-related outcomes, reduce possible disabilities, optimize survivorships, and enhance the quality of care for breast cancer survivors.

**Conceptual Framework**

Asking a well-worded question for this PIP is a crucial initial step (Polit & Beck, 2012; Polit & Beck, 2018). One way of accomplishing it is by creating a PICO question (Polit & Beck, 2012; Polit & Beck, 2018). PICO stands for: Population, Intervention (or Issue), Comparison, and Outcome (Polit & Beck, 2012; Polit & Beck, 2018). Figure 1 illustrates the PICO statement as a conceptual framework of this PIP. In this PIP, the population is clinics/providers. The intervention is having BIS instead of clinical diagnosis or traditional modality (i.e., arm circumference or water level displacement).

The outcomes were to: bring awareness to early BCRL screening using BIS, increase the use of BIS, improve routine breast cancer care, enhance the quality of care, and possibly encourage community-wide adoption. BCRL can occur as early as two months to as late as a couple of years (Dominick et al., 2012; Soran et al., 2016; Impedimed, 2017). BIS can detect BCRL as early as four months, however (Dominick et al., 2012; Soran et al., 2016; Impedimed, 2017).
The Diffusion of Innovation (DOI) theory is utilized in this PIP to gain momentum and adoption of early screening for BCRL through BIS (The University of Oklahoma, n.d.; Orr, 2003; Kaminski, 2011). Adoption starts with the perception that BIS is not only innovative but also safe and improves the quality of routine breast cancer care (The University of Oklahoma, n.d.). The next step of persuasion becomes inherently integrated (The University of Oklahoma, n.d.; Orr, 2003). Human interaction through an interpersonal network plays an integral role (The University of Oklahoma, n.d.). Such diffusion involves communication through a given channel that occurs over time (Orr, 2003). Although the goal is sooner rather than later, practically speaking, BIS is not going to be adopted by each practice setting immediately and not all at the same time (The University of Oklahoma, n.d.). There is a time sequence for adoption, how long it takes to begin the use of BIS (The University of Oklahoma, n.d.; Orr, 2003).

There are different adopter categories embedded within the DOI theory (The University of Oklahoma, n.d.; Orr, 2003; Kaminski, 2011). Innovators are eager to try a new idea but

Healthcare providers who are early majority members will be willing to follow the BIS innovation, whereas those who are late majority members will be skeptical because of economic perspectives and social pressures (The University of Oklahoma, n.d.; Kaminski, 2011). The “newness and unfamiliarity” of BIS, although the FDA has approved it since 2010, can be driving forces for cost-analysis investigations (Orr, 2003). Late majority members, too, are reluctant unless all others have altogether participated (The University of Oklahoma, n.d.; Kaminski, 2011). The term “laggards” under the DOI theory means individuals who are fixated on the past and have their decisions based on traditions (The University of Oklahoma, n.d.; Kaminski, 2011). Laggards may be suspicious of BIS innovation itself and any change agents (The University of Oklahoma, n.d.; Kaminski, 2011).

Chapter Three: Project Design and Evaluation Plan

In this chapter, the project design and evaluation plan will be discussed. The diffusion of innovation (DOI) theory helped disseminate the clinical implications of BIS, for early screening and identification of BCRL (The University of Oklahoma, n.d.; Kaminski, 2011). An initial step of this PIP was to contact healthcare institutions within the community; in turn, this served as the population because of an entire group of broader interest (Polit & Beck, 2012, 2018).

Data Method and Instrument

The primary method of data collection was a survey, which contained 22 questionnaires and took about six to 10 minutes. The time commitment was specified (Polit & Beck, 2012, 2018). The survey was done via a Survey Monkey link or an attached Word document, depending on clinic/provider preference. Part of the requirement for the latter option was to
email it back to Melford Lazarte, Doctor of Nursing Practice (DNP) candidate and co-investigator. Both options were offered for ease, feasibility, and affordability (Polit & Beck, 2012; 2018). Clinics/providers in Wailuku, Kahului, Makawao, Kihei-Wailea, and Lahaina of different specialties were targeted.

Before doing the survey were attached information regarding personal introduction, affiliation with the UHH DNP program, the overall purpose of the anonymous survey, and voluntary participation. Prefacing the survey included relevant information on BCRL and its clinical significance. In other words, prefacing the survey was a strategic method of saying enough helpful information but not too much (Polit & Beck, 2012, 2018).

The preface included a concise yet brief statement about BIS, the importance of early screening for both patients and clinics, as well as possible reimbursement benefits. It served in a manner that supported a health communication tool (Polit & Beck, 2012, 2018). Its overall significance aided in the elaboration of this PIP, enhancement of interest or participation, and introduction of the use of BIS for early BCRL screening.

Many of the clinics/providers were primary care settings, community clinics while others were private practices. Specialty areas like Medical and Radiation Oncology were included. Medical doctors (MDs) and nurse practitioners (NPs), even physician assistants (PAs), could complete the survey. Voluntary participation and no direct compensation were emphasized. Benefits were mainly to improve BCRL screening using BIS and the quality of routine breast cancer care.

**The Survey Itself**

The survey contained information about the clinical significance of BIS as a non-invasive tool similar to standing on a weighing scale while providing a snapshot of a patient’s tissue or fluid change (Impedimed, 2017). Other relevant information included the cost of the device, a list price of approximately $9,000 with possible monthly lease agreement (Impedimed, 2017). The cost of treating BCRL through a reactive model of care is estimated at $14,000 to $23,000.
(Shih et al., 2009; as cited by Impedimed, 2019). Plus, there has been a proposed increase in reimbursement rate in Current Procedural Terminology (CPT) code 93702 of 13%, now at $128 to $135 (Impedimed, 2017).

There are about 2.5 million breast survivors in the nation, and the possible occurrence rate of BCRL is about 2% to 65% (Sozo, 2019). If the highest percentage of occurrence rate is taken, there will be more than 1.5 million survivors who need screening – this could mean saving many lives and thousands of dollars. Investing in a BIS device is better in improving patient outcomes and economically sound for most, if not all, clinics. Adding the cost-benefit ratio was outlined.

The survey also asked about different patient characteristics (i.e., age, gender), population (i.e., ethnicity), types of breast cancer commonly observed, types of screening for BCRL, and – after reading the information provided on BIS – interest in adopting the device, even when to anticipate adopting it. All of these survey questions were in the form of nominal, ordinal, and or rank-order data.

The survey began on January 13th and ended on February 15th; thus, a timeframe of data collection for one month.

Primary resources for the survey included time, cost of supplies (i.e., ink, white printer paper), and Survey Monkey subscription; all of which was approximately $300. The final cost was incurred by the UHH DNP candidate and co-investigator of this PIP.

**Target Population**

Non-probability or convenience, rather than randomized, sampling was employed (Polit & Beck, 2012, 2018). Non-probability meant that participants were picked in terms of location and characteristics of clinics/providers (i.e., primary care/community clinic, private practice, or specialty area (Polit & Beck, 2012, 2018). The actual participants themselves participated randomly and anonymously. There were twenty-six clinics/providers in the areas of Wailuku, Kahului, Makawao, Kihei-Wailea, and Lahaina that were contacted. They were primary
care/community, private practice, and specialty clinics. Of those 26 clinics/providers, six of them had at least two to thirty providers. Of those 26 clinics/providers, too, one had four different distant satellites in Maui. Of those 26 clinics/providers, 18 agreed to have this PIP along with the survey emailed to them. Of those 18 that agreed, there were 12 clinics/providers that participated. There were 12 participants (n = 12) overall. The interplay of anonymity was carried out. Figure 2 illustrates the interplay of clinics/providers breakdown, actual participants, and anonymity:

**Figure 2.** Clinics/providers breakdown, actual participants (n = 12), and anonymity.
Research Design

The research design of this PIP required following the decision-making criteria in a strategic fashion (Polit & Beck, 2012, 2018). There was not a random assignment, a control group, or multiple measures. A single point in time was measured in terms of the use of BIS or not. There was no manipulation of variables (Polit & Beck, 2012, 2018).

The research design was a non-experimental, descriptive, cross-sectional research at a single point in time – as it related to function, direction, and timeframe, respectively (Polit & Beck, 2012, 2018). Such design described characteristics regarding risks and outcomes, even those that existed within the various specialty areas (Polit & Beck, 2012, 2018). It also organized the prevalence of broad categories such as breast cancer, type of breast cancer treatment, frequency of BCRL, method of BCRL diagnosis or screening, use of BIS, BIS recommendation, and interest in BIS adoption.

Overall, this research design described a real-life situation and aspect of individual characteristics (i.e., clinics or patients) (Polit & Beck, 2012, 2018). It described variables that would otherwise be unethical to manipulate in a real experiment (i.e., with control and intervention groups). In other words, this clinic should have BIS for BCRL screening, while another should not have it (Polit & Beck, 2012, 2018). This PIP aimed to bring awareness to early screening for BCRL and standardization of using BIS.

Ethics, Privacy, Confidentiality, and Anonymity

Ethics in any nursing research was highly considered, according to Polit and Beck (2018). The three essential standards were kept in mind throughout the research process: “beneficence, respect for human dignity, and justice” (p. 79). Duties that minimized harm and maximize benefits fell under beneficence. For instance, BIS is non-invasive and the process is similar to standing on a weighing scale. BIS is, however, contraindicated for patients with an existing pacemaker or who are pregnant. Having a breast cancer diagnosis with pregnancy is rare.
The main participants were the different clinics in Maui, not actual patients. All participants were assured that voluntary information provided in the survey were not used against them at all through consent, which was approved by the Institutional Review Board (IRB). Researcher-participant relationships were not exploited in any way. The right to self-determination and the right to full disclosure were part of the second ethical principle – respect for human dignity.

The participants had the right to decide voluntary participation, ask additional questions, even refuse or skip questions. Ethically sound, full disclosures, although they could “create biases and recruitment problems” was included in addition to risks and benefits (Polit & Beck, 2018, p. 81). The right to fair treatment and the right to privacy were under the third principle of justice (Polit & Beck, 2018). In this PIP, part of the selection of participants was based on research requirements, whether BIS was used or not, instead of incapability of individual health institutions to provide such testing. Although the actual survey was anonymous, any participants who unknowingly declined were treated, once again, without prejudice; they were treated with continued honor and respect. For those who voluntarily participated, any data were kept confidential at every step of the process through an anonymous online survey accessed through a password-secured account.

All information was kept in strict privacy and confidentiality at any point in data collection. Polit and Beck (2018) mentioned that a survey as a structured self-report instrument could include close-and-open-ended questionnaires. Close-ended questions may be dichotomous as in a yes or no question. Open-ended questions allowed participants to respond in their own words. For instance, common factors that aided in the frequency of BIS testing if applicable. There could be multiple-choice, rank-order, and rating questions. Scales consisted of declarative statements that clarified certain viewpoints; for example, how likely they were to recommend or adopt BIS in their practice. Different types of questions, the types of variables, categorical data, and permissible rating were laid out in the survey.
Participants and their subsequent responses were anonymous (see Figure 2). Anonymity was maintained as the survey, be it the online format via Survey Monkey or Word document format, did not require to enlist the name of a specific clinic/provider. Instead, the survey asked the type of clinic in a generalized manner. For example, if the clinic was Primary Care/Community Clinic, Private Practice, or Specialty Clinic.

**Data Analysis Methods and Evaluations**

This PIP was a non-experimental, descriptive, cross-sectional research at a single point in time. The statistical analysis was in the form of a descriptive with a non-parametric test. Polit and Beck (2018) stated that a descriptive analysis reported association rather than comprehended causal pathways. Descriptive analysis was utilized to address the health concern of BCRL, whether BIS yielded or could yield associated information on the outcome of quality care among breast cancer patients.

A non-parametric test was applied due to the small sample size. The availability of the BIS device for early BCRL screening in the Maui community was anticipated to be limited. There were 12 actual survey participants. A non-parametric test included categorical, rank order, nominal, dichotomous, and continuous data. An example of rank order data was “Question #21 (Q21). On the scale of 1-10, how would you rate your readiness to adopt BIS in the future?.” For nominal data, “Q3. What is the most common gender of patients with breast cancer in your clinic?” was a good example. “Q15. Is BIS available? Yes or No” was a dichotomous data. A continuous data example was “Q4. Of those patients diagnosed with breast cancer, what is the most common age range?.”

The responses from all 12 participants were extrapolated (see Chapters Four and Five). Each response for each survey question was transferred into separate Excel spreadsheets (see Figure 3). There were 21 questions, so there were 21 separate Excel spreadsheets and bar graphs. For example, Q13 (Figure 3):
Figure 3. Data on excel spreadsheet

As a non-parametric test could not assume a normal distribution or that such distribution would be unknown, the $\chi^2$ test was performed. The $\chi^2$ test could help determine the association, rather than infer causation (Polit & Beck, 2012, 2018). Association may imply a relationship (Polit & Beck, 2012, 2018). In particular, the relationship of screening BCRL with or without the use of BIS by $n = 12$ participants of various specialties. The $\chi^2$ test formula applied was: $\chi^2 = \sum \frac{(o-e)^2}{e}$.

The first step of the $\chi^2$ test was to formulate two competing hypotheses – a null ($H_0$) and an alternative ($H_A$) hypothesis separately (Polit & Beck, 2012, 2018). A $H_0$ hypothesis would be no association or relationship, whereas a $H_A$ hypothesis would be that an association or relationship existed. Utilizing Q13 as the same example, $n = 12$ participants responded if BMI was a contributing factor. The $H_0$ hypothesis was that: BMI was not a contributing factor. On the other hand, the $H_A$ hypothesis was: BMI was a contributing factor (see Figure 4):
Excel spreadsheet was utilized in the next few steps for automatic and methodical calculation. To proceed, the observed (O) and expected (E) data were calculated. The O was the actual number of responses. For Q13, 10 of the participants responded “Yes,” while two responded “No.” The O data for “Yes” would be 10, and “No” would be two (see Figure 5):

Figure 5. O data

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>10</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
</tr>
</tbody>
</table>

Conversely, the E was calculated by the number of participants divided by the number of categories (Polit & Beck, 2012, 2018). For Q13, 12 participants responded, and two categories (Yes or No). The E data was six (12 ÷ 6 = 6), which would be the same integer utilized in both the categories (see Figure 6):

Figure 6. O and E data

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

Then, the O and E were subtracted. For “Yes,” 10 minus 6 equaled 4. For “No,” 2 minus 6 equaled -4 (see Figure 7):

Figure 7. O minus E data

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O – E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>6</td>
<td>-4</td>
</tr>
</tbody>
</table>
The result of $O$ minus $E$ was squared. For “Yes,” 4 squared equaled 16. For “No,” -4 squared equaled 16 as well (see Figure 8):

**Figure 8.** Square root of $O$ and $E$ calculation part one of two

<table>
<thead>
<tr>
<th>Category</th>
<th>$O$</th>
<th>$E$</th>
<th>$O-E$</th>
<th>$(O-E)^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>10</td>
<td>6</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>6</td>
<td>-4</td>
<td>16</td>
</tr>
</tbody>
</table>

The answer from $O$ minus $E$ squared was divided by the $E$. For “Yes,” 16 divided by 6 equaled 2.67. The same was true for “No” ($16 \div 6 = 2.67$) (see Figure 9):

**Figure 9.** Square root of $O$ and $E$ calculation part two of two

<table>
<thead>
<tr>
<th>Category</th>
<th>$O$</th>
<th>$E$</th>
<th>$O-E$</th>
<th>$(O-E)^2$</th>
<th>$x^2$ = $\sum \frac{(O-E)^2}{E}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>10</td>
<td>6</td>
<td>4</td>
<td>16</td>
<td>2.666666667</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>6</td>
<td>-4</td>
<td>16</td>
<td>2.666666667</td>
</tr>
</tbody>
</table>

The results were summed as indicated by the $\Sigma$ symbol: 2.67 plus 2.67 equaled 5.33. Thus, $x^2 = 5.33$ (see Figure 10):

**Figure 10.** Overall summation and $x^2$ calculation

To proceed, the concepts of the degree of freedom (df) and probability (p) value were important. The first concept, df, meant the value in the final calculation that was free to vary or independent (Polit & Beck, 2012, 2018). The formula for df was: the number of categories minus one. So for Q13: two (“Yes” and “No” categories) minus one equaled one. The df for Q13 was one.

The latter concept, p-value, was the probability of whether the effect found by chance in this PIP was as significant, with the assumption that the $H_o$ hypothesis was true (Polit & Beck, 2012, 2018). To minimize this probability, the p-value indicated with an alpha ($\alpha$) symbol was
set to the generally low standard of 0.05 or 5% (Polit & Beck, 2012, 2018). Such $\alpha$ set at that level meant a 0.05 or 5% probability that there would be an error (Polit & Beck, 2012, 2018). To calculate the p-value in Excel, the formula utilized was: =CHISQ.TEST(Observed, Expected). This formula meant: typing in Excel =CHISQ.TEST, applying open parenthesis symbol, highlighting observed data, placing a comma, highlighting Expected, and using close parenthesis. The p-value then would be calculated automatically. For Q13, the p-value was 0.17.

At this point, df and p-value were identified, one and 0.02, respectively. Now, $x^2 = 5.33$, as initially determined, could be reconfirmed in Excel using df and p-value. In Excel, the $x^2$ formula was: =CHISQ.INV.RT(p,df); this meant typing =CHISQ.INV.RT, applying open parenthesis symbol, highlighting p result, placing a comma, highlighting df, and applying close parenthesis symbol. The $x^2 = 5.33$ was reconfirmed.

The final $x^2$ was expressed in: $x^2$ (df, n) = actual $x^2$ value, p-value = actual value. For instance, in Q10: $x^2$ (1, n = 12) = 8.33, p = 0.00 (see Figure 11):

**Figure 11.** $x^2$ test, df, p-value or $\alpha$ value calculation

Refer back to the survey: 12 answered, zero skipped.

**Q13.** 12 clinics/providers were surveyed to determine if: BMI is a contributing factor in patients diagnosed with BCRL?

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O - E</th>
<th>$\Sigma (O - E)^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>10</td>
<td>6</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>6</td>
<td>-4</td>
<td>16</td>
</tr>
</tbody>
</table>

Excel formulas:

\[ x^2 = \frac{\Sigma (O - E)^2}{E} \]

\[ df = \text{number of category - one} \]

\[ p \text{ value} = \text{CHISQ.TEST(Observed, Expected)} \]

$\alpha = 0.05$

$\alpha = 0.05$
The steps from extrapolating data to Excel, to creating individual bar graphs per each survey question, determining O and E data, calculating $x^2$, and reconfirming $x^2$ using df and p-value were repeated for most, if not all 22, survey questions. The $x^2$ test was not utilized in Q15 through Q17, as these questions only pertained to one participant and otherwise would yield an irrelevant result (see Chapters Four and Five).

Q21 had additional calculations due to its nature as a rank-order data. The responses from n = 12 participants were transferred into Excel spreadsheets. There were n = 3 participants who chose one, n = 2 participants chose five, and the like (see Results). Still, with Excel spreadsheets, more statistical information was identified. Data Analysis until Tools had the option to choose Descriptive Statistics. Descriptive Statistics automatically calculated: frequency distribution, central tendency, variability, and 95% CI (see Chapters Four and Five).

The frequency of distribution ordered in numerical data and arranged values from lowest to highest (Polit & Beck, 2012, 2018). As in Q21 that asked participants to rank level of readiness from one to 10. To dig deeper into the frequency of distribution was the concept of normal distribution, which indicated that the graph was symmetric and had one peak (unimodal) (Polit & Beck, 2012, 2018) (see Results). The frequency of distribution clarified patterns (Polit & Beck, 2012, 2018).

Central tendency, on the other hand, indicated what was typical and summarized the distribution with the mode, median, and mean (Polit & Beck, 2012, 2018). The mode was the value that frequently occurred (Polit & Beck, 2012, 2018). The median was the middle value (Polit & Beck, 2012, 2018). Mean was calculated with the formula: the sum of all responses divided by 10 categories.

Variability meant how spread out the data (Polit & Beck, 2012, 2018). In Q21, how various clinics differed in their level of readiness “from one another on the attribute” (Polit & Beck, 2018, p. 232). There were two most common indexes considered: range and SD (Polit & Beck, 2012) (see Chapters Four and Five). The range was the highest value subtracted from
the lowest value (Polit & Beck, 2012, 2018). Although automatically calculated, the SD was “based on every value in a distribution” (Polit & Beck, 2018, p. 233). SD summarized the average amount of deviation of “values from the mean” (Polit & Beck, 2012, p. 743).

The upper and lower limits of a 95% CI in Q21 were essential to identify as well. CI, which was set at the most generally used probability of 95%, was the range of values within a population parameter was estimated to lie (Polit & Beck, 2012, 2018). The upper limit (UL) was the highest true value of the population parameter (Polit & Beck, 2012, 2018). UL was calculated with the formula: the mean plus the SD. Conversely, the lower limit (LL) was the lowest true value of the population parameter (Polit & Beck, 2012, 2018). LL was calculated with the formula: the mean minus the SD. The final result was expressed in the form of: 95% CI (LL, UL). Of note, CI was not calculated in the rest of the survey questions because they were of nominal, dichotomous, and continuous data; these types of data could not be converted to numerical data as in Q21.

Both the mean and the SD for Q21 were instrumental in Excel to create a normal distribution graph (see Result). The mean was set to the general three SDs toward the LL and UL. If the actual mean was 1.1, three SDs toward the LL and UL would be -2.1 and 4.1, respectively. The deviations in between -2.1 and 4.1 were calculated in Excel with the formula: =-2.1 plus 0.1. The integer 0.1 was as an increment of 0.1 from -2.1 to 4.1 to get a bell curve.

SD was calculated with the formula: =NORM.DIST(-2.1 as the last value, mean, SD, false). This latter formula meant typing: =NORM.DIST, open parenthesis, -2.1, 1.1, 1.29, false, close parenthesis. The term “false” determined the peak of the graph itself automatically.

Methods of data collection, management, and evaluation required careful attention to details (Polit & Beck, 2012, 2018). The transformation of data into numbers, including percentages, graphs, and x² using Excel spreadsheets was structured (Polit & Beck, 2012, 2018). Data entry and confirmation, even reconfirmation, that they made sense were maintained as evidenced by methodical calculations (Polit & Beck, 2012, 2018).
Conclusions meant that relevant results were carefully weighed, thought of, and analyzed for significance, association, or relationship. Different types of questions – categorical, nominal, dichotomous, scale, or continuous – were instrumental. Research instruments were easy to use, accessible, appropriate, accurate, and within reasonable cost. Overall findings of this PIP indicated that the results were unlikely due to chance, not that they were of overt significance, or that they warranted further intensive research in the future (Polit & Beck, 2012, p. 478).

Chapter Four: Implementation Process and Results

BIS is a non-invasive tool, similar to standing on a weighing scale but measures fluid change in the affected arm. It is utilized in early screening for BCRL to improve routine breast cancer care. The purpose of this PIP was to bring awareness to early screening and possible adoption of BIS in the process by n = 12 participants of various specialties. In this chapter, the implementation process and results are discussed.

Implementation Process

Aim #1. Determined the current method of BCRL screening of n = 12 participants in Maui.

A list of different clinics/providers was searched online. They were around the areas of Wailuku, Kahului, Makawao, Kihei-Wailea, and Lahaina. Twenty-six were contacted on January 13, 2020. Key stakeholders were identified such as managers, executive assistants, office staff, or providers themselves. Phone conversation included a personal introduction, affiliation with the UHH DNP program, the general purpose of this PIP, and survey contents. Through phone conversation, open communication established rapport between the UHH DNP candidate and co-investigator, and possible participant.

Figure 2 illustrated the breakdown of participants and the interplay of anonymity. To reiterate, of those 26 clinics/providers, six of them had at least two to thirty providers. Of those 26 clinics/providers, too, one had four different distant satellites in Maui.
clinics/providers, 18 agreed to have this PIP along with the survey emailed to them. Of those 18 that agreed, there were 12 clinics/providers that participated. There were 12 actual participants (n = 12) overall.

Of the 12 participants that completed the survey, 11 did the online survey via Survey Monkey while one did the Word document version. The latter was emailed back to UHH DNP candidate and co-investigator, without specific identifying information on actual survey responses. Anonymity was maintained at every step of the process. There was no discernable information on whom else this PIP was sent to by keyholders (i.e., managers, executive assistants, office staff, or providers). Also, there was no discernable name on who participated.

The first question on the survey indeed asked for the description of the clinic, but did not explicitly asked for the name of the provider (see Appendices E and F). The job title of each of the 12 participants – be it MD, NP, or PA – was unknown. Anonymity was at the core of this PIP (see Figure 2). Table 2 summarized Aim #1:

**Table 2.** Summary of aim #1 with associated objectives and progress

<table>
<thead>
<tr>
<th>Aim #1</th>
<th>Objectives</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determined the current method of BCRL screening of n = 12 participants in Maui.</td>
<td>1. Partnered with n = 12 participants of various specialties through phone or email for information about their current method of BCRL screening.</td>
<td>Twenty-six local community health clinics/providers in Wailuku, Kahului, Makawao, Kihei-Wailea, and Lahaina were contacted. There were n = 12 participants.</td>
</tr>
<tr>
<td></td>
<td>2. Identified a key stakeholder as a point of contact.</td>
<td>Managers, executive assistants, office staff, or providers themselves were identified as key stakeholders. Through phone conversation, affiliation with the UHH DNP program, the general purpose of this PIP, method of participation, and modality of the survey were briefly explained.</td>
</tr>
</tbody>
</table>
Aim #2. Disseminated information about early BCRL screening using BIS.

Through phone conversation and identification of key stakeholders, this PIP was emailed and disseminated. The email included related information about BCRL and BIS (see Appendix D). Of note, a notice at the beginning and end of the email referred to an informed consent to willfully or voluntarily participate. The actual consent approved by the Institutional Review Board (IRB) was attached (see Appendix B). At the very bottom of such approved IRB consent, too, was explicit statements of: “Filling out the survey will be considered your consent to participate in this study” and “Please keep a copy of the consent form.” Explicit consent was covered in numerous areas.

The link to the online survey via Survey Monkey or Word document version was attached in the email. The online version was a continuous survey without a page break or had the option to click “Next” after each question. Participants were to click their answers and leave a comment in some respective areas when particularly asked. Eleven of the 12 participants completed the online version.

Another option for participants based on preference was to fill out the same survey but in a Word document format (see Appendix F). Apart from the survey in a Word document, another

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Established rapport and open communication with key stakeholders through phone and email.</td>
<td>Rapport and open communication were established through phone and subsequent email conversations. Future and actual participants were appreciated for their time and help. A reminder email was sent before the end date of the survey.</td>
</tr>
<tr>
<td>4. Incorporated the survey, both online via Survey Monkey and Word document versions.</td>
<td>The survey was emailed to key stakeholders, who, in turn disseminated it in a mass email to all relevant providers within their clinic.</td>
</tr>
</tbody>
</table>
difference to that of the online version was the instruction of “marking, highlighting, bolding, italicizing, underlining” their answers. If this version was chosen, then it was to be emailed back to the UHH DNP candidate and co-investigator. One of 12 participants completed the Word document version, which was emailed by office staff.

Both versions, be it the online or Word document, were anonymous. Anonymity was maintained as the survey did not require the name of participants, but rather a generalized description of their clinic (i.e., primary care/community clinic, private practice, or specialty clinic). This generalized description was the very first question in the survey in both versions.

The timeframe of data collection started on January 13, 2020 and ended on February 15, 2020. Data collection was a total of one month (see Table 3):

**Table 3.** Summary of aim #2 with associated objectives and progress

<table>
<thead>
<tr>
<th>Aim # 2</th>
<th>Objectives</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disseminated information about early BCRL screening using BIS to n = 12 participants.</td>
<td>1. Created a survey, which included the purpose of this PIP and brief yet concise information about BIS for early BCRL screening. The survey served as a health communication tool.</td>
<td>1. The first part of the research was an email, which included the personal introduction, information on BCRL and BIS, and consent to participate. The second part of the research was the survey itself, which was created in both online and Word document versions. The first version was via Survey Monkey, while the latter version was in a Word document. Regardless of the version, the survey served as a health communication tool in general.</td>
</tr>
<tr>
<td></td>
<td>2. Emailed the survey to n = 12 participants.</td>
<td>The email was sent to key stakeholders with both formats and consent to participate attached. Anonymity was maintained, regardless of version. Both versions did not require to list the name of any of the 12 participants (n = 12), but rather a generalized</td>
</tr>
</tbody>
</table>
**Aim #3**. Determined the interest of these $n=12$ participants in adopting BIS for early BCRL screening as part of prospective surveillance and routine breast cancer care. Surveys from $n=12$ participants were collected and obtained from password-secured accounts. Data were extrapolated into Excel spreadsheets (see Chapter Three and Four). Bar graphs and $\chi^2$ test calculations were utilized for analyses (see Chapter Three and Four). Overall findings were disseminated in HOKU, the UHH institutional repository (see Table 4):  

**Table 4.** Summary of aim #3 with associated objectives and progress

<table>
<thead>
<tr>
<th>Aim #3</th>
<th>Objectives</th>
<th>Progress</th>
</tr>
</thead>
</table>
| Determined the interest of $n=12$ participants in adopting BIS for early BCRL screening as part of prospective surveillance and routine breast cancer care. | 1. Collected the survey via an online survey and Word document. Both versions were accessed using password secured accounts, via Survey Monkey and university email.  
2. Analyzed data from the survey.  
3. Based on analyzed data, disseminated findings via HOKU, the UHH institutional repository. | 1. Collected $n=12$ surveys from both versions through password secured Survey Monkey and university email accounts.  
2. Analyzed data using graphs and $\chi^2$ tests for all $n=12$ participants and their responses to 22 survey questionnaires.  
3. Disseminated findings via HOKU. |

**Results**

This particular section presents the results from $n=12$ participants and their responses to 22 survey questionnaires. Their responses were collected and extrapolated into Excel
spreadsheets and in table formats. Calculations of their responses in percentages, as outlined in Chapter Three, were essential to creating separate bar graphs for each survey question. Hence, there was a total of 22 bar graphs.

For each survey question, competing hypotheses ($H_0$ and $H_A$) were made. More calculations – concerning O and E data, $x^2$ test, df, p-value, and $\alpha$ – were performed (see Chapter Three). Competing hypotheses and calculations were instrumental in most survey questions, except Q15 through Q17 (see Chapter Four and Five). In turn, they all played integral roles in yielding results for discussion (see Chapter Four and Five).

Q1. Twelve participants were surveyed about their type of clinic. Were the participants distributed normally? All $n = 12$ participants answered. None skipped this question. This was a nominal data (see Table 5):

Table 5. Q1 data

<table>
<thead>
<tr>
<th>My clinic is a _____. Please select from the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Care/Community Clinic</strong></td>
</tr>
<tr>
<td>25%, n=3</td>
</tr>
<tr>
<td><strong>Private Practice</strong></td>
</tr>
<tr>
<td>33.33%, n=4</td>
</tr>
<tr>
<td><strong>Specialty Clinic. If checked, please state the type of specialty clinic (i.e., radiation oncology, medical oncology, etc.). Specify below.</strong></td>
</tr>
<tr>
<td>41.67%, n=5</td>
</tr>
</tbody>
</table>

Responses ($n = 12$)
Q2. Twelve participants were surveyed to determine: the distribution of their patient panel with breast cancer. Were the participants distributed normally? All n = 12 participants answered. None skipped this question. This was a continuous data (see Table 6):

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O – E</th>
<th>(O – E)^2</th>
<th>x^2 = Σ (O – E)^2/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Care/Community Clinic</td>
<td>3</td>
<td>4</td>
<td>-1</td>
<td>1</td>
<td>0.25</td>
</tr>
<tr>
<td>Private Practice</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Specialty Clinic</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Excel formulas:

- x^2 = CHISQ.INV.RT(p, df)
- df = number of category – one
- p-value = CHISQ.TEST(Observed, Expected)
- α = 0.05

Result: x^2 (2, n = 12) = 0.5, p = 0.78
**Table 6.** Q2 data

![Bar chart showing the percentage of clinic’s patient panel with breast cancer.](chart)

**Legends:**
- Chi-square = $x^2$
- Sum = $\Sigma$
- Observed = $O$
- Expected = $E$
- Null hypothesis = $H_0$
- Alternative hypothesis = $H_A$
- Degree of freedom = $df$
- Probability value = $p$-value
- Confidence (alpha) level = $\alpha$
- Number of responses = $n$

**Formulas:**
- Chi-square test:
  \[ x^2 = \Sigma \frac{(O - E)^2}{E} \]
- $O = $ actual response
- $E = $ number of actual response $\div$ number of category
- Excel formulas:
  \[ x^2 = \text{CHISQ.INV.RT}(p, df) \]
  \[ df = $\text{number of category} - 1$ \]
  \[ p\text{-value} = \text{CHISQ.TEST}(\text{Observed}, \text{Expected}) \]
  \[ \alpha = 0.05 \]

**Result:**
- $x^2 (df, n) = $ actual $x^2$ value, $p = $ actual value

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>$O - E$</th>
<th>$(O - E)^2$</th>
<th>$x^2$ = $\Sigma \frac{(O - E)^2}{E}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10%</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>16</td>
<td>5.333333333333</td>
</tr>
<tr>
<td>10-39%</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0.333333333333</td>
</tr>
<tr>
<td>40-50%</td>
<td>0</td>
<td>3</td>
<td>-3</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>More than 50%</td>
<td>1</td>
<td>3</td>
<td>-2</td>
<td>4</td>
<td>1.333333333333</td>
</tr>
</tbody>
</table>

$\Sigma = 10$

$x^2 = 10$

$H_0$: Not normally distributed

$H_A$: Normally distributed
Q3. Twelve participants were surveyed to determine: the distribution of the most common gender of patients with breast cancer in their clinic? Were they distributed normally? All n = 12 answered. None skipped this question. This was a dichotomous data (see Table 7):

Table 7. Q3 data

<table>
<thead>
<tr>
<th>What is the most common gender of patients with breast cancer in your clinic?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
</tbody>
</table>

Legends:
Chi-square = $x^2$
Sum = $\Sigma$
Observed = O
Expected = E
Null hypothesis = $H_0$
Alternative hypothesis = $H_A$
Degree of freedom = df
Probability value = p-value
Confidence (alpha) level = $\alpha$
Number of responses = n

Formulas:
Chi-square test:
$$x^2 = \Sigma \frac{(o - e)^2}{e}$$
O = actual response
E = number of actual response ÷ number of category

Excel formulas:
$$x^2 = \text{CHISQ.INV.RT}(p, df)$$
df = number of category – one
p-value = CHISQ.TEST(Observed, Expected)
$\alpha = 0.05$

Result:
$$x^2 (df, n) = \text{actual } x^2 \text{ value, } p = \text{actual value}$$
Q4. Twelve participants were surveyed to determine: the distribution of the most common age range of those diagnosed with breast cancer in their clinic? Were they distributed normally? All n = 12 participants answered. None skipped this question. One participant chose two options: 41-50 years old and 61-60 years old. This was a continuous data (see Table 8):

Table 8. Q4 data
Q5. Twelve participants were surveyed to determine: the distribution of the most common race/ethnicity of patients diagnosed with breast cancer in their clinic? Were they distributed normally? All n = 12 answered. None skipped this question. One participant responded “Other,” which was specified as “White and Asian/Pacific Islander.” Participants could choose more than one option. This was nominal data (see Table 9):
Table 9. Q5 data

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O – E</th>
<th>(O – E)^2</th>
<th>(x^2 = \Sigma \frac{(O – E)^2}{E})</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>African-American</td>
<td>0</td>
<td>2</td>
<td>-2</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Legends:
Chi-square = \(x^2\)
Sum = \(\Sigma\)
Observed = \(O\)
Expected = \(E\)

Null hypothesis = \(H_0\)
Alternative hypothesis = \(H_A\)

Degree of freedom = \(df\)
Probability value = \(p\)-value
Confidence (alpha) level = \(\alpha\)

Number of responses = \(n\)

Formulas:
Chi-square test:
\(x^2 = \Sigma \frac{(O – E)^2}{E}\)

\(O = \) actual response
\(E = \) number of actual response ÷ number of category

Excel formulas:
\(x^2 = \text{CHISQ.INV.RT}(p,df)\)
\(df = \) number of category – one
\(p\)-value = \(\text{CHISQ.TEST}(\text{Observed}, \text{Expected})\)
\(\alpha = 0.05\)

Result:
\(x^2 (\text{df, n}) = \) actual \(x^2\) value, \(p = \) actual value

\(H_0\): Not normally distributed
\(H_A\): Normally distributed

Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?
### Q6. Early Screening for BCRL Using BIS

Eleven of the $n = 12$ participants surveyed to determine if: the most common sub-race of Asian Americans diagnosed with breast cancer is distributed normally? Were they distributed normally? Thus, $n = 11$ answered. One participant skipped this question.

Participants could choose more than one option. This was a nominal data (see Table 10):

**Table 10. Q6 data**

<table>
<thead>
<tr>
<th>Race</th>
<th>0</th>
<th>2</th>
<th>-2</th>
<th>4</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic</td>
<td>0</td>
<td>2</td>
<td>-2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Asian American</td>
<td>9</td>
<td>2</td>
<td>7</td>
<td>49</td>
<td>24.5</td>
</tr>
<tr>
<td>American Indian/Alaska Native</td>
<td>0</td>
<td>2</td>
<td>-2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>2</td>
<td>-1</td>
<td>1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Σ = 33

$x^2 = 33$

**Excel formulas:**

$$x^2 = \text{CHISQ.INV.RT}(p, df)$$

$df =$ number of category – one

$p$-value $= \text{CHISQ.TEST}(\text{Observed}, \text{Expected})$

$\alpha = 0.05$

$x^2 = 33$

$df = 5$

$p$-value $= 0.00$

$\alpha = 0.05$

**Result:** $x^2 (5, n = 12) = 33, p = 0.00$
Early Screening for BCRL Using BIS

**Legends:**
- Chi-square = \(x^2\)
- Sum = \(\Sigma\)
- Observed = \(O\)
- Expected = \(E\)
- Null hypothesis = \(H_0\)
- Alternative hypothesis = \(H_A\)
- Degree of freedom = \(df\)
- Probability value = \(p\)-value
- Confidence (alpha) level = \(\alpha\)
- Number of responses = \(n\)

**Formulas:**
- Chi-square test:
  \[x^2 = \Sigma \frac{(O - E)^2}{E}\]
  - \(O\) = actual response
  - \(E\) = number of actual response ÷ number of category
- Excel formulas:
  - \(x^2 = \text{CHISQ.INV.RT}(p, df)\)
  - \(df = \text{number of category} - 1\)
  - \(p\)-value = \(\text{CHISQ.TEST}(\text{Observed, Expected})\)
  - \(\alpha = 0.05\)

**Result:**
- \(x^2 (df, n) = \) actual \(x^2\) value, \(p = \) actual value

<table>
<thead>
<tr>
<th>Category</th>
<th>(O)</th>
<th>(E)</th>
<th>(O - E)</th>
<th>((O - E)^2)</th>
<th>(x^2 = \Sigma \frac{(O - E)^2}{E})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese</td>
<td>0</td>
<td>2.2</td>
<td>-2.2</td>
<td>4.84</td>
<td>2.2</td>
</tr>
<tr>
<td>Japanese</td>
<td>2</td>
<td>2.2</td>
<td>-0.2</td>
<td>0.04</td>
<td>0.018181818</td>
</tr>
<tr>
<td>Filipino</td>
<td>8</td>
<td>2.2</td>
<td>5.8</td>
<td>33.64</td>
<td>15.2909090909</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>7</td>
<td>2.2</td>
<td>4.8</td>
<td>23.04</td>
<td>10.472727272</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>2.2</td>
<td>-2.2</td>
<td>4.84</td>
<td>2.2</td>
</tr>
</tbody>
</table>

\[\Sigma = 30.18\]
\[x^2 = 30.18\]

**Result:** \(x^2 (4, n = 11) = 30.18, p = 0.00\)

**Q7.** Eleven of the \(n = 12\) participants were surveyed to determine if: the type of breast cancer treatment the majority of patients were distributed normally? Were they distributed normally? Thus, \(n = 11\) answered. One participant skipped this question. Participants could choose more than one option. This was a nominal data (see **Table 11**):
Table 11. Q7 data

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O – E</th>
<th>(O – E)^2</th>
<th>x^2 = Σ (O – E)^2/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation</td>
<td>0</td>
<td>2.2</td>
<td>-2.2</td>
<td>4.84</td>
<td>2.2</td>
</tr>
<tr>
<td>Surgery</td>
<td>2</td>
<td>2.2</td>
<td>-0.2</td>
<td>0.04</td>
<td>0.018181818</td>
</tr>
</tbody>
</table>
Q8. Twelve participants were surveyed to determine if: the distribution of patients who had undergone lymph node removal was distributed normally? Were they distributed normally? All n = 12 answered. None skipped this question. If the options were just “Yes” or “No,” then this question would be dichotomous. However, a “Some” option was included. This question became a nominal data (see Table 12):

Table 12. Q8 data

| For patients who had surgical intervention, did they have lymph nodes removed? |
|---|---|---|---|
| Yes | 33.33%, n=4 |
| No  | 0.00% |
| Some| 66.67%, n=8 |

Responses (n = 12)
Early Screening for BCRL Using BIS

Legends:
Chi-square = $x^2$
Sum = $\Sigma$
Observed = $O$
Expected = $E$

Null hypothesis = $H_0$
Alternative hypothesis = $H_A$

Degree of freedom = df
Probability value = p-value
Confidence (alpha) level = $\alpha$
Number of responses = $n$

Formulas:
Chi-square test:
\[
x^2 = \frac{\sum (O - E)^2}{E}
\]

Excel formulas:
\[
x^2 = \text{CHISQ.INV.RT}(p, df)
df = \text{number of category} - 1
p-value = \text{CHISQ.TEST}(\text{Observed}, \text{Expected})
\alpha = 0.05
\]

Result:
\[
x^2 (df, n) = \text{actual } x^2 \text{ value}, p = \text{actual value}
\]

<table>
<thead>
<tr>
<th>Category</th>
<th>$O$</th>
<th>$E$</th>
<th>$O - E$</th>
<th>$(O - E)^2$</th>
<th>$x^2 = \frac{\sum (O - E)^2}{E}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
<td>4</td>
<td>-4</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Yes</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Excel formulas:
\[
x^2 = \text{CHISQ.INV.RT}(p, df)
df = \text{number of category} - 1
p-value = \text{CHISQ.TEST}(\text{Observed}, \text{Expected})
\alpha = 0.05
\]

Result: $x^2 (2, n = 12) = 8, p = 0.02$

Q9. Twelve participants were surveyed to determine if: the main indication for lymph node removal was distributed normally in their clinic? Were they distributed normally? The first option was: Tumor dimension between one to two according to the Tumor, Node, Metaplasia (TNM) classification. The second option was: Ductal carcinoma in situ (DCIS). The third option was: DCIS with suspected/proved microinvasion. The fourth option was: Clinically negative axillary nodes following neoadjuvant chemotherapy. The last option was: Other. All $n = 12$ participants answered. None skipped this question. Two participants chose “Other” and
specified: “mastectomy patients or lumpectomy patients with invasive ductal carcinoma or prophylactic mastectomy,” and “sentinel lymph node biopsy as standard practice for clinically negative axilla.” Participants could choose more than one option. This was a nominal data (see Table 13):

Table 13. Q9 data

For those who had their lymph nodes removed, what was the main indication for removal?

<table>
<thead>
<tr>
<th>Tumor dimension between...</th>
<th>Ductal Carcinoma in Situ...</th>
<th>DCIS with...</th>
<th>Clinically negative axillary...</th>
<th>Other (please specify)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80%</td>
<td>75.00%, n=9</td>
<td>25.00%, n=3</td>
<td>16.67%, n=2</td>
<td>0.00%</td>
</tr>
<tr>
<td>70%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legends:
- Chi-square = $x^2$
- Sum = $\Sigma$
- Observed = O
- Expected = E
- Null hypothesis = $H_0$
- Alternative hypothesis = $H_A$
- Degree of freedom = df
- Probability value = p-value
- Confidence (alpha) level = $\alpha$
- Number of responses = n

Formulas:
- Chi-square test:
  
  $$x^2 = \Sigma \frac{(o - e)^2}{e}$$

  O = actual response
  E = number of actual response ÷ number of category

Excel formulas:
- $x^2 =$CHISQ.INV.RT(p,df)
- df = number of category – one
- p-value =CHISQ.TEST(Observed, Expected)
- $\alpha = 0.05$

Result:
- $x^2$ (df, n) = actual $x^2$ value, $p =$ actual value
Early Screening for BCRL Using BIS

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O – E</th>
<th>(O – E)²</th>
<th>$x^2 = \Sigma \frac{(O - E)^2}{E}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tumor dimension…</td>
<td>9</td>
<td>2.4</td>
<td>6.6</td>
<td>43.56</td>
<td>18.15</td>
</tr>
<tr>
<td>Ductal carcinoma…</td>
<td>3</td>
<td>2.4</td>
<td>0.6</td>
<td>0.36</td>
<td>0.15</td>
</tr>
<tr>
<td>DCIS with…</td>
<td>4</td>
<td>2.4</td>
<td>1.6</td>
<td>2.56</td>
<td>1.066666667</td>
</tr>
<tr>
<td>Clinically…</td>
<td>0</td>
<td>2.4</td>
<td>-2.4</td>
<td>5.76</td>
<td>2.4</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>2.4</td>
<td>-0.4</td>
<td>0.16</td>
<td>0.066666667</td>
</tr>
</tbody>
</table>

**Excel formulas:**

- $x^2 = \text{CHISQ.INV.RT}(p, df)$
- $df = \text{number of category} - 1$
- $p\text{-value} = \text{CHISQ.TEST}(\text{Observed}, \text{Expected})$

**Result:** $x^2 (4, n = 12) = 21.83, p = 0.00$

**Q10.** Twelve participants were surveyed to determine: how BCRL was diagnosed in their clinic? Were they distributed normally? All $n = 12$ participants answered. None skipped this question. This was a nominal data (see Table 14):

**Table 14.** Q10 data

![Chart](chart.png)

How is BCRL diagnosed in your clinic?

- 91.67%, n=11
- 8.33%, n=1

- Responses (n = 12)
Q11. Twelve participants were surveyed to determine: how frequent BCRL was diagnosed in their clinic? All n = 12 participants answered. None skipped this question. This was a nominal data (see Table 15):
Table 15. Q11 data

### How frequent is BCRL observed in your clinic?

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O – E</th>
<th>(O – E)^2</th>
<th>x^2 = Σ (O – E)^2/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not frequent</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>36</td>
<td>9</td>
</tr>
<tr>
<td>Frequent</td>
<td>2</td>
<td>4</td>
<td>-2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Very frequent</td>
<td>0</td>
<td>4</td>
<td>-4</td>
<td>16</td>
<td>4</td>
</tr>
</tbody>
</table>

### Legends:

- Chi-square = x^2
- Sum = Σ
- Observed = O
- Expected = E
- Null hypothesis = H₀
- Alternative hypothesis = Hₐ
- Degree of freedom = df
- Probability value = p-value
- Confidence (alpha) level = α
- Number of responses = n

### Formulas:

**Chi-square test:**

\[ x^2 = \frac{\sum (O - E)^2}{E} \]

- O = actual response
- E = number of actual response ÷ number of category

**Excel formulas:**

- \( x^2 = \text{CHISQ.INV.RT}(p, df) \)
- \( df = \text{number of category} - 1 \)
- \( p\text{-value} = \text{CHISQ.TEST}(\text{Observed}, \text{Expected}) \)
- \( \alpha = 0.05 \)

**Result:**

\[ x^2 (df, n) = \text{actual } x^2 \text{ value, } p = \text{actual value} \]
Q12. Twelve participants were surveyed to determine: how common BCRL was in their clinic? All n = 12 participants answered. None skipped this question. This was a continuous data (see Table 16):

Table 16. Q12 data

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Responses (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10%</td>
<td>0.00%</td>
</tr>
<tr>
<td>10 to 29%</td>
<td>25.00%, n = 3</td>
</tr>
<tr>
<td>30 to 50%</td>
<td>75.00%, n = 9</td>
</tr>
<tr>
<td>More than 50%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

Legends:
- Chi-square = $x^2$
- Sum = $\Sigma$
- Observed = $O$
- Expected = $E$
- Null hypothesis = $H_0$
- Alternative hypothesis = $H_A$
- Degree of freedom = df
- Probability value = p-value
- Confidence (alpha) level = $\alpha$
- Number of responses = n

Formulas:
- Chi-square test:
  $$x^2 = \sum \frac{(O - E)^2}{E}$$
- Excel formulas:
  $$x^2 = \text{CHISQ.INV.RT}(p, df)$$
  $$\text{df} = \text{number of category} - \text{one}$$
  $$\text{p-value} = \text{CHISQ.TEST(Observed, Expected)}$$
  $$\alpha = 0.05$$
Early Screening for BCRL Using BIS

Result:
\[ x^2 (df, n) = \text{actual } x^2 \text{ value, } p = \text{actual value} \]

**H₀:** Not common

**Hₐ:** Common

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O – E</th>
<th>(O – E)²</th>
<th>[ x^2 = \sum \frac{(O – E)^2}{E} ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10%</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td>36</td>
<td>12</td>
</tr>
<tr>
<td>10 to 29%</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>30 to 50%</td>
<td>0</td>
<td>3</td>
<td>-3</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>More than 50%</td>
<td>0</td>
<td>3</td>
<td>-3</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>

| Σ = 18 |
| \( x^2 = 18 \) |

**Excel formulas:**
\[ x^2 = \text{CHISQ.INV.RT}(p, df) \]
\[ df = \text{number of category – one} \]
\[ p\text{-value} = \text{CHISQ.TEST}(\text{Observed, Expected}) \]
\[ x^2 = 18 \]
\[ df = 3 \]
\[ p\text{-value} = 0.00 \]
\[ \alpha = 0.05 \]

**Result:** \( x^2 (3, n = 12) = 18, p = 0.00 \)

**Q13.** Twelve participants were surveyed to determine if BMI was a contributing factor in patients diagnosed with BCRL? All \( n = 12 \) participants answered. None skipped this question.

This was a dichotomous data (see **Table 17**):

**Table 17.** Q13 data

<table>
<thead>
<tr>
<th>Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?</th>
<th>Responses (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>83.33%, n=10</td>
</tr>
<tr>
<td>No</td>
<td>16.67%, n=2</td>
</tr>
</tbody>
</table>
Q14. Twelve participants were surveyed to determine if: the average BMI of those with BCRF? Was the average BMI high or not? All n = 12 participants answered. None skipped this question. This was a continuous data (see Table 18):
Table 18. Q14 data

What is the average BMI of those with BCRL?

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O - E</th>
<th>(O - E)^2</th>
<th>x^2 = Σ (O - E)^2/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI &lt;18</td>
<td>0</td>
<td>3</td>
<td>-3</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>BMI 18 to 25</td>
<td>0</td>
<td>3</td>
<td>-3</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>BMI 26 to 29</td>
<td>1</td>
<td>3</td>
<td>-2</td>
<td>4</td>
<td>1.333333333</td>
</tr>
<tr>
<td>BMI &gt;30</td>
<td>11</td>
<td>3</td>
<td>8</td>
<td>64</td>
<td>21.333333333</td>
</tr>
</tbody>
</table>

Σ = 28.67
x^2 = 28.67

Legends:
Chi-square = x^2
Sum = Σ
Observed = O
Expected = E
Null hypothesis = H₀
Alternative hypothesis = Hₐ
Degree of freedom = df
Probability value = p-value
Confidence (alpha) level = α
Number of responses = n

Formulas:
Chi-square test:
\[ x^2 = \frac{\sum (O - E)^2}{E} \]

O = actual response
E = number of actual response ÷ number of category

Excel formulas:
\[ x^2 = \text{CHISQ.INV.RT}(p, df) \]

df = number of category – one
\[ p\text{-value} = \text{CHISQ.TEST}(\text{Observed}, \text{Expected}) \]
α = 0.05

Result:
\[ x^2 (df, n) = \text{actual } x^2 \text{ value, } p = \text{actual value} \]
Excel formulas:
\[ x^2 = \text{CHISQ.INV.RT}(p, df) \]
\[ df = \text{number of category} - \text{one} \]
\[ p\text{-value} = \text{CHISQ.TEST(Observed, Expected)} \]

Result: \[ x^2 (3, n = 12) = 28.67, p = 0.00 \]

Q15. Twelve of the participants were surveyed if BIS was available? All \( n = 12 \) participants answered. None skipped this question. If the participant answered “Yes,” then the instruction was to proceed to Question #16. Otherwise, if the participant answered “No,” then skipping to Question #18 was warranted. A bar graph was created. The \( x^2 \) test, on the other hand, was not performed (see Discussion under Chapter Five). This was a dichotomous data (see Table 19):

Table 19. Q15 data

<table>
<thead>
<tr>
<th>Is BIS available?</th>
<th>Responses (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. If answered no, please skip to Question 18.</td>
<td>91.67%, n=11</td>
</tr>
<tr>
<td>Yes. If answered yes, please continue to Question 16.</td>
<td>8.33%, n=1</td>
</tr>
</tbody>
</table>

Q16. This question only pertained to one participant, who was surveyed to determine: how long BIS had been in the clinic? Eleven of the \( n = 12 \) participants had to skip this question.
A bar graph was created. As there was only one participant, the $x^2$ test was performed (see Discussion under Chapter Five). This was continuous data (see Table 20):  

Table 20. Q16 data

<table>
<thead>
<tr>
<th>How long have you had BIS in your clinic?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2 years</td>
</tr>
<tr>
<td>100%</td>
</tr>
</tbody>
</table>

Q17. This question pertained to the same one participant, who was surveyed to determine: if there was a noted difference in the quality of screening, treatment, and management for BCRL? Eleven of the n = 12 participants had to skip this question. As this pertained to only one participant, the $x^2$ test was performed. This was a dichotomous data (see Table 21):
Table 21. Q17 data

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you find a difference in the quality of screening, treatment, and management for BCRL?</td>
<td>100.00%, n=1</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

Q18. Twelve participants were surveyed to determine: their interest in adopting BIS in the future? All n = 12 participants answered. None skipped this question. If the options were just “Yes” or “No,” then this question would be a dichotomous data. However, a “Some” option was included. This question was overall a nominal data (see Table 22):

Table 22. Q18 data

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>Maybe</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?</td>
<td>25.00%, n=3</td>
<td>28.00%, n=7</td>
<td>16.67%, n=2</td>
</tr>
</tbody>
</table>
Q19. Twelve participants were surveyed to determine if: they would recommend BIS?

All n = 12 participants answered. Aside from the “Yes” or “No” option, there was also a “Maybe” option. This question was a nominal data rather than dichotomous data (see Table 23):
Table 23. Q19 data

Would you recommend other clinics to have BIS?

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O − E</th>
<th>(O − E)^2</th>
<th>(x^2 = \frac{\sum (O - E)^2}{E})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>3</td>
<td>4</td>
<td>-1</td>
<td>1</td>
<td>0.25</td>
</tr>
<tr>
<td>Maybe</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>9</td>
<td>2.25</td>
</tr>
</tbody>
</table>

\[\Sigma = 6.5\]

\[x^2 = 6.5\]

Legends:
Chi-square = \(x^2\)
Sum = \(\Sigma\)
Observed = \(O\)
Expected = \(E\)
Null hypothesis = \(H_0\)
Alternative hypothesis = \(H_A\)
Degree of freedom = \(df\)
Probability value = \(p\)-value
Confidence (alpha) level = \(\alpha\)
Number of responses = \(n\)

Formulas:
Chi-square test:
\[x^2 = \frac{\sum (O - E)^2}{E}\]

\(O\) = actual response
\(E\) = number of actual response \(\div\) number of category

Excel formulas:
\(x^2 = \text{CHISQ.INV.RT}(p, \text{df})\)
\(\text{df} = \text{number of category} - 1\)
\(p\)-value = \(\text{CHISQ.TEST}(\text{Observed}, \text{Expected})\)
\(\alpha = 0.05\)

Result:
\(x^2 (df, n) = \text{actual } x^2 \text{ value}, \ p = \text{actual value}\)
Q20. Eleven of the 12 participants were surveyed to determine if they were likely to adopt BIS in the future? All n = 11 participants answered. One skipped this question. This was a nominal data (see Table 24):

Table 24. Q20 data

<table>
<thead>
<tr>
<th>How likely are you to adopt BIS in the future?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likely</td>
</tr>
<tr>
<td>9.09%, n=1</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
<tr>
<td>45.45%, n=5</td>
</tr>
<tr>
<td>Not likely</td>
</tr>
<tr>
<td>45.45%, n=5</td>
</tr>
</tbody>
</table>

Legends:

Chi-square = $x^2$
Sum = $\Sigma$
Observed = $O$
Expected = $E$
Null hypothesis = $H_0$
Alternative hypothesis = $H_A$
Degree of freedom = df
Probability value = p-value
Confidence (alpha) level = $\alpha$

Formulas:

Chi-square test:

$$x^2 = \Sigma \frac{(o - e)^2}{e}$$

$O$ = actual response
$E$ = number of actual response ÷ number of category

Excel formulas:

$x^2$ = CHISQ.INV.RT(p,df)
$df$ = number of category – one
p-value = CHISQ.TEST(Observed, Expected)
Number of responses = n
\[ \alpha = 0.05 \]

**Result:**
\[ x^2 \ (df, n) = \text{actual } x^2 \text{ value}, \ p = \text{actual value} \]

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O – E</th>
<th>((O – E)^2)</th>
<th>(\sum (O – E)^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not likely</td>
<td>5</td>
<td>3.666666667</td>
<td>1.333333333</td>
<td>1.777777778</td>
<td>0.484848485</td>
</tr>
<tr>
<td>Neutral</td>
<td>5</td>
<td>3.666666667</td>
<td>1.333333333</td>
<td>1.777777778</td>
<td>0.484848485</td>
</tr>
<tr>
<td>Likely</td>
<td>1</td>
<td>3.666666667</td>
<td>-2.666666667</td>
<td>7.111111111</td>
<td>1.939393939</td>
</tr>
</tbody>
</table>

\[ \Sigma = 2.91 \]

\[ x^2 = 2.91 \]

**Excel formulas:**
\[ x^2 = \text{CHISQ.INV.RT}(p, df) \]
\[ df = \text{number of category - one} \]
\[ p\text{-value} = \text{CHISQ.TEST(Observed, Expected)} \]
\[ \alpha = 0.05 \]

**Result:**
\[ x^2 \ (2, n = 11) = 2.91, \ p = 0.23 \]

**Q21.** Eleven of the \( n = 12 \) participants were surveyed to determine: their readiness to adopt BIS in the future? All \( n = 11 \) participants answered. One skipped this question. This was a rank order data (see Table 25):

**Table 25.** Q21 data
Early Screening for BCRL Using BIS

Legends:
Chi-square = $x^2$
Sum = $\Sigma$
Observed = $O$
Expected = $E$

Null hypothesis = $H_0$
Alternative hypothesis = $H_A$

Degree of freedom = df
Probability value = p-value
Confidence (alpha) level = $\alpha$
Number of responses = $n$

Formulas:
Chi-square test:
$$x^2 = \Sigma \frac{(O - E)^2}{E}$$

$O$ = actual response
$E$ = number of actual response ÷ number of category

Excel formulas:
$$x^2 = \text{CHISQ.INV.RT}(p, df)$$
$$\text{df} = \text{number of category} - 1$$
$$p\text{-value} = \text{CHISQ.TEST}(\text{Observed, Expected})$$
$$\alpha = 0.05$$

Result:
$$x^2 (df, n) = \text{actual } x^2 \text{ value, } p = \text{actual value}$$

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>$O - E$</th>
<th>$(O - E)^2$</th>
<th>$x^2 = \Sigma \frac{(O - E)^2}{E}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Not ready)</td>
<td>3</td>
<td>1.1</td>
<td>1.9</td>
<td>3.61</td>
<td>3.281818182</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1.1</td>
<td>-1.1</td>
<td>1.21</td>
<td>1.1</td>
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<td>1.1</td>
</tr>
<tr>
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<td>1.1</td>
<td>0.9</td>
<td>0.81</td>
<td>0.736363636</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>1.1</td>
<td>0.9</td>
<td>0.81</td>
<td>0.736363636</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>1.1</td>
<td>0.9</td>
<td>3.61</td>
<td>3.281818182</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>1.1</td>
<td>-1.1</td>
<td>1.21</td>
<td>1.1</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>1.1</td>
<td>-1.1</td>
<td>1.21</td>
<td>1.1</td>
</tr>
<tr>
<td>10 (Ready)</td>
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<td>1.1</td>
<td>-0.1</td>
<td>0.01</td>
<td>0.009090909</td>
</tr>
</tbody>
</table>

Excel formulas:
$$x^2 = \text{CHISQ.INV.RT}(p, df)$$
$$\text{df} = \text{number of category} - 1$$
$$p\text{-value} = \text{CHISQ.TEST}(\text{Observed, Expected})$$
$$\alpha = 0.05$$

Result: $x^2 (9, n = 11) = 13.55, p = 0.14$

Furthermore, the level of readiness and responses as well as descriptive statistics were extrapolated with automatic calculations via Excel spreadsheets (see Chapter Three). The results are shown in Figures 11 and 12. The indexes for frequency distribution of mode,
median, and mean were identified: zero, 0.5, and 1.1, respectively. The range and the SD, three and 1.29 respectively, were integral parts of variability. CI was set at 95%, with the LL of -0.19 and UL of 2.39. Increments of 0.1 from LL and UL were calculated to create a normal distribution graph. The final values of increments were utilized to produce such graph, which was symmetrical and unimodal (Polit & Beck, 2012, 2019):

Figure 11. Descriptive statistics

<table>
<thead>
<tr>
<th>Level of Readiness</th>
<th>Responses</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Not ready)</td>
<td>3</td>
<td>1.1</td>
<td>1.286683938</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2.00</td>
<td>0.124711655</td>
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<td>1</td>
<td>1.00</td>
<td>0.528614742</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0.50</td>
<td>0.345879889</td>
</tr>
<tr>
<td>5 (Neutral)</td>
<td>2</td>
<td>1.50</td>
<td>0.345707719</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>1.40</td>
<td>0.47862122</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>1.30</td>
<td>0.54762308</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1.20</td>
<td>0.03103079</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>1.10</td>
<td>0.27238744</td>
</tr>
<tr>
<td>10 (Ready)</td>
<td>1</td>
<td>1.00</td>
<td>0.682189488</td>
</tr>
</tbody>
</table>

Descriptive Statistics:
- Mean: 1.1
- Standard Deviation: 1.286683938
- Range: 3
- Minimum: 0
- Maximum: 3
- Sum: 11
- Count: 10
- Confidence Level (CI, 95.0%): 0.920438241
- Upper Limit (UL): 2.386683938
- Lower Limit (LL): -0.18668394

CI was set at 95%, with the LL of -0.19 and UL of 2.39. Increments of 0.1 from LL and UL were calculated to create a normal distribution graph. The final values of increments were utilized to produce such graph, which was symmetrical and unimodal (Polit & Beck, 2012, 2019):

Figure 11. Descriptive statistics
**Figure 12.** Frequency distribution and bell curve

**Q22.** Twelve clinics/surveyed to determine if: barriers existed that would impact their decision to adopt BIS? All n = 12 participants answered. None skipped this question. One participant chose “Other” and specified: “Would need to research articles to be provided for review.” Participants could choose more than one option. This was a categorical data (see Table 26):
### Table 26. Q22 data

<table>
<thead>
<tr>
<th>Category</th>
<th>O</th>
<th>E</th>
<th>O − E</th>
<th>(O − E)²</th>
<th>$x^2 = \sum \frac{(O - E)^2}{E}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of applicability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organizational/Institutional</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insurance/Financial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient adherence/Compliance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment related adverse events</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legends:**
- Chi-square = $x^2$
- Sum = $\Sigma$
- Observed = $O$
- Expected = $E$
- Null hypothesis = $H_0$
- Alternative hypothesis = $H_A$
- Degree of freedom = df
- Probability value = p-value
- Confidence (alpha) level = $\alpha$
- Number of responses = $n$

**Formulas:**
- Chi-square test:
  $$x^2 = \sum \frac{(O - E)^2}{E}$$
- $O$ = actual response
- $E$ = number of actual response ÷ number of category

**Excel formulas:**
- $x^2 = $CHISQ.INV.RT(p,df)
- df = number of category - one
- p-value = $=$CHISQ.TEST(Observed, Expected)
- $\alpha = 0.05$

**Result:**
- $x^2$ (df, n) = actual $x^2$ value, $p$ = actual value
Chapter Five: Discussion of Results, Implications for Practice, Future Recommendations, Strengths, Limitations or Weaknesses, and Conclusion

The overarching purpose of this PIP was to determine the current method of BCRL screening of n = 12 clinics/providers (participants) in Maui and the possible adoption of BIS for early BCRL screening. Such purpose was divided into three separate aims. Aim #1 was to determine their current method of BCRL screening. Aim #2, on the other hand, was to disseminate information about early BCRL screening with the use of BIS. Aim #3 was to determine their interest in BIS adoption as part of prospective surveillance and routine breast cancer care.

Conceptual and theoretical frameworks guided this PIP. On the one hand, the conceptual framework was in the form of PICO: clinics/providers to use BIS for early BCRL screening instead of clinical diagnosis or traditional modality (i.e., arm circumference or water displacement). This format was established to yield outcomes of: increasing the use of BIS, bringing awareness to early BCRL screening using BIS, improving routine breast cancer care,
enhancing the quality of care, and possibly community-wide adoption. On the other hand, the Diffusion of Innovation (DOI) theory served as a theoretical framework that would help gain momentum by providing relevant information on BCRL and BIS as well as their timely significance for adoption. There were different adopter categories within the DOI theory such as innovators, early adopters, early majority members, late majority members, and laggards. Open communication and subsequent persuasion were embedded in the information provided to n = 12 participants.

This chapter details the discussion of results and recommendations. Strengths and limitations or weaknesses are also discussed.

**Discussion of Results**

The overall findings supported the overarching purpose, aims, objectives, and both frameworks that guided this PIP. These findings identified specific characteristics and factors (i.e., age, race/ethnicity, most common age and gender with a breast cancer diagnosis, average BMI, etc.) from n = 12 participants.

The O data was utilized to create separate bar graphs for all 22 survey questions. With the O and E data, the $\chi^2$ test was performed predominantly to determine possible associations or if an association was unknown (Polit & Beck, 2012, 2018). The $\chi^2$ test, however, could not quantify any given variability such as gender-based risks, the number of patients, frequency of populations, prevalence and incidences, and lifestyles among others (Polit & Beck, 2012, 2018). This PIP attempted to address possible variability pertinent to each survey question.

Statistical significance was evaluated using the p-value and $\alpha$, which was set at 0.05. If the p-value was less or greater than the $\alpha$, then the $H_0$ would be rejected (or the $H_A$ would be accepted) or failed to reject the $H_0$ (or the $H_0$ was true) respectively.

**Q1:** My clinic is a __. This nominal data identified the types of clinic. There was n = 3, n = 4, and n = 5 Primary Care/Community Clinic, Private Practice, and Specialty Clinic,
respectively. The majority of the participants were in Specialty Clinic areas. Q1 was too
general. Each option needed to be clearly defined to avoid overlap of categorization. For
example, Private Practice could be Primary Care or Specialty Clinic. Specialty Clinic should
have been individually identified, rather than conglomerated. The p-value 0.78 was greater than
\( \alpha \) 0.05, which was statistically not significant and failed to reject the \( H_0 \). The \( H_0 \) was true: not
normally distributed, likely because the number of types of clinic was not equal.

Q1 supported the Aim #2 of this PIP to disseminate information about early BCRL
screening using BIS not just to \( n = 12 \) actual participants but also to the rest of those who were
contacted yet did not participate. Q1 determined a characteristic of the participants in a general
sense.

**Q2**: The percentage of the clinic’s patient panel with breast cancer. This continuous
data provided an approximation of percentage and a characteristic of the population of breast
cancer patients within their clinic. More than 58% chose the option of less than 10%. Less than
10% was a relatively small percentage of patients with breast cancer. Q2 did not account for
the actual number of patients, however. There may be more accounted in a Specialty Clinic
(i.e., medical oncology or radiation oncology) per se than in Community Clinic, or vice versa.
Although less than 10% might appear as a relatively small percentage, it does not negate
screening and prevention as well as treatment that would impact overall management.

The actual number of patients would be challenging and time-consuming to identify.
Unless the focus of this PIP was shifted in that direction, then a stricter process would need to
be followed including an agreement between the facility and UHH, IRB approval for a human
subject, patient consent and more. The p-value 0.02 was less than \( \alpha \) 0.05, which was
statistically significant and rejected the \( H_0 \). The \( H_A \) of normal distribution was accepted. Some
association existed, which may be due to the inherent sharing or overlap of patients in each
practice. A patient with breast cancer may likely end up in Specialty Clinic like General Surgery, Medical Oncology, or Radiation Oncology as needed.

**Q3:** The distribution of the most common gender of patients with breast cancer in their clinic. This dichotomous data was specific to the subject matter being asked in the question; hence, a general characteristic within their clinic. Q3 supported the general notion that a breast cancer diagnosis was more common in women and provided a focus of a target population for primary prevention (Wells et al., 2012; Buttaro, Trybulski, Polgar-Bailey, & Sandberg-Cook, 2013; Doherty, 2015). It did not specify the number of actual patients in both genders. There could be a small number of men with breast cancer in Maui as well.

The p-value 0.00 was less than \( \alpha \) 0.05, which was statistically significant and rejected the \( H_0 \). The \( H_A \) of normal distribution was accepted. Although some association existed, which was once again from the inherent sharing or overlap of patients, statistical results could not quantify variability (Polit & Beck, 2012, 2018). In particular, the variability of higher gender-based risks with race/ethnicity, prevalence, incidences, and lifestyles among others (Akinyemiju, Wiener, & Pisu, 2017).

**Q4:** The distribution of the most common age range of those diagnosed with breast cancer in their clinic. This continuous data provided an estimation of the subject matter being asked in the question, and another general characteristic within their clinic. Like Q3, Q4 provided a target age group for primary prevention (Wells et al., 2012; Buttaro et al., 2013; Doherty, 2015). The majority of the participants chose 51 to 60 years old, which supported current literature (Wells et al., 2012; Doherty, 2015; Center for Disease Control and Prevention [CDC], 2018). Some participants chose options below and above the most common age group.

The p-value 0.00 was less \( \alpha \) 0.05, which was statistically significant and rejected the \( H_0 \). The \( H_A \) of normal distribution was accepted possibly from the same association of inherent sharing or overlap of patients. Such distribution could not quantify variability (Polit & Beck,
Early Screening for BCRL Using BIS

2012, 2018). The number of patients between the ages of 51 to 60 years old (or other age groups) with breast cancer could be higher (or lower) in another clinic versus another. To determine the most common age would, once again, be challenging, time-consuming, and require a stricter process.

Q5: The distribution of the most common race/ethnicity of patients diagnosed with breast cancer in their clinic. This nominal data specified the subject matter being asked as another general characteristic within their clinic. Q5 provided a target race/ethnicity for primary prevention (Wells et al., 2012; Buttaro et al., 2013; Doherty, 2015). Asian-Americans were the highest, followed by Whites, and Others. One out of n = 12 participants chose Others and specified “Whites and Asian Americans.” Even then, the highest and subsequent populations would still be the same and supported the findings of Braun, Fong, Gotay, Pagano, and Chong (2005). These authors concluded that Asian Americans had higher rates of positive receptor breast cancer than Whites locally (Braun et al., 2005). They also stated that although disparities in survival were reduced in both Asian Americans and Whites, those disparities still existed.

The p-value 0.00 was less than α 0.05, which was statistically significant and rejected the H₀. The Hₐ of normal distribution was accepted, possibly from association tied to the sharing or overlap of patients. Such association could also be from the fact that nearly half of Maui’s population is Asian Americans (Asian and Pacific Islander American Vote, 2018; U.S. Census Bureau, 2019). One could argue that the number of Asian Americans (or other races/ethnicities), let alone those with breast cancer, in a given clinic could vary – be it higher or lower – in another.

Q6: The most common sub-race of Asian Americans diagnosed with breast cancer is distributed normally. This nominal data was a follow up to Q5 to further identify the subject matter being asked in the question. Q6 could be a target population for primary prevention as well (Wells et al., 2012; Buttaro et al., 2013; Doherty, 2015). The results supported the findings of Braun et al. (2005): among the highest of Asian Americans diagnosed with breast cancer
were Filipinos, Pacific Islanders, and Japanese. Pacific Islanders needed to be delineated as it
could entail other local groups.

The p-value 0.00 was less than \( \alpha 0.05 \), which was statistically significant and rejected
the \( H_0 \). The \( H_A \) of normal distribution was accepted, possibly from the inherent sharing or
overlap of patients.

Q7: The type of breast cancer treatment the majority of patients were distributed
normally. This nominal data identified the subject matter being asked in the question. More
than 81% of the participants chose the option that enlisted both radiation and surgery. Each
option carries a degree of variability. For instance, radiation might involve length and dose.
The same tenet would apply in chemoprevention. Surgery may include removal of the lump
versus removal of the entire breast, with or without node biopsy.

There would also be the variability of certain types of breast cancer and other
pathological findings like atypical hyperplasia, usual ductal hyperplasia, comedo necrosis, etc.
(NCCN, 2019). This PIP recognized such variabilities existed but certainly beyond its scope.
The p-value 0.00 was less than \( \alpha 0.05 \), which was statistically significant and rejected the \( H_0 \).
The \( H_A \) of normal distribution was accepted, perhaps from the inherent sharing or overlap of
patients.

Q8: The distribution of patients who had undergone lymph node removal was distributed
normally. Compared to dichotomous data with two options, Q8 was a nominal data because
there were more than two options. The most commonly chosen answers were “Some” and
“Yes” at more than 66% and 33%, respectively. The overall result reinforced the findings of
multiple studies that lymph node removal was a contributing factor to an increased risk of
developing BCRL (Soran et al., 2006; Bulley et al., 2013; Sierla et al., 2013; Fu, 2014; Shah et
al., 2016).
These studies asserted that the more lymph nodes removed, the higher the incidence of BCRL would be (Soran et al., 2006; Bulley et al., 2013; Sierla et al., 2013; Fu, 2014; Shah et al., 2016). The chief variability regarding the number of lymph nodes was beyond the scope of this PIP. Determination of this variability would require a stricter process, perhaps an even large sample and at a large cancer center.

Given that the lymph node distribution was unknown, the $x^2$ test was performed. The p-value 0.02 was less than $\alpha 0.05$, which was statistically significant and rejected the $H_0$. Surprisingly, the $H_A$ of normal distribution was accepted. Although a possible association could be unknown, it might be due to the inherent sharing or overlap of patients, specific breast cancer diagnosis, and indication for lymph node removal. Lymph node removal, via sentinel node or axillary node dissection, needed to be delineated.

Q9: The main indication for lymph node removal was distributed normally in their clinic. This nominal data identified the subject matter being asked in this question. Seventy-five percent of the participants chose the option of tumor dimension between one to two according to the TNM classification. Such option was followed by DCIS with suspect/proved microinvasion and DCIS at 33% and 25%, respectively. Accurate determination of each indication from each participant would be challenging, time-consuming, and require a stricter process. Q19 determined a characteristic of lymph node removal particular to the community, which supported the current clinical guidelines as outlined by NCCN (2020).

Similar to Q8, since the distribution being asked in Q9 was unknown, the $x^2$ test was performed. The p-value 0.00 was less than $\alpha 0.05$, which was statistically significant and rejected the $H_0$. The $H_A$ of normal distribution was accepted. Q9 possibly followed the findings in Q8 that association could also be unknown and related to inherent sharing or overlap of patients.
Q10: Determined how BCRL was diagnosed, either clinical diagnosis or with screening tool/device/machine, and if it was distributed normally. This nominal data yielded that 11 out of the 12 participants utilized clinical diagnosis for BCRL. The remaining participant utilized the latter method. The latter method, however, did not specify which type – be it BIS, a tape measure for arm circumference measurement, or water in water displacement (Stout et al., 2012; Shah et al., 2012; Soran et al., 2016). Q19 confirmed that clinical diagnosis was most commonly used; in turn, this could mean that the local community was not as generally innovative per the DOI theory.

One could argue that such a common way of diagnosis was the most readily available method. In other words, the need for a screening tool/device/machine was inadequate. Aside from inter-and-intraobserver variability associated with clinically diagnosing BCRL, the inadequate need would be another variability that the $\chi^2$ test could not quantify (Shah et al., 2016). Since Q9 confirmed that clinical diagnosis was most commonly used, Q9 supported the Aim #1 of this PIP.

Interestingly, the p-value 0.00 was less than $\alpha 0.05$, which was statistically significant and rejected the $H_0$. The $H_A$ of normal distribution was accepted, likely from the inherent sharing or overlap of patients. The number of patients with BCRL between clinics/providers might indeed differ. Another possible association would be a degree of saturation, meaning despite the number of patients with BCRL in the clinic/provider ($n = 1$) that utilized a screening tool/device/machine was saturated by the number of patients with BCRL in the rest of the clinics/providers ($n = 11$) (Cousins, 2013). The $n = 1$ participant, as an innovator per the DOI theory, with a screening tool/device/machine could be a focus of a more extensive study prospectively.

Q11: How frequent BCRL was diagnosed in their clinic. This was a nominal data that yielded findings of “Not frequent” from $n = 10$ participants, at more than 83%. Sixteen percent ($n = 2$) noted that BCRL was “Frequent.” The actual number of patients with breast cancer and
those with BCRL – both of which vary in one clinic versus another – would be challenging, time-consuming, and require a stricter process to determine. Perhaps, the n = 2 participants that noted “Frequent” could be targeted in a prospective study.

The p-value 0.00 was less than $\alpha 0.05$, which was statistically significant and rejected the $H_0$. The $H_A$ of BCRL as frequent was accepted, likely from the inherent sharing or overlap of patients. Another possible association could be that there were more participants in General Surgery and Radiation Oncology, even those in Private Practice, in this PIP to observe the frequency of BCRL than do Primary Clinic/Community Clinic (see Q1 Discussion).

One could argue that the frequency of BCRL could vary when clinical diagnosis or a screening tool/device/machine was utilized. For clinical diagnosis, BCRL could remain undetected until swelling became apparent, in turn, would add to underreported frequency. If swelling became apparent, then it might be too late and run the risk of cascading complications, even the risk of having the affected arm never return to baseline again. An insurance claim could estimate the overall financial burden, but the detrimental impacts on QOL would be challenging to quantify.

On the contrary, BIS as a screening tool can detect even the most subclinical form of BCRL (NLN, 2011; Shah et al., 2012; O’Toole et al., 2013; Otsby et al., 2014). BIS could be more objective in determining individualized results over time and useful in monitoring frequency (NLN, 2011; Shah et al., 2012; O’Toole et al., 2013; Otsby et al., 2014).

**Q12:** How common BCRL was in their clinic. This was a nominal data relatively similar to Q11, but asked for estimation in percentage. Seventy-five percent (n = 9) of the participants chose the option “Less than 10%” that supported the finding in Q11 of BRCL being not as frequent. The following highest result in Q12 was “10 to 29%” from the rest of the participants (n = 3). Although this question might have yielded an approximation, the result was significant in the sense that those n = 3 participants that responded “10 to 29%” could be targeted in a future study.
A future study to determine the actual commonality of BCRL in the community and, in turn, would generate a needs assessment for practice (Community Tool Box, 2019). For example, the need for early BCRL screening and bring community-wide awareness accordingly. In other words, n = 3 participants could be a starting point of a more extensive study in the future. Although anonymity was employed, this PIP determined that the majority of the participants were in General Surgery, Radiation Oncology, and Private Practice (see Q1). To reiterate, the category of Private Practice needed to be clearly defined.

The p-value 0.00 was less than \( \alpha \) 0.05, which was statistically significant and rejected the \( H_0 \). The \( H_A \) of BCRL as common was accepted. Overall, Q12 generated more room for educational and professional curiosity relevant to BCRL screening in Maui.

**Q13:** If BMI was a contributing factor in patients diagnosed with BCRL. This a dichotomous data. More than eighty three percent (n = 10) and 16% (n = 2) answered “Yes” and “No” respectively. The \( X^2 \) test supported the majority of participants and the findings of Dominick et al. (2012) in the WHEL study (see Literature Review). The p-value 0.02 was less than \( \alpha \) 0.05, which was statistically significant and rejected the \( H_0 \). The \( H_A \) of BMI as a contributing factor was accepted.

Perhaps, variability that could be not quantified was tied to the perception of all participants (n = 12), set aside their answers, regarding BMI with breast cancer or BMI with BCRL. From their perspectives, it would be tough to deduce in their minds of patients’ BMI, BMI before a breast cancer diagnosis, BMI after a breast cancer diagnosis, or BMI with BCRL. By extension of these same dilemmas, there was also the variability of having a different number of patients. Q13 was a proceeding and exploratory inquiry of Q14.

**Q14:** The average BMI of those with BCRL. This was a continuous data, which yielded 91% (n = 11) that chose a BMI greater than 30 and 8% (n = 1) that chose BMI of 26 to 29. The p-value 0.00 was less than \( \alpha \) 0.05, which was statistically significant and rejected the \( H_0 \). The
H$_{A}$ that the average BMI of those with BCRL was high was accepted. Q14 supported the findings found in Q13 and Dominick et al. (2012). The same variabilities or dilemmas presented in Q13 could apply to Q14.

One might argue that if participants frequently observed BCRL, as statistically noted in Q11 and Q12, that they would contemplate about contributing factors, for instance, a high BMI. Indeed, there are various causes of BMI, including stress or physiological changes related to cancer treatments among others, but were beyond the scope of this PIP.

**Q15:** If BIS was available. This was a dichotomous data and $\chi^2$ test was not performed as Q15 only pertained to $n = 1$ participant. For disclosure, because the co-investigator of this PIP currently has some professional knowledge or association relevant to Q15, that the co-investigator could deduce the general practice this data would be tied to.

Of note, there were two MDs in the practice to pinpoint who participated or did the anonymous survey. Indeed, there would be a 50% chance of seeking who responded between the two, but would otherwise disrupt the interplay of anonymity and ethics. To reiterate, this PIP acknowledged full recognition of anonymity, the need not to know the participants, and ethics to avoid any conflicts of interest.

To focus on the data presented in Q15, the $n = 1$ participant could be a focus of a future study, irrespective of the co-investigator had an association or not. The $n = 1$ participant would be able to identify helpful information like the one asked in Q17 about the difference in the quality of screening, treatment, and management. Perhaps even the impacts on patients throughout their course of experience with BCRL may be enlightened. Other findings such as cost-benefit ratios, insurance coverages, physical disabilities, psychological effects, even progress or improvements, and reimbursements could be discovered (Quirion, 2010; Sierla et al., 2014, Impedimed, 2017). Also, how the integration of BIS improved prompt detection, reduced physical limitations or complications, decreased medical cost, enhanced patient safety,
expanded routine breast cancer care or survivorship, and improved the overall quality of care (Dominick et al., 2012; Runowicz, 2016; Soran et al., 2016; Vicini et al. 2016).

To apply the paradigm of DOI theory in Q15, this n = 1 participant has progressed from being an innovator to an early adopter, and an early majority member (see Theoretical Framework). Respectively, the n = 1 participant has moved from being eager to try an innovative idea by having BIS, sped up the diffusion of valuable information relevant to overall BCRL care, and adopted the innovation in practice (The University of Oklahoma, n.d.; Kaminski, 2011).

Q16: How long was BIS available. This was a continuous data and served as an exploratory inquiry following Q15. The n = 1 participant has had the BIS between two to five years. Q16 provided a timeframe to explore if a future study were to be done. This future study could of a retrospective (look back) or prospective (look forward) design (Polit & Beck, 2012, 2018).

If the future study were retrospective in nature, the difference in costs, benefits, reimbursements, and insurance coverages to name a few would be challenging to determine. If the future study were to be prospective, then attrition and changes in variables among others would be factored in. Such prospective study could be longitudinal to recruit based on the population of interest, determine baseline information, and look forward to exposure versus outcome (Polit & Beck, 2012, 2018).

This PIP was a non-experimental, descriptive, cross-sectional research at a single point in time. Respectively, there was not a random assignment, a control group, or multiple measures. Overall, the timeframe identified in Q16 could provide useful information on patients’ course of experience with BCRL from screening, diagnosis, treatment, and management.

Q17: If there was a difference in the quality of screening, treatment, and management for BCRL. This was a dichotomous data pertinent to only n = 1 participant. It was a follow up to Q15 and Q16. Q15 and Q16 determined the type of practice and timeframe, respectively. Both
questions would assist in confirming Q17 if a future study were to be conducted. Just like Q12 served as a starting point, the same tenet would apply to Q15, Q16, and Q17 that when combined as a whole could be a starting point as well.

**Q18**: Interested in adopting BIS in the future. Apart from the “Yes” or “No” option, “Maybe” was added that made Q18 a nominal data as opposed to dichotomous data. “Yes” or “No” would have provided a straightforward answer from the n = 12 participants. “Maybe” was added in an attempt to find out those that could be convinced and on the fence per se. The overarching purpose of this PIP, to recapitulate, was to determine the current method of BCRL screening and possible adoption of BIS.

Sixteen percent (n = 2), 28% (n = 7), and 25% (n = 3) answered “No,” “Maybe,” and “Yes,” respectively. Given the “Maybe” and “Yes” responses, there was some interest in the majority of the participants based on the graph. The $\chi^2$ was performed to determine possible associations or because an association was unknown (Polit & Beck, 2012, 2018). The result regarding interest proved otherwise. The p-value 0.17 was greater than $\alpha$ 0.05, which was statistically not significant and so failed to reject the $H_0$. In essence, the $H_0$ as no interest was true.

A variability that $\chi^2$ could not quantify was the difference in the overall practice of each clinic. The broad categories (i.e., Primary Care/Community Clinic, Private Practice, or Specialty Clinic) needed to be delineated. Plus, the term “future” could have been objectified, say, in a year or two years, and so on. There was also the variability of having different or unknown numbers of patients with BCRL in each clinic to satisfy the need for BIS.

Q18 supported Aim #3. The result from statistical significance proved no interest but did not specify the reason why, which Q22 could enlighten later.

**Q19**: If they recommended BIS. As was the same reason for Q18, Q19 turned out to be a nominal data. The same findings in Q18 were true in Q19, that majority of participants
because of their “Maybe” and “Yes” responses could display some recommendation of the use of BIS. Unlike Q18, the $x^2$ test in Q19 revealed an exciting result: the participants would recommend BIS. The $p$-value 0.04 was less than $\alpha$ 0.05, which was statistically significant and rejected the $H_0$. The $H_A$ of BIS recommendation was accepted.

In Q18, statistics noted no interest in adopting BIS; on the contrary, in Q19, they would recommend BIS. Given the result of Q19, the participants found value in using BIS that they would recommend it, despite if they adopted it themselves or not. This sense of recommendation:

- Could be utilized as driving or persuading factor to gain further momentum for early BCRL screening using BIS,
- Supported the overarching purpose of this PIP and the theoretical framework on DOI theory,
- Carried, and still carries, significance in improving the quality of routine breast cancer care within the local community to start.

Q19 supported both Aims #1 and #2. The result was pivotal.

Q20: If they were likely to adopt BIS in the future. This was a nominal data with options of descriptive type (i.e., Likely, Not likely, Neutral). The percentage of those “Not Likely” ($n = 5$) and “Neutral” ($n = 5$) were the same at 45%. A participant ($n = 1$) skipped this question for some unknown reason. Q20 was similar to Q18, even the need to clarify the term “future.” The $p$-value 0.23 was greater than $\alpha$ 0.05, which was statistically not significant and failed to the reject $H_0$. The $H_0$ of not likely to adopt BIS was true.

To apply the DOI theory, the majority of the participants could be late majority members (The University of Oklahoma, n.d.; Kaminski, 2011). This particular type of adopters would generally be skeptical due to economic perspectives and social pressures (The University of Oklahoma, n.d.; Kaminski, 2011). Knowing the characteristics of this particular adopter type
Early Screening for BCRL Using BIS

lends an opportunity to come up with a strategy. A strategy that would address the momentum for early BCRL screening using BIS, as determined in Q19. For instance, if the skepticism was about the economic benefit for a given clinic, then perhaps an in-depth look of the clinic’s characteristics as determined in Q1 through Q6 (i.e., patient panel with breast cancer, most common age groups, race/ethnicities, sub-races of Asian Americans etc.).

The same variabilities in Q18 could apply to Q20. Q20 supported Aim #2.

Q21: Their readiness to adopt BIS in the future. This was a rank-order data and yielded findings that were widespread from one to 10. The spectrum was: one as ready, five as neutral, and 10 as ready. Three (n = 3) participants rated their readiness at one, and the same number of participants (n= 3) chose seven. Two (n = 2) participants chose five (neutral) and same number of participants (n = 2) chose six.

Variability of a neutral choice existed between a participant who chose five and another who chose six. Being neutral would be inherently difficult to ascertain. In other words, what factors did a participant consider when rating a five versus six, or a six versus a seven.

Q21 was similar to Q18 and Q20, again even the need to clarify the term “future.” The p-value 0.14 was greater than α 0.05, which was statistically not significant and failed to reject the H₀. The H₀ of not ready to adopt BIS was true. Although the H₀ was true, Q21 did not specify why. A possible association would be the characteristic of each clinic regarding their patient population and inadequate need – from an economic perspective or an infrequency in a BCRL diagnosis, for instance – to justify having a BIS device.

In addition, the CI was applied to ascertain if the sample statistic estimated the underlying population. It provided a range of values that would likely contain the population of interest, in this case the clinics/providers and their level of readiness from zero to 10. The CI was set at 95%. How confident was this PIP that the participants were not ready to adopt BIS? The frequency of distribution, with the lowest and highest scores, yielded a normal, unimodal distribution; this meant, a bell-shaped curve and one peak.
Central tendency using the mode, median, and mean indicated what was typical. Variability, from calculating the range and SD, expressed how different the participants were from one another on their level of readiness. The SD specified how much, based on average, their scores deviated from the mean. With these concepts in mind, the CI supported the result of the $x^2$ test. This PIP was 95% confident that the population mean would fall between -0.19 to 2.38, which meant much closer to the spectrum of “Not Ready.”

Q21 did not specify the reason why just like in Q18 and Q21. As already mentioned, there could be underlying or unknown variabilities that the $x^2$ test, even the CI, could not quantify. Q21 supported Aim #3.

Q22: If barriers existed that would impact their decision to adopt BIS. This was a categorical data. Most, if not all, variabilities thought of from different perspectives at this point have been highlighted. Q22 enlisted particular barriers to choose from. These same barriers were likely the reasons why participants would not adopt BIS at this time.

“Organizational/Institutional” followed by “Insurance/Financial” was the common barrier. Organizational/Institutional would mean the nature of the clinic itself, internal or external pressures, political or economic conditions, competitive vitality, marketability, and financial status (Kovner & Knickman, 2011; Marshall & Broome, 2017). Insurance/Financial could mean a lack of reimbursement or monetary funding to satisfy the need for BIS.

Any changes in clinical practice would be accompanied by barriers in some ways (National Institute of Health and Clinical Excellence [NICE], 2007; Fischer, Lange, Klose, Greiner, & Kramer, 2016). To statistically prove that barriers existed, the $x^2$ test was performed. The p-value 0.00 was less than 0.05, which was statistically significant and rejected the $H_0$. The $H_A$ that barriers existed was true.

Change is not without barriers (NICE, 2007; Fischer et al., 2016). By extension, knowing these main barriers can be instrumental in contemplating specific strategies necessary for future
adoption (NICE, 2007; Fischer et al., 2016). These strategies may be in the form of creating a pilot project, interactive training material, educational meetings, attending monthly staff meetings, continuing education, marketing outreach, obtaining financial assessments and security, and creating a standing order (NICE, 2007; Fischer et al., 2016).

**Implications for Practice**

This PIP identified numerous implications and future recommendations for practice. The conceptual framework, in the PICO format, served as a guide to come up with a well-worded research question (Polit & Beck, 2012, 2018). The population was clinics and providers, which yielded specific characteristics within their practice. For example, the type of clinic or method of BCRL diagnosis. The latter was the intervention in terms of using a traditional method or the use of a screening tool/device/machine. Both diagnostic methods were compared, especially in which type of practice setting utilized one method versus another. The outcomes encompassed bringing awareness to early BCRL screening, increasing the use of BIS, and consequently adopting or recommending BIS into practice.

The DOI theory was also a guiding framework but a theoretical one. It included the different types of adopters – from innovators to early adopters, early majority members, late majority members, and laggards (The University of Oklahoma, n.d.; Orr, 2003; Kaminski, 2011; LaMorte, 2019). It was instrumental in communicating or explaining the importance of using BIS in early BCRL screening, as evidenced by the anonymous survey as a research instrument (The University of Oklahoma, n.d.; Orr, 2003; Kaminski, 2011; LaMorte, 2019). The different types of adopters, by which an adoption or diffusion was accomplished, required awareness of the need for BIS (The University of Oklahoma, n.d.; Orr, 2003; Kaminski, 2011; LaMorte, 2019). Needs assessment – to adopt or reject the innovation, initial use to test BIS, and continued use of BIS if already applicable – was warranted (The University of Oklahoma, n.d.; Orr, 2003; Kaminski, 2011; LaMorte, 2019).
Such a theoretical framework and research instrument offered a means to gain momentum or diffusion a change in clinical practice throughout the clinics/providers in Maui (The University of Oklahoma, n.d.; Orr, 2003; Kaminski, 2011; LaMorte, 2019). At least some of the practice settings situated in Wailuku, Kahului, Makawao, Kihei-Wailea, and Lahaina. The location of these practices and the possibility of a larger sample – because of the number of providers within each practice – were promising. The number of participants (n = 12) ended up being small. Each practice needed to be clearly categorized, without overlap in definition: in other words, what constituted as a primary care clinic versus community clinic versus private practice versus specialty clinic. The results of this PIP did support the outcomes abovementioned.

This PIP did not explicitly clarify ahead of time the factors that could influence adoption as outlined in the DOI theory, which was asserted by LaMorte (2019). In particular, the relative advantage that BIS was a better idea than and to replace clinical diagnosis. Compatibility could have been explained by the needs of potential clinics/providers. Complexity should be that adoption was easy, but could not definitively characterize some barriers in the process. The option of triability may have added a strategy to convince the participants. In turn, this triability would yield observability – the tangible results to adopt (or reject) the entire clinical idea that this PIP was trying to accomplish. These factors were the possible associations and variability embedded in the results – the possible associations and variability that could not be anticipated or quantified ahead of time (Polit & Beck, 2012, 2018).

Any changes in clinical practice would not be without barriers. Some of these barriers were included. The Organizational/Institutional and Insurance/Financial were identified as the most common ones. With both results in mind, they could be the main focus of strategic measures to increase adoption prospectively. Measures that would need to take into consideration influences such as internal or external pressures, economic vitality, financial
status, political or governmental support to name a few (Kovner & Knickman, 2011; Marshall & Broome, 2017).

Once again, the results supported the abovementioned outcomes, along with the aims and objectives of this PIP. There were n = 12 participants. Taken as a whole, they identified specific characteristics that not only supported but also paralleled current literature. For instance, some of the common findings of breast cancer in women, the use of radiation and surgery, indications for lymph node removal, high BMI as a contributing factor to BCRL, breast cancer in Asian Americans, clinical diagnosis for BCRL versus the use of BIS. These common findings would be challenging, time-consuming, and require a stricter process to identify in a more extensive study. Like the noted barriers, they could be the main focus of strategic measures for adoption. They provided target populations for primary prevention, too. For example, focusing on Asian Americans to prevent breast cancer or BCRL and, to hone down even further, those with a high BMI.

Even deeper, the n = 1 participant, with the only BIS device for early screening BCRL in Maui, could be part of an extensive study in the future. Statistical significance, using the \( x^2 \) test or CI set at 95%, revealed that the n = 12 participants were not likely or not ready, respectively, to adopt BIS in the future. The term “future” needed to be clarified. All of them, however, would recommend BIS despite the existence of unknown association or variability. Given such an overall recommendation, this particular n = 1 participant could be promisingly instrumental.

This n = 1 participant could solidify its progress from being an innovator to early adopter and early majority member. It could determine in the future the far-reaching impacts surrounding BCRL using BIS – from screening to diagnosis, costs, differences in outcomes, and management, even patient experiences. It could persuade other participants, or clinics/providers at large, that might fall under late majority members and laggards. It was progressive in its time, adoption, application, and practice. Of note, this PIP was unable to determine what type of adopter the participants would be unless explicitly asked.
The timeframe of data collection and method were relatively adequate for this PIP. The participants started to dwindle at some point, a point described as saturation (Cousins, 2012). Both the timeframe and method could be modified to bolster a future study. A month of data collection might need to be extended based upon a new method. If the new method was attending or presenting in a monthly meeting, then perhaps the timeframe could be a few months. Each clinic/provider may meet only once a month and most likely on different days. Hence, if multiple clinics/providers were targeted in a future study, then data collection and method could use some modification accordingly.

**Future Recommendations**

There were quite a few future recommendations discovered by this PIP. The different types of clinics or potential participants needed to be delineated. In addition to an explicit direction to characterize their type of adopter, the DOI should have also explained the different influencing factors. The term "future" must be defined in numbers, not necessarily a definitive date but rather a range – be it within one to three years, four to six years, and the like.

Determination of timeframe would parallel the tenets surrounding new research methods or instruments desired.

Instead of anonymous online surveys, perhaps personal meetings might significantly impact persuasion and communication. By extension, specific barriers might be revealed. These barriers could be shifted not as limitations but rather strategies to gain momentum for adoption.

A single participant as the main target of interest – better yet, a sample population within the target population – would yield specific findings. These findings could be pivotal in the overall concept surrounding BCRL using BIS and, more importantly, add to the quality of routine breast cancer care.
Strengths

According to Smyth and Pearson (2011), an online survey is reasonably cost-and-timesaving compared to other survey modalities. With the increasing use of virtual programs, like Survey Monkey, devising a survey in the database is made relatively simple, assuming that programming is correct from the beginning. Designing it with various colors and arts add visual features. Flexibility in creating different questions in various formats, like multiple choice or rank-order data, is possible.

There is a unique advantage of being able to send it to different local communities and clinics/providers. It can be sent in the wide-ranging target population in an instant. An option to create a desktop or mobile smartphone version exists. To circumvent the concern of having the survey end up in a junk email, the point-of-contact within the clinic/facility would need to email the survey to all providers.

Individual response is associated with a certain degree of anonymity because the survey is self-administered rather than interviewer-administered. Self-administration can lead to more honest reporting on specific sensitive questions without the factor of being pressured in an interview. The premise of "respondent burden" may be resolved by "skipping pattern," meaning that an online program jumps to a different survey question automatically as needed. Each respondent has more control over the pace in a self-administered survey compared to being pressured during a face-to-face interaction.

Limitations or Weaknesses

Respondents have less social pressure to finish a self-administered survey compared to a face-to-face interview per Smyth and Pearson (2011). They may feel the need to rush or hasten the process just to get the online survey over with. There can be multiple distractions occurring at the same time. Colors and arts can be visually enticing but are also distractive. Visual effects might lead to an untoward effect on overall measurements or responses because of symbolic manipulation. The response rate is highly variable – at a rate of 6 to 15% lower.
than other survey modalities – due to the type of target population, be it specialized or general population. The foremost population yields a much higher response rate compared to the latter by reasons of specificity, salience, or applicability. All of which reasons can lead to decreased motivation to participate.

**Conclusion**

Breast cancer is considered the most common type of cancer in women (Papadakis & McPhee, 2012; NCCN, 2015). The lifetime risk increases with age, along with poor lifestyle habits, exercise, diet, and low socioeconomic factors, to name a few (Papadakis & McPhee, 2012; NCCN, 2015). Diagnosis or treatment is complex (Papadakis & McPhee, 2012; NCCN, 2015). Systemic therapy with the use of chemotherapy and endocrine drug exists (Papadakis & McPhee, 2012; NCCN, 2015). There is also radiation and surgical option (Papadakis & McPhee, 2012; NCCN, 2015).

If surgery is warranted, removal of the affected breast (or mastectomy) is performed (Papadakis & McPhee, 2012; NCCN, 2015). If the unaffected side is removed to reduce breast cancer risk significantly, then bilateral mastectomy can be done (Papadakis & McPhee, 2012; NCCN, 2015). An axillary node dissection or sentinel node biopsy is essential to provide more clinical information, predictive factors, and guide therapy (Papadakis & McPhee, 2012; NCCN, 2015).

Inherently in the process of surgical intervention, fluid distribution by the lymphatic system is disrupted and can manifest as lymphedema (Shi, 2009; Papadakis & McPhee, 2012; ILF, 2015; NCCN, 2015; ISL, 2016). BCRL can occur as early as a couple of months and as late as two years postoperatively, and a lifetime risk (Armer & Stewart, 2010; Dominick et al., 2012; Soran et al., 2016). If BCRL is detected, only conservative management exists such as decompressive compression therapy, physical therapy, manual massage, and weight loss (NLN, 2011; O’Toole et al., 2013; Otsby et al., 2014). Otherwise if left undetected, BCRL can result in pain, immobility, contracture, infection, inflammation, and sensory loss, even
Early Screening for BCRL Using BIS

associated with long-term psychological impacts (Armer & Stewart, 2010; Hayes et al., 2011; O’Toole et al., 2013; ILF, 2015; ISL, 2016).

BCRL is a lifelong risk (Papadakis & McPhee, 2012; NCCN, 2015). As there is currently no definitive treatment, early screening through BIS is paramount (Dominick et al., 2012; Shah et al., 2012). BIS can detect even subclinical form of BCRL as early as four months (NLN, 2011; Shah et al., 2012; O’Toole et al., 2013; Otsby et al., 2014). The proposed intervention of this PIP is to have BIS for early BCRL screening in most, perhaps all, clinics in Maui. In particular, the use of BIS at every routine clinic visit related to breast cancer care. Such early screening can: improve safety, identify risk factors, enhance health-related outcomes, decrease patient medical costs, economically benefit clinics, improve the quality of care and survivorship of breast cancer patients (NLN, 2011; Dominick et al., 2012; Shah et al., 2012; O’Toole et al., 2013; Otsby et al., 2014).
References


Papadakis, M., & McPhee, S. (2017). Current Medical Diagnosis & Treatment (56th ed.).


Therapy, 92(1), 152-163. Retrieved from the University of Hawaii at Hilo Edwin H. Mookini Library.


Appendices

Appendix A. Scientific review committee approval

[Image of Scientific Review Committee Approval form]

- Student’s Name: Melford Lazarte
- Date Submitted: 5/6/2019
- Title of Proposal: Early screening for arm swelling related to breast cancer treatment
- Name of Committee Chair: Dr. Pagan (PIP Committee Chair), Dr. Norris-Taylor (Second Committee Chair), Dr. Van Hoose and Dr. Arzaga (PIP Committee Members)
- Department Scientific Review Decision: Approved
- Not Approved: Comments:
- Signature of SRC Chair: [Signature]
- Date: 5/7/2019
- IRB
- Date Submitted:
- Committee: Social & Behavioral □ Biomedical □
- Type of Review (check one)
  □ Exempt
  □ Expedited
  □ Full Review
- Approved □ Not Approved □
- Comments:

Attach a copy of the IRB approval letter to this form
Appendix B. IRB approval
Appendix C. Consent

University of Hawai‘i at Hilo
Consent to Participate in a Research Project
Joan Thompson-Pagan, PhD, APRN, RNC, CNE, Principal Investigator
Melford Lazarte, Doctor of Nursing Practice Candidate, Co-Investigator
Project title: Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Aloha! My name is Melford Lazarte and you are invited to take part in a research study. I am a graduate student at the University of Hawai‘i at Hilo in the Department of School of Nursing, Doctor of Nursing Program. As part of the requirements for earning my doctoral degree, I am doing a research project.

What am I being asked to do?
If you participate in this project, you will be asked to fill out a survey.

Taking part in this study is your choice.
Your participation in this project is completely voluntary. You may stop participating at any time. If you stop being in the study, there will be no penalty or loss to you.

Why is this study being done?
The purpose of my project is to gain an understanding of your clinic’s current method of screening for breast-cancer-related lymphedema and possible adoption of bioimpedance spectroscopy as an ancillary strategy to improve routine breast cancer care.

What will happen if I decide to take part in this study?
The survey will consist of 21 survey questionnaires. It will take approximately 10 minutes. The survey questions will include questions like, “How is breast cancer related lymphedema diagnosed in your clinic?” “How frequent is breast cancer related lymphedema observed in your clinic?” “Is bioimpedance spectroscopy available?” “Would you recommend other clinics to have bioimpedance spectroscopy?” The survey is accessed on a website to which I will provide you a secured link (a link through surveymonkey.com).

What are the risks and benefits of taking part in this study?
I believe there is little risk to you for participating in this research project. You may become stressed or uncomfortable answering any of the survey questions. If you do become stressed or uncomfortable, you can skip the question or take a break. You can also stop taking the survey or you can withdraw from the project altogether.

There will be no direct benefit to you for participating in this survey. The results of this project may help improve the quality of routine breast cancer care and improve survivorship of future breast cancer patients.

Privacy and Confidentiality:
I will not ask you for any personal information, such as your name or address. Please do not include any personal information in your survey responses. I will keep all study data secure in a locked filing cabinet in a locked office on a password protected computer. Only my University of Hawai‘i co-investigator and I will have access to the information. Other agencies that have legal permission have the right to review research records. The University of Hawai‘i Human Studies Program has the right to review research records for this study.
University of Hawai‘i at Hilo
Consent to Participate in a Research Project
Joan Thompson-Pagan, PhD, APRN, RNC, CNE, Principal Investigator
Melford Lazarte, Doctor of Nursing Practice Candidate, Co-Investigator
Project title: Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Compensation:
There will not be any monetary or other means of compensation in participating in this research project. Your participation is strictly voluntary.

Future Research Studies:
Even after removing identifiers, the data from this study will not be used or distributed for future research studies.

Questions:
If you have any questions about this study, please call (808) 446 6264 or email me at mlazarte@hawaii.edu. You may also contact my principal investigator and advisor, Dr. Joan Pagan, at (808) 443 8004 and jniaukea@hawaii.edu. You may contact UH Human Studies Program at (808) 946 5007 or uhirb@hawaii.edu to discuss problems, concerns and questions, obtain information, or offer input with an informed individual who is unaffiliated with the specific research protocol. Please visit https://researchcompliance.hawaii.edu/ for more information on your rights as a research participant.

Filling out the survey will be considered your consent to participate in this study.

Please keep a copy of the consent form for your records.

Mahalo!
Appendix D. Email prefacing PIP

Aloha! My name is Melford Lazarte. I am currently a Nurse Practitioner and a graduate student pursuing a doctoral degree at the University of Hawai‘i at Hilo (UHH). You are invited to take part in a research study approved by the UHH Doctor of Nursing Program and Institutional Review Board. As part of the requirements for earning my doctoral degree, I am doing a research project on early screening for breast-cancer-related lymphedema (BCRL) through the use of bioimpedance spectroscopy (BIS).

The purpose of this anonymous online survey (the link is provided below) is to gain an understanding of your clinic’s current method of screening BCRL, possible adoption of BIS as an ancillary strategy to improve routine breast cancer care, and bring overall awareness to early screening. The survey consists of 22 easy questionnaires and only takes no more than 6 minutes.

BCRL is a commonly feared sequela following cancer treatment, particularly in the setting of radiation or mastectomy with lymph node dissection, or both.1 Other risk factors include the number of lymph nodes removed, sedentary lifestyle, and a high body mass index.2,3,4 BCRL can occur early or late, and a lifelong risk.5,6 If left undetected, it can result in future complications like skin changes, infection, immobility, extremity contracture, risk of having the affected arm never return to baseline, pain, and psychological impacts, even concerns for associated medical costs.7 Based on a two-year cohort study, there is a significant economic burden with a cost difference of $14,800 to $23,100 between women with BCRL than their counterparts.8 There is currently no definitive treatment for BCRL as well, just conservative management such as manual massage, compression garment, or weeks of physical therapy.9 Early screening is thus critical before it is too late.

BIS can assist in early screening, risk identification, diagnosis, and the institution of management as needed.10,11 It provides an objective measurement of fluid changes on the at-risk limb. Personalized results are utilized for trends. BIS is similar to standing on a weighing scale. It is a non-invasive tool that sends an electrical impulse, which is not even felt by patients at all.12 It is contraindicated for patients with a pacemaker or those who are pregnant.13 The device costs about $9,000, but a monthly lease agreement can be arranged.14 Prospective method of surveillance like anticipatory guidance or education on BCRL is about $630 per patient per year, and reimbursement in the Current Procedural Terminology (CPT) code 93702 for BCRL screening with the use of BIS is $128 to $135.15,16 If a patient is seen for a medically necessary visit the same day BIS is done, then modifier 25 may be used to indicate that the evaluation and management (E&M) code is separate.17 BIS can add to early BCRL surveillance, the quality of routine breast cancer care or survivorship, and clinic reimbursement.

Your voluntary participation is one-time by filling out a survey online at the link provided below or the attached Word document then emailing your response. There is no risk of your participation in this research project. Your responses will be kept strictly confidential, and data will not be used or distributed for future studies. There is no financial interest or affiliation concerning material discussed in this research. There is also no direct benefit to you but instead brings awareness of adopting BIS for early BCRL screening, which will benefit breast cancer patients and clinics in the community.

Your voluntary participation and overall support greatly appreciated. If you have any additional questions regarding this research, please feel free to email me at mlazarte@hawaii.edu or call me at (808) 446 6264.

Sincerely,

Melford Lazarte, APRN-Rx, AGACNP-BC, ACNPC-AG, CNOR
Co-Investigator, Doctor of Nursing Practice Candidate

Joan Thompson-Pagan, Ph.D., APRN, RNC, CNE
Principal Investigator, Director and Associate Professor

Notice:
Advancing in this section is an indication that you have read the attached consent, and willfully or voluntarily participate in this one-time survey. You have the option of doing the online survey at the link provided here (https://www.surveymonkey.com/r/9PQ688) or filling out the attached Word document and emailing it back to me (mlazarte@hawaii.edu).


Impedimed (personal communication, January, 2020).


Appendix E. Survey monkey survey

Notice:
Advancing in this section is an indication that you have read the attached consent, and willfully or voluntarily participate in this one-time survey.

* 1. My clinic is a ___. Please select from the following:
   - Primary Care/Community Clinic
   - Private Practice
   - Specialty Clinic. If checked, please state the type of specialty clinic (i.e., radiation oncology, medical oncology, etc.). Specify below.
   Other (please specify)

* 2. Please select the percentage of clinic’s patient panel with breast cancer.
   - [ ] Less than 10%
   - [ ] 10-39%
   - [ ] 40-50%
   - [ ] More than 50%

* 3. What is the most common gender of patients with breast cancer in your clinic?
   - [ ] Male
   - [ ] Female
4. Of those patients diagnosed with breast cancer, what is the most common age range?
   - 30-40 years old
   - 41-50 years old
   - 51-60 years old
   - 61-70 years old
   - > 71 years old

5. Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?
   - White
   - African-American
   - Hispanic
   - Asian-American (i.e., Chinese, Japanese, Filipino, Pacific Islander)
   - American Indian/Alaskan Native
   - Other (please specify)

6. Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?
   - Chinese
   - Japanese
   - Filipino
   - Pacific Islander
   - Other (please specify)

7. What type of breast cancer treatment did the majority of patients have undergone?
   - Radiation
   - Surgery
   - Both radiation and surgery
   - Chemoprevention
   - Other (please specify)
8. For patients who had surgical intervention, did they have lymph nodes removed?

- [ ] Some
- [ ] No
- [ ] Yes

9. For those who had their lymph nodes removed, what was the main indication for removal?

- [ ] Tumor dimension between 1-2 according to the TNM Classification
- [ ] Ductal Carcinoma in Situ (DCIS)
- [ ] DCIS with suspected/proved microinvasion
- [ ] Clinically negative axillary nodes following neoadjuvant chemotherapy
- [ ] Other (please specify)

10. How is BCRL diagnosed in your clinic?

- [ ] Clinical diagnosis
- [ ] Screening tool/device/machine

11. How frequent is BCRL observed in your clinic?

- [ ] Not frequent
- [ ] Frequent
- [ ] Very frequent

12. From what you have observed in your clinic, how common is BCRL?

- [ ] Less than 10%
- [ ] 10 to 29%
- [ ] 30 to 50%
- [ ] More than 50%

13. Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?

- [ ] Yes
- [ ] No
14. What is the average BMI of those with BCRL?
   - BMI < 18
   - BMI 18 to 25
   - BMI 26 to 29
   - BMI > 30

15. Is BIS available?
   - Yes. If answered yes, please continue to Question 16.
   - No. If answered no, please skip to Question 18.

16. How long have you had BIS in your clinic?
   - Less than 2 years
   - Between 2 to 5 years
   - More than 5 years

17. Do you find a difference in the quality of screening, treatment, and management for BCRL?
   - Yes
   - No

18. Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?
   - Yes
   - Maybe
   - No

19. Would you recommend other clinics to have BIS?
   - Yes
   - Maybe
   - No

20. How likely are you to adopt BIS in the future?
   - Not likely
   - Neutral
   - Likely
* 21. On the scale of 1-10, how would you rate your readiness to adopt BIS in the future?

Not Ready   Neutral   Ready

* 22. What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.

- Lack of applicability
- Lack of time
- Organizational/Institutional
- Insurance/Financial
- Patient adherence/Compliance
- Treatment related adverse events
- Other (please specify)
Appendix F. Word document survey

Purpose: To gain an understanding of your current method of screening BCRL and possible adoption of BIS as an ancillary strategy to improve routine breast cancer care.

Instructions:
Please fill out the survey by marking, highlighting, bolding, italicizing, or underlining your answers.

Survey Questions:
1. My clinic is a ___. Please select from the following:
   ___ Primary Care/Community Clinic
   ___ Private Practice
   ___ Specialty Clinic. If checked, please state the type of specialty clinic (i.e., radiation oncology, medical oncology, etc.): ______

   The following questions are related to patients you have taken care for in your practice.

2. Please select the percentage of clinic’s patient panel with breast cancer.
   ___ Less than 10%
   ___ 10-39%
   ___ 40-50%
   ___ More than 50%

3. What is the most common gender of patients with breast cancer in your clinic?
   ___ Male
   ___ Female

4. Of those patients diagnosed with breast cancer, what is the most common age range?
   ___ 30-40 years old
   ___ 41-50 years old
   ___ 51-60 years old
   ___ 61-70 years old
   ___ > 71 years old

5. Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?
   ___ White
   ___ African-American
   ___ Hispanic
   ___ Asian-American (i.e. Chinese, Japanese, Filipino, Pacific Islander, etc.)
   ___ American-Indian/Alaskan Native
   ___ Other

6. Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?
   ___ Chinese
   ___ Japanese
   ___ Filipino
__Pacific Islander
__Other (please specify): ___

7. What type of breast cancer treatment did the majority of patients have undergone?
   _Radiation
   _Surgery
   _Both radiation and surgery
   _Chemoprevention
   _Other (please specify): ___

8. For patients who had surgical intervention, did they have lymph nodes removed?
   _Some
   _No
   _Yes

9. For those who had their lymph nodes removed, what was the main indication for removal?
   _Tumor dimension between 1-2 according to the TNM Classification
   _Ductal Carcinoma in Situ (DCIS)
   _DCIS with suspected/proved microinvasion
   _Clinically negative axillary nodes following neoadjuvant chemotherapy
   _Other. Please specify: __________

10. How is BCRL diagnosed in your clinic?
    _Clinical diagnosis
    _Screening tool/device/machine

11. How frequent is BCRL observed in your clinic?
    _Not frequent.
    _Frequent.
    _Very frequent.

12. From what you have observed in your clinic, how common is BCRL?
    _Less than 10%
    _10 to 29 %
    _30 to 50%
    _More than 50%

13. Of those with BCRL, is there any indication that high body mass index (BMI) is a
    contributing factor?
    _Yes
    _No

14. What is the average BMI of those with BCRL?
    _BMI <18
    _BMI 18 to 25
    _BMI 26 to 29
15. Is BIS available?
   ___Yes. If answered yes, please continue to Question 16.
   ___No. If answered no, please skip to Question 18.

16. How long have you had BIS in your clinic?
   ___Less than 2 years   ___Between 2 to 5 years   ___More than 5 years

17. Do you find a difference in the quality of screening, treatment, and management for BCRL?
   ___Yes        ___No

18. Would you recommend other clinics to have BIS?
   ___Yes        ___Maybe        ___No

19. Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?
   ___Yes        ___Maybe        ___No

20. How likely are you to adopt BIS in the future?
    ___Not likely     ___Neutral     ___Likely

21. On the scale of 1-10, how would you rate your readiness to adopt BIS in the future?
    Not ready Ready
    1       2       3       4       5       6       7       8       9       10

22. What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.
    ___Lack of applicability
    ___Lack of time
    ___Organizational/Institutional
    ___Patient adherence/Compliance
    ___Treatment related adverse events
    ___Other (please specify): ________

End of Survey.
Thank you for your voluntary participation!
Appendix G. Actual survey responses via survey monkey

Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Q1. My clinic is a ___. Please select from the following:
   Specialty Clinic. If checked, please state the type of specialty clinic (i.e., radiation oncology, medical oncology, etc.). Specify below.
   Other (please specify):
   General Surgery

Q2. Please select the percentage of clinic's patient panel with breast cancer.
   More than 50%

Q3. What is the most common gender of patients with breast cancer in your clinic?
   Female

Q4. Of those patients diagnosed with breast cancer, what is the most common age range?
   51-60 years old

Q5. Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?
   Asian-American (i.e., Chinese, Japanese, Filipino, Pacific Islander)

Q6. Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?
   Pacific Islander

Q7. What type of breast cancer treatment did the majority of patients have undergone?
   Both radiation and surgery

Q8. For patients who had surgical intervention, did they have lymph nodes removed?
   Yes
Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Q9 For those who had their lymph nodes removed, what was the main indication for removal?
   Tumor dimension between 1-2 according to the TNM Classification
   Ductal Carcinoma in Situ (DCIS),
   DCIS with suspected/proved microinvasion

Q10 How is BCRL diagnosed in your clinic?
   Screening tool/device/machine

Q11 How frequent is BCRL observed in your clinic?
   Not frequent

Q12 From what you have observed in your clinic, how common is BCRL?
   Less than 10%

Q13 Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?
   Yes

Q14 What is the average BMI of those with BCRL?
   BMI >30

Q15 Is BIS available?
   Yes. If answered yes, please continue to Question 16.

Q16 How long have you had BIS in your clinic?
   Between 2 to 5 years

Q17 Do you find a difference in the quality of screening, treatment, and management for BCRL?
   Yes

Q18 Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?
   Yes

Q19 Would you recommend other clinics to have BIS?
   Yes

Q20 How likely are you to adopt BIS in the future?
   Likely

Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future?
   (no label)

Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.
   Organizational/Institutional,
   Insurance/Financial
Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

#2

Collector: Web Link 1 (Web Link)
Started: Tuesday, January 14, 2020 1:11:09 PM
Last Modified: Tuesday, January 14, 2020 1:14:24 PM
Time Spent: 00:03:15

Page 1

Q1 My clinic is a ___. Please select from the following:
Specialty Clinic. If checked, please state the type of specialty clinic (i.e., radiation oncology, medical oncology, etc.). Specify below.

Other (please specify):
Radiation oncology

Q2 Please select the percentage of clinic's patient panel with breast cancer.
10-39%

Q3 What is the most common gender of patients with breast cancer in your clinic?
Female

Q4 Of those patients diagnosed with breast cancer, what is the most common age range?
> 71 years old

Q5 Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?
White

Q6 Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?
Filipino

Q7 What type of breast cancer treatment did the majority of patients have undergone?
Both radiation and surgery

Q8 For patients who had surgical intervention, did they have lymph nodes removed?
Some

Q9 For those who had their lymph nodes removed, what was the main indication for removal?
Other (please specify): SLNB as standard practice for clinically negative axilla

Q10 How is BCRL diagnosed in your clinic?
Clinical diagnosis
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q11 How frequent is BCRL observed in your clinic?</td>
<td>Frequent</td>
</tr>
<tr>
<td>Q12 From what you have observed in your clinic, how common is BCRL?</td>
<td>10 to 29%</td>
</tr>
<tr>
<td>Q13 Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?</td>
<td>Yes</td>
</tr>
<tr>
<td>Q14 What is the average BMI of those with BCRL?</td>
<td>BMI &gt;30</td>
</tr>
<tr>
<td>Q15 Is BIS available?</td>
<td>No. If answered no, please skip to Question 18.</td>
</tr>
<tr>
<td>Q16 How long have you had BIS in your clinic?</td>
<td>Respondent skipped this question</td>
</tr>
<tr>
<td>Q17 Do you find a difference in the quality of screening, treatment, and management for BCRL?</td>
<td>Respondent skipped this question</td>
</tr>
<tr>
<td>Q18 Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?</td>
<td>Maybe</td>
</tr>
<tr>
<td>Q19 Would you recommend other clinics to have BIS?</td>
<td>Maybe</td>
</tr>
<tr>
<td>Q20 How likely are you to adopt BIS in the future?</td>
<td>Not likely</td>
</tr>
<tr>
<td>Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future? (no label)</td>
<td>Not Ready</td>
</tr>
<tr>
<td>Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.</td>
<td>Organizational/Institutional</td>
</tr>
</tbody>
</table>
Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

#3

Collector: Web Link 1 (Web Link)
Started: Wednesday, January 15, 2020 6:02:08 AM
Last Modified: Wednesday, January 15, 2020 6:06:37 AM
Time Spent: 00:04:29

Q1 My clinic is a ___. Please select from the following: Specialty Clinic. If checked, please state the type of specialty clinic (i.e., radiation oncology, medical oncology, etc.). Specify below.
Less than 10%
Other (please specify):
College Health Services

Q2 Please select the percentage of clinic’s patient panel with breast cancer.
Less than 10%

Q3 What is the most common gender of patients with breast cancer in your clinic?
Female

Q4 Of those patients diagnosed with breast cancer, what is the most common age range?
41-50 years old

Q5 Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?
Asian-American (i.e., Chinese, Japanese, Filipino, Pacific Islander)

Q6 Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?
Pacific Islander

Q7 What type of breast cancer treatment did the majority of patients have undergone?
Both radiation and surgery

Q8 For patients who had surgical intervention, did they have lymph nodes removed?
Yes

Q9 For those who had their lymph nodes removed, what was the main indication for removal?
DCIS with suspected/proved microinvasion

Q10 How is BCRL diagnosed in your clinic?
Clinical diagnosis
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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</thead>
<tbody>
<tr>
<td>Q11 How frequent is BCRL observed in your clinic?</td>
<td>Not frequent</td>
</tr>
<tr>
<td>Q12 From what you have observed in your clinic, how common is BCRL?</td>
<td>Less than 10%</td>
</tr>
<tr>
<td>Q13 Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?</td>
<td>No</td>
</tr>
<tr>
<td>Q14 What is the average BMI of those with BCRL?</td>
<td>BMI 26 to 29</td>
</tr>
<tr>
<td>Q15 Is BIS available?</td>
<td>No. If answered no, please skip to Question 18.</td>
</tr>
<tr>
<td>Q16 How long have you had BIS in your clinic?</td>
<td>Respondent skipped this question</td>
</tr>
<tr>
<td>Q17 Do you find a difference in the quality of screening, treatment, and management for BCRL?</td>
<td>Respondent skipped this question</td>
</tr>
<tr>
<td>Q18 Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?</td>
<td>Maybe</td>
</tr>
<tr>
<td>Q19 Would you recommend other clinics to have BIS?</td>
<td>Yes</td>
</tr>
<tr>
<td>Q20 How likely are you to adopt BIS in the future?</td>
<td>Not likely</td>
</tr>
<tr>
<td>Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future?</td>
<td>Not Ready</td>
</tr>
<tr>
<td>Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.</td>
<td>Lack of applicability, Organizational/Institutional, Insurance/Financial</td>
</tr>
</tbody>
</table>
**Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy**

<table>
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<td>Wednesday, January 15, 2020 4:17:54 PM</td>
</tr>
<tr>
<td>Time Spent:</td>
<td>00:02:23</td>
</tr>
</tbody>
</table>

**Page 1**

**Q1** My clinic is a ____. Please select from the following:
- Private Practice

**Q2** Please select the percentage of clinic’s patient panel with breast cancer.
- Less than 10%

**Q3** What is the most common gender of patients with breast cancer in your clinic?
- Female

**Q4** Of those patients diagnosed with breast cancer, what is the most common age range?
- 51-60 years old

**Q5** Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?
- Asian-American (i.e., Chinese, Japanese, Filipino, Pacific Islander)

**Q6** Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?
- Japanese

**Q7** What type of breast cancer treatment did the majority of patients have undergone?
- Surgery

**Q8** For patients who had surgical intervention, did they have lymph nodes removed?
- Some

**Q9** For those who had their lymph nodes removed, what was the main indication for removal?
- Tumor dimension between 1-2 according to the TNM Classification

**Q10** How is BCRL diagnosed in your clinic?
- Clinical diagnosis

**Q11** How frequent is BCRL observed in your clinic?
- Not frequent
Q12 From what you have observed in your clinic, how common is BCRL? Less than 10%

Q13 Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor? No

Q14 What is the average BMI of those with BCRL? BMI >30

Q15 Is BIS available? No. If answered no, please skip to Question 18.

Q16 How long have you had BIS in your clinic? Respondent skipped this question

Q17 Do you find a difference in the quality of screening, treatment, and management for BCRL? Respondent skipped this question

Q18 Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future? No

Q19 Would you recommend other clinics to have BIS? No

Q20 How likely are you to adopt BIS in the future? Not likely

Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future? Not Ready

Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply. Lack of applicability
Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Q1 My clinic is a ___. Please select from the following:
- Specialty Clinic. If checked, please state the type of specialty clinic (i.e., radiation oncology, medical oncology, etc.). Specify below.
- Other (please specify):
  - Surgery

Q2 Please select the percentage of clinic's patient panel with breast cancer.
- 10-39%

Q3 What is the most common gender of patients with breast cancer in your clinic?
- Female

Q4 Of those patients diagnosed with breast cancer, what is the most common age range?
- 61-70 years old

Q5 Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?
- Asian-American (i.e., Chinese, Japanese, Filipino, Pacific Islander)

Q6 Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?
- Filipino

Q7 What type of breast cancer treatment did the majority of patients have undergone?
- Both radiation and surgery

Q8 For patients who had surgical intervention, did they have lymph nodes removed?
- Some

Q9 For those who had their lymph nodes removed, what was the main indication for removal?
- Other (please specify):
  - mastectomy pts or lumpectomy pts with invasive ductal carcinoma or prophylactic mastectomy
<table>
<thead>
<tr>
<th>Question</th>
<th>Response/Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q10 How is BCRL diagnosed in your clinic?</td>
<td>Clinical diagnosis</td>
</tr>
<tr>
<td>Q11 How frequent is BCRL observed in your clinic?</td>
<td>Frequent</td>
</tr>
<tr>
<td>Q12 From what you have observed in your clinic, how common is BCRL?</td>
<td>10 to 29%</td>
</tr>
<tr>
<td>Q13 Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?</td>
<td>Yes</td>
</tr>
<tr>
<td>Q14 What is the average BMI of those with BCRL?</td>
<td>BMI &gt;30</td>
</tr>
<tr>
<td>Q15 Is BIS available?</td>
<td>No. If answered no, please skip to Question 18.</td>
</tr>
<tr>
<td>Q16 How long have you had BIS in your clinic?</td>
<td>Respondent skipped this question</td>
</tr>
<tr>
<td>Q17 Do you find a difference in the quality of screening, treatment, and management for BCRL?</td>
<td>Respondent skipped this question</td>
</tr>
<tr>
<td>Q18 Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?</td>
<td>Yes</td>
</tr>
<tr>
<td>Q19 Would you recommend other clinics to have BIS?</td>
<td>Maybe</td>
</tr>
<tr>
<td>Q20 How likely are you to adopt BIS in the future?</td>
<td>Neutral</td>
</tr>
<tr>
<td>Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future? (no label)</td>
<td>(no label)</td>
</tr>
<tr>
<td>Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.</td>
<td>Organizational/Institutional</td>
</tr>
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</table>
Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

#6
COMPLETE

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 My clinic is a ___ Please select from the following:</td>
<td>Private Practice</td>
</tr>
<tr>
<td>Q2 Please select the percentage of clinic's patient panel with breast cancer.</td>
<td>10-39%</td>
</tr>
<tr>
<td>Q3 What is the most common gender of patients with breast cancer in your clinic?</td>
<td>Female</td>
</tr>
<tr>
<td>Q4 Of those patients diagnosed with breast cancer, what is the most common age range?</td>
<td>61-70 years old</td>
</tr>
<tr>
<td>Q5 Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?</td>
<td>White</td>
</tr>
<tr>
<td>Q6 Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?</td>
<td>Filipino</td>
</tr>
<tr>
<td>Q7 What type of breast cancer treatment did the majority of patients have undergone?</td>
<td>Surgery</td>
</tr>
<tr>
<td>Q8 For patients who had surgical intervention, did they have lymph nodes removed?</td>
<td>Yes</td>
</tr>
<tr>
<td>Q9 For those who had their lymph nodes removed, what was the main indication for removal?</td>
<td>Tumor dimension between 1-2 according to the TNM Classification, DCIS with suspected/proved microinvasion</td>
</tr>
<tr>
<td>Q10 How is BCRL diagnosed in your clinic?</td>
<td>Clinical diagnosis</td>
</tr>
<tr>
<td>Q11 How frequent is BCRL observed in your clinic?</td>
<td>Not frequent</td>
</tr>
</tbody>
</table>
Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Q12 From what you have observed in your clinic, how common is BCRL?  
Less than 10%

Q13 Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?  
Yes

Q14 What is the average BMI of those with BCRL?  
BMI >30

Q15 Is BIS available?  
No. If answered no, please skip to Question 18.

Q16 How long have you had BIS in your clinic?  
Respondent skipped this question

Q17 Do you find a difference in the quality of screening, treatment, and management for BCRL?  
Respondent skipped this question

Q18 Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?  
No

Q19 Would you recommend other clinics to have BIS?  
Yes

Q20 How likely are you to adopt BIS in the future?  
Not likely

Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future?  
(no label)

Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.  
Organizational/Institutional, Insurance/Financial
Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

#7

Collector: Web Link 1 (Web Link)
Started: Wednesday, February 05, 2020 2:21:49 AM
Last Modified: Wednesday, February 05, 2020 2:24:49 AM
Time Spent: 00:03:00

Page 1

Q1 My clinic is a ___. Please select from the following: Primary Care/Community Clinic

Q2 Please select the percentage of clinic’s patient panel with breast cancer.

Q3 What is the most common gender of patients with breast cancer in your clinic? Female

Q4 Of those patients diagnosed with breast cancer, what is the most common age range? 51-60 years old

Q5 Of those patients diagnosed with breast cancer, what is the most common race/ethnicity? Asian-American (i.e., Chinese, Japanese, Filipino, Pacific Islander)

Q6 Of Asian Americans diagnosed with breast cancer, what is the most common sub-race? Filipino, Pacific Islander

Q7 What type of breast cancer treatment did the majority of patients have undergone? Both radiation and surgery

Q8 For patients who had surgical intervention, did they have lymph nodes removed? Some

Q9 For those who had their lymph nodes removed, what was the main indication for removal? Tumor dimension between 1-2 according to the TNM Classification

Q10 How is BCRL diagnosed in your clinic? Clinical diagnosis

Q11 How frequent is BCRL observed in your clinic? Not frequent
Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Q12 From what you have observed in your clinic, how common is BCRL?  
Less than 10%

Q13 Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?  
Yes

Q14 What is the average BMI of those with BCRL?  
BMI >30

Q15 Is BIS available?  
No. If answered no, please skip to Question 18.

Q16 How long have you had BIS in your clinic?  
Respondent skipped this question

Q17 Do you find a difference in the quality of screening, treatment, and management for BCRL?  
Respondent skipped this question

Q18 Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?  
Yes

Q19 Would you recommend other clinics to have BIS?  
Maybe

Q20 How likely are you to adopt BIS in the future?  
Neutral

Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future?  
(no label)

Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.  
Organizational/Institutional, Insurance/Financial
Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Q1 My clinic is a ___. Please select from the following: Primary Care/Community Clinic

Q2 Please select the percentage of clinic's patient panel with breast cancer: 10-39%

Q3 What is the most common gender of patients with breast cancer in your clinic? Female

Q4 Of those patients diagnosed with breast cancer, what is the most common age range? 51-60 years old

Q5 Of those patients diagnosed with breast cancer, what is the most common race/ethnicity? White, Asian-American (i.e., Chinese, Japanese, Filipino, Pacific Islander)

Q6 Of Asian Americans diagnosed with breast cancer, what is the most common sub-race? Japanese, Filipino, Pacific Islander

Q7 What type of breast cancer treatment did the majority of patients have undergone? Both radiation and surgery

Q8 For patients who had surgical intervention, did they have lymph nodes removed? Some

Q9 For those who had their lymph nodes removed, what was the main indication for removal? Tumor dimension between 1-2 according to the TNM Classification, Ductal Carcinoma in Situ (DCIS), DCIS with suspected/proved microinvasion
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q10 How is BCRL diagnosed in your clinic?</td>
<td>Clinical diagnosis</td>
</tr>
<tr>
<td>Q11 How frequent is BCRL observed in your clinic?</td>
<td>Not frequent</td>
</tr>
<tr>
<td>Q12 From what you have observed in your clinic, how common is BCRL?</td>
<td>Less than 10%</td>
</tr>
<tr>
<td>Q13 Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?</td>
<td>Yes</td>
</tr>
<tr>
<td>Q14 What is the average BMI of those with BCRL?</td>
<td>BMI &gt;30</td>
</tr>
<tr>
<td>Q15 Is BIS available?</td>
<td>No. If answered no, please skip to Question 18.</td>
</tr>
<tr>
<td>Q16 How long have you had BIS in your clinic?</td>
<td>Respondent skipped this question</td>
</tr>
<tr>
<td>Q17 Do you find a difference in the quality of screening, treatment, and management for BCRL?</td>
<td>Respondent skipped this question</td>
</tr>
<tr>
<td>Q18 Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?</td>
<td>Maybe</td>
</tr>
<tr>
<td>Q19 Would you recommend other clinics to have BIS?</td>
<td>Maybe</td>
</tr>
<tr>
<td>Q20 How likely are you to adopt BIS in the future?</td>
<td>Neutral</td>
</tr>
<tr>
<td>Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future?</td>
<td>Neutral</td>
</tr>
<tr>
<td>(no label)</td>
<td></td>
</tr>
<tr>
<td>Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.</td>
<td>Organizational/Institutional, Insurance/Financial</td>
</tr>
</tbody>
</table>
# Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

**Q1** My clinic is a ___. Please select from the following:  
- Private Practice

**Q2** Please select the percentage of clinic’s patient panel with breast cancer.  
- Less than 10%

**Q3** What is the most common gender of patients with breast cancer in your clinic?  
- Female

**Q4** Of those patients diagnosed with breast cancer, what is the most common age range?  
- 51-60 years old

**Q5** Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?  
- Asian-American (i.e., Chinese, Japanese, Filipino, Pacific Islander)

**Q6** Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?  
- Filipino,  
  - Pacific Islander

**Q7** What type of breast cancer treatment did the majority of patients have undergone?  
- Both radiation and surgery

**Q8** For patients who had surgical intervention, did they have lymph nodes removed?  
- Some

**Q9** For those who had their lymph nodes removed, what was the main indication for removal?  
- Tumor dimension between 1-2 according to the TNM Classification

**Q10** How is BCRL diagnosed in your clinic?  
- Clinical diagnosis

**Q11** How frequent is BCRL observed in your clinic?  
- Not frequent
Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Q12 From what you have observed in your clinic, how common is BCRL? Less than 10%

Q13 Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor? Yes

Q14 What is the average BMI of those with BCRL? BMI >30

Q15 Is BIS available? No. If answered no, please skip to Question 18.

Q16 How long have you had BIS in your clinic? Respondent skipped this question

Q17 Do you find a difference in the quality of screening, treatment, and management for BCRL? Respondent skipped this question

Q18 Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future? Maybe

Q19 Would you recommend other clinics to have BIS? Maybe

Q20 How likely are you to adopt BIS in the future? Not likely

Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future? (no label) (no label)

Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply. Organizational/Institutional, Insurance/Financial
<table>
<thead>
<tr>
<th>Q1</th>
<th>My clinic is a _____. Please select from the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Private Practice</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q2</th>
<th>Please select the percentage of clinic's patient panel with breast cancer.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than 10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q3</th>
<th>What is the most common gender of patients with breast cancer in your clinic?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q4</th>
<th>Of those patients diagnosed with breast cancer, what is the most common age range?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>51-60 years old</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q5</th>
<th>Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asian-American (i.e., Chinese, Japanese, Filipino, Pacific Islander)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q6</th>
<th>Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Filipino, Pacific Islander</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q7</th>
<th>What type of breast cancer treatment did the majority of patients have undergone?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Both radiation and surgery, Chemoprevention</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q8</th>
<th>For patients who had surgical intervention, did they have lymph nodes removed?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Some</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q9</th>
<th>For those who had their lymph nodes removed, what was the main indication for removal?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tumor dimension between 1-2 according to the TNM Classification</td>
</tr>
<tr>
<td></td>
<td>Ductal Carcinoma in Situ (DCIS)</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Q10</th>
<th>How is BCRL diagnosed in your clinic?</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Clinical diagnosis</td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Q11 How frequent is BCRL observed in your clinic?</td>
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<td>Q12 From what you have observed in your clinic, how common is BCRL?</td>
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<td>Q13 Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?</td>
<td>Yes</td>
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<tr>
<td>Q14 What is the average BMI of those with BCRL?</td>
<td>BMI &gt;30</td>
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<tr>
<td>Q15 Is BIS available?</td>
<td>No. If answered no, please skip to Question 18.</td>
</tr>
<tr>
<td>Q16 How long have you had BIS in your clinic?</td>
<td>Respondent skipped this question</td>
</tr>
<tr>
<td>Q17 Do you find a difference in the quality of screening, treatment, and management for BCRL?</td>
<td>Respondent skipped this question</td>
</tr>
<tr>
<td>Q18 Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?</td>
<td>Maybe</td>
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<td>Q19 Would you recommend other clinics to have BIS?</td>
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<td>Q20 How likely are you to adopt BIS in the future?</td>
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<tr>
<td>Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future? (no label)</td>
<td>Neutral</td>
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<tr>
<td>Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.</td>
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Early Screening for Breast-Cancer-Related Lymphedema Using Bioimpedance Spectroscopy

Q1 My clinic is a ___ Please select from the following: Primary Care/Community Clinic

Q2 Please select the percentage of clinic's patient panel with breast cancer.

Less than 10%

Q3 What is the most common gender of patients with breast cancer in your clinic?

Female

Q4 Of those patients diagnosed with breast cancer, what is the most common age range?

51-60 years old

Q5 Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?

White,
Asian-American (i.e., Chinese, Japanese, Filipino, Pacific Islander)

Q6 Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?

Filipino,
Pacific Islander

Q7 What type of breast cancer treatment did the majority of patients have undergone?

Both radiation and surgery

Q8 For patients who had surgical intervention, did they have lymph nodes removed?

Some

Q9 For those who had their lymph nodes removed, what was the main indication for removal?

Tumor dimension between 1-2 according to the TNM Classification

Q10 How is BCRL diagnosed in your clinic?

Clinical diagnosis
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<tr>
<td>Q21 On the scale of 1-10, how would you rate your readiness to adopt BIS in the future?</td>
<td>(no label)</td>
</tr>
<tr>
<td>Q22 What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.</td>
<td>Organizational/Institutional, Insurance/Financial</td>
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</tbody>
</table>
Appendix H. Actual response via word document

Purpose: To gain an understanding of your current method of screening BCRL and possible adoption of BIS as an ancillary strategy to improve routine breast cancer care.

Instructions:
Please fill out the survey by marking, highlighting, bolding, italicizing, or underlining your answers.

Survey Questions:
1. My clinic is a ____. Please select from the following:
   __ Primary Care/Community Clinic
   __ Private Practice
   __ Specialty Clinic. If checked, please state the type of specialty clinic (i.e., radiation oncology, medical oncology, etc.): SURGERY ________

The following questions are related to patients you have taken care for in your practice.

2. Please select the percentage of clinic’s patient panel with breast cancer.
   __ Less than 10%
   __ 10-39%
   __ 40-50%
   __ More than 50%

3. What is the most common gender of patients with breast cancer in your clinic?
   __ Male    __ Female

4. Of those patients diagnosed with breast cancer, what is the most common age range?
   __ 30-40 years old
   __ 41-50 years old
   __ 51-60 years old
   __ 61-70 years old
   __ > 71 years old

5. Of those patients diagnosed with breast cancer, what is the most common race/ethnicity?
   __ White
   __ African-American
   __ Hispanic
   __ Asian-American (i.e. Chinese, Japanese, Filipino, Pacific Islander, etc.)
   __ American-Indian/Alaskan Native
   __ Matches population served: white and Asian/Hawaiian__Other

6. Of Asian Americans diagnosed with breast cancer, what is the most common sub-race?
   __ Chinese
   __ Japanese
   __ Filipino
Early Screening for BCRL Using BIS

7. What type of breast cancer treatment did the majority of patients have undergone?
   ___ Radiation
   ___ Surgery
   ___ Both radiation and surgery
   ___ Chemoprevention
   ___ Other (please specify): ___

8. For patients who had surgical intervention, did they have lymph nodes removed?
   ___ Some ___ No ___ Yes

9. For those who had their lymph nodes removed, what was the main indication for removal?
   ___ Tumor dimension between 1-2 according to the TNM Classification
   ___ Ductal Carcinoma in Situ (DCIS)
   ___ DCIS with suspected/proved microinvasion
   ___ Clinically negative axillary nodes following neoadjuvant chemotherapy
   ___ Other. Please specify: ________

10. How is BCRL diagnosed in your clinic?
    ___ Clinical diagnosis ___ Screening tool/device/machine

11. How frequent is BCRL observed in your clinic?
    ___ Not frequent.
    ___ Frequent.
    ___ Very frequent.

12. From what you have observed in your clinic, how common is BCRL?
    ___ Less than 10%
    ___ 10 to 29%
    ___ 30 to 50%
    ___ More than 50%

13. Of those with BCRL, is there any indication that high body mass index (BMI) is a contributing factor?
    ___ Yes
    ___ No

14. What is the average BMI of those with BCRL?
    ___ BMI <18
    ___ BMI 18 to 25
    ___ BMI 26 to 29
15. Is BIS available?
   _Yes_. If answered yes, please continue to Question 16.
   _No_. If answered no, please skip to Question 18.

16. How long have you had BIS in your clinic?
   _Less than 2 years_  _Between 2 to 5 years_  _More than 5 years_

17. Do you find a difference in the quality of screening, treatment, and management for BCRL?
   _Yes_  _No_

18. Would you recommend other clinics to have BIS?
   _Yes_  _Maybe_  _No_

19. Given the synopsis about BIS provided in the email, would you be interested in adopting BIS in the future?
   _Yes_  _Maybe_  _No_

20. How likely are you to adopt BIS in the future?
   _Not likely_  _Neutral_  _Likely_

21. On the scale of 1-10, how would you rate your readiness to adopt BIS in the future?

<table>
<thead>
<tr>
<th>Not ready</th>
<th>Ready</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
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<tr>
<td>3</td>
<td>4</td>
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<td>5</td>
<td>6</td>
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<tr>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

22. What are potential barriers that may impact your decision to adopt BIS? Please select all that apply.
   _Lack of applicability_  _Lack of time_  _Organizational/Institutional_  _Patient adherence/Compliance_  _Treatment related adverse events_
   _Other (please specify): ___WOULD NEED RESEARCH ARTICLES TO BE PROVIDED FOR REVIEW___

End of Survey.
Thank you for your voluntary participation!
Appendix I. Collaborative institutional training initiative certificate
**Appendix J.** Non-exempt social and behavioral sciences researchers and key personnel certificate

![Certificate Image]

This is to certify that:

**Melford Lazarte**

Has completed the following CITI Program course:

**Information Privacy Security (IPS)**
**Non-Exempt Social & Behavioral Sciences Researchers and Key Personnel IPS**
**1 - Basic Course**

Under requirements set by:

**University of Hawaii**

Verify at [www.citiprogram.org/verify/?w3902837d-6f57-4c9e-832d-b27926e6d1c9-34684883](http://www.citiprogram.org/verify/?w3902837d-6f57-4c9e-832d-b27926e6d1c9-34684883)