

**BREAST CANCER SCREENING IN BRITISH COLUMBIA:
IMPLICATIONS OF DIAGNOSTIC TRAJECTORIES**

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ABSTRACT

Despite reductions in mortality rates, breast cancer remains the most common cancer and the second most common cause of cancer death in Canadian women. Organized screening programs have contributed to the decrease in breast cancer mortality by allowing for early diagnosis and treatment. The diagnostic phase following an abnormal screen has implications for patient well-being, clinical practice, and resource management in health care. We present data from British Columbia that show that improvements at the diagnostic phase are necessary in order to capitalize on the benefit offered by breast cancer screening. The results are discussed in the context of population and public health practice, and recommendations for further study and improvement of the efficiency of the diagnostic phase are suggested.

Keywords: breast cancer; screening; diagnostic trajectory; health service delivery; population health

Subject terms: health services; breast cancer; screening; diagnosis; population health

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INTRODUCTION

Despite reductions in mortality rates, breast cancer remains the most common cancer and the second most common cause of cancer death in Canadian women (National Cancer Institute of Canada, 2007). Breast cancer affects one in nine Canadian women in her lifetime, and one in 27 will die from this disease (ibid.). Breast tumours detected by screening have been shown to be smaller than tumours detected by other means, and to be more likely to have features associated with better prognosis (Klemi et al., 1992). Organized screening mammography programs are associated with a decrease in mortality attributable to breast cancer (Coldman, Phillips, Warren, & Kan, 2006). The Screening Mammography Program of British Columbia (SMPBC) has been associated with detection of smaller tumours, greater conservation of breast during treatment, and decreased likelihood of being treated with chemotherapy or tamoxifen (Olivotto et al., 1999). The benefit of screening has also been reported across Canada (Public Health Agency of Canada, 2005), in Finland (Klemi et al., 1992), Denmark (Olsen et al., 2005), and Sweden (Nyström et al., 2002), among other places. The SMPBC has published or been affiliated with a large amount of high quality research, using local data. This paper will highlight that work where possible, in discussing the role of breast cancer screening in population and public health. Many of the questions, difficulties, and successes of the BC experience will be similar in other regions or countries with similar resources.

Therefore the discussion presented here could be applicable in a general way to other regions, with the understanding that local context and data should always be factored into local solutions.

The process of investigating abnormalities detected on screening, by conducting tests and assessments in order to arrive at a diagnosis is an important phase in clinical cancer screening programs. A screening program is not always directly responsible for this phase, but, as is the case in BC, the program usually initiates the process and has established partnerships with diagnostic facilities and providers. The diagnostic process is important for several reasons: first, this is often a time of emotional distress and confusion for the patient as she awaits information that may profoundly affect her future; second, it provides an opportunity for physicians to gather information necessary to begin prompt and appropriate treatment given a positive diagnosis; and third, it is a time of considerable health care expense. Given that the SMPBC provided 266,792 screens in 2006, and 7.4% were found to be abnormal, follow-up diagnostic tests and assessments were conducted on 19,702 patients in BC that year. Positive diagnoses of breast cancer were made in 1020 cases (0.4% of all screens and 5.2% of positive screens) (BC Cancer Agency, 2007). There is thus good reason to expect the diagnostic trajectory (the course of procedures conducted during the diagnostic phase) to be as quick, effective, and efficient as possible. This means ensuring that the procedures carried out are appropriate to the situation. This paper considers the diagnostic process in breast cancer, from

abnormal screen to diagnosis, and highlights some of the issues and opportunities around delivering this public health service.

Following a brief discussion of the epidemiology of breast cancer and a discussion of screening programs to set the context, the effects of the diagnostic trajectory are considered from three perspectives: the emotional implications for the patient; the clinical practice implications; and the resource management implications. These perspectives represent the main interests at stake in a screening program of this nature. In addition, results from a research study are presented that describe the pattern of diagnostic trajectories in BC and suggest links between the interests above and indicators from local data. Duration of time from abnormal screen to diagnosis, number of procedures undertaken, type of procedure conducted, and approximate cost of procedures were analyzed descriptively. Finally, risks and benefits attributed to improving the efficiency of diagnostic trajectories for breast cancer are considered from the perspective of population and public health practice.

Epidemiology

A number of factors are associated with an increased risk of developing breast cancer. Research has indicated that older age, family history of breast cancer, personal history of benign breast disease, intake of two or more alcoholic drinks per day, higher body mass index, and carrying the BRCA genes, increase the chance that an individual woman will have breast cancer (Roberts et al., 1984; Singletary, 2003). Studies have also documented an increased risk in women who begin menarche before age 12, whose menopause occurs after age

55, and who are nulliparous or have a first child after age 30 (Singletary, 2003). Based on these observations, it has been suggested that the increase in risk related to reproductive factors is a function of a woman's lifetime number of ovulatory menstrual cycles (Vogel, as discussed in Singletary, 2003). Some risk factors are known to have synergistic effects, increasing the risk associated with having different combinations of risk factors (Singletary, 2003). Among the strongest risk factors (those with a relative risk higher than 4) are age (over 65 years compared to under 65), past history of invasive breast cancer, germline mutations in BRCA genes, and radiation exposure for Hodgkin's disease (BC Cancer Agency, 2007; Singletary, 2003). Moderate risk factors (those with a relative risk between 2 and 4) include having two first-degree relatives with breast cancer, having a first-degree relative with premenopausal breast cancer, and cytology indicating proliferation without atypia. Weak risk factors (those with a relative risk less than 2) include moderate alcohol intake, body mass index, hormone replacement therapy, early menarche and being nulliparous or having a first child after the age of 30 (Singletary, 2003).

Screening Programs

Screening tests are justified when they are valid and acceptable, they result in minimal diagnosis of inconsequential or non-progressive disease, effective therapy or intervention is available, and they are cost effective (Miller, 2000).

Debate continues (Gøtzsche & Olsen, 2000; Horton, 2001) about the actual decrease in mortality from breast cancer due to screening weighed against

the risks of screening, primarily physical discomfort (Marshall, 1996) and low doses of radiation (Hurley & Kaldor, 1992). As yet, the possibility of genetic susceptibility of radiation effects has not been an issue. However, as we learn more in the future, screening protocols for breast cancer may become more nuanced if we find variation among women in susceptibility to the harmful effects of radiation exposure. Some trials reporting the benefits of screening have been criticized for methodological flaws, e.g. questionable randomisation (Gøtzsche & Olsen, 2000). Despite the debate, mammography screening programs are widely recommended as an effective means for the early detection of breast cancer in women aged 50-69 (Coldman et al., 2006). Further controversy has focused specifically on the benefit of screening in women aged 40-49. As incidence of breast cancer increases with age (Armstrong, Moye, Williams, Berlin, & Reynolds, 2007), the incidence of disease in this age group is relatively small. The accuracy of screening mammography increases with age (Feig, 2000). In previous unpublished data we found that as the age of women being screened increased, the percentage of clearly differentiated abnormalities seen on screening mammograms increased while the percentage of unclear abnormalities decreased. However, despite the age-related accuracy of mammography, studies have shown that women in this age group, as well as between 70-79, still benefit from screening (Coldman et al., 2006; Qaseem et al., 2007; Ringash, 2001). Mortality from breast cancer is reduced by screening between the ages of 40 and 79 (Coldman et al., 2006). Organized breast cancer

screening programs operate in all 10 Canadian provinces, as well as in the Yukon and Northwest Territories (Public Health Agency of Canada, 2005).

Evidence suggests that screening programs are associated with the detection of tumours that are smaller (Cortesi et al., 2006; Olivotto et al., 1999) and less biologically aggressive (Klemi et al., 1992). An accumulation of evidence confirms a reduction in mortality for screen-detected breast cancers (Andersson et al., 1988; Coldman et al., 2006; Cortesi et al., 2006). The SMPBC provides screening mammography to eligible women between the ages of 40 and 79 without doctor referral, and will accept clients under the age of 40 and above 80 with a doctor's referral (BC Cancer Agency, 2007). Women under the age of 50 are offered screening mammograms annually, and those over 50 every 2 years (Coldman et al., 2006). The radiologist performing the screening mammogram classifies abnormal mammograms as low abnormality, moderate abnormality, and high abnormality based on the level of clinical suspicion.

In 2006, 266,792 mammographic screens were performed by SMPBC (BC Cancer Agency, 2007). Of these, 19,702 (7.4%) were found to be abnormal, and 1020 diagnoses of breast cancer were made (0.4% of all screens; 5.2% of abnormal screens). Participation in screening is largest in the 50-69 age group (Public Health Agency of Canada, 2005). In 2006, 50% of BC women aged 50-69 participated in the BCSMP. The lowest participation rates for this age group (30%) were in the East Kootenay region, and the highest rates (57%) were in the Okanagan (BC Cancer Agency, 2007).

The target guidelines in Canada state that less than 10% of initial screens (people who are having their first mammogram with the screening program) and less than 5% of rescreens (people who are returning for a yearly or 2-yearly screen) should be recalled (due to abnormalities detected by the radiologist) (BC Cancer Agency, 2007). These targets are based on a balancing of sensitivity (the rate of accurate detection of disease that is present) and specificity (the rate of negative results among those who do not have the disease) of mammography. The sensitivity depends on a number of factors, including patient, tumour, and radiology characteristics, but overall has been shown to be 70-90% (Urbain, 2005). The overall specificity is about 90% (ibid.). Public and political values also probably influence recall rates, evidenced by the fact that Canada has a higher rate of recall than international standards, which is likely due to the lower tolerance in this country for risk of missed cancers (Miller, 2000; Poole, Gelmon, Borugian, Kan, & Stilwell, 2008).

Following an abnormal mammography result, diagnostic tests are performed to clarify and confirm a diagnosis. An abnormal screening result could therefore ultimately be associated with a normal state, a diagnosis of benign breast disease, ductal carcinoma *in situ* (DCIS), lobular carcinoma *in situ* (LCIS), or malignant breast cancer. Malignant breast cancer can include invasive and inflammatory types. DCIS is a non-invasive breast cancer where the cancer cells are inside the walls of the milk ducts and have not spread to surrounding tissue. LCIS refers to when the cancer cells originate in the milk-producing glands called lobules. LCIS is often considered not to be a true cancer; however, women with

LCIS are at a higher risk for developing invasive breast cancer (American Cancer Society, 2007). Invasive breast cancer most commonly originates in the ducts, although it can also originate in the lobules. Invasive breast cancer has spread into surrounding fatty breast tissue. Inflammatory breast cancer is a rare type, occurring in 1-3% of cases, has a poor prognosis and tends to occur in younger women (ibid.). This type of breast cancer does not involve a single tumour, is characterized by redness and warmth of the breast skin, and presents as skin that is often described as looking like an orange peel (ibid.). Discussion of positive cancers in this paper refers to those diagnosed as malignant or DCIS.

All abnormal screens are followed up, either directly until a final diagnosis is reached or until a regular interval of monitoring is recommended. Diagnostic procedures usually begin with additional mammographic views, and any combination of ultrasound, biopsy (in the form of fine-needle aspiration, open biopsy with or without fine wire localization, or stereotaxic core biopsy), surgical consult, or follow-up with a primary health care provider. The SMPBC generally alerts the patient's family physician who then initiates the diagnostic testing phase. In 1999, a "Fast Track" program was implemented, whereby patients of participating physicians are referred directly to the diagnostic process upon abnormal mammogram (while the physician is still sent a report with the results). This facilitated referral process resulted in a 1.5 week reduction in the median time between abnormal screening report and first diagnostic procedure (BC Cancer Agency, 2007).

A Working Group on the Integration of Screening and Diagnosis was established by the National Committee for the Canadian Breast Cancer Screening Initiative (CBCSI) in response to concerns about the delays during the assessment process and poor integration of screening and diagnosis (Public Health Agency of Canada, 2005). This working group produced timeliness targets, which are currently used as benchmarks for screening programs across Canada (discussed below). While the timelines are regularly monitored, the actual sequence of procedures has not yet figured into many discussions. This is important to discuss because not all procedures are equivalent – they acquire different kinds of information, and involve varying levels of invasiveness or discomfort. In order to deliver the best care possible, it is necessary to talk not only about the timeliness of diagnosis, but also about the appropriateness of sequences of procedures. The process of diagnosis is about getting the right information, quickly.

Implications for Patients

False-positive screening results, or suspected cancers that are not cancer, are common; studies have shown that 50% of women who take part in regular screening are likely to have a false-positive during their lifetime (Elmore et al., 1998). The experience of undergoing screening, and being recalled for an abnormal mammogram, provokes anxiety. The uncertainty involved in having to undergo further testing can induce varying degrees of emotion (Fridfinnsdottir, 1997). A great deal of anxiety and worry is associated, for many women, with the waiting period during the diagnostic phase for breast cancer (Thorne, Harris,

Hislop, & Vestrup, 1999). While not all women experience this process in the same way, anxiety and stress are commonly reported responses. Women have indicated that the lack of information about the process increases distress (Thorne et al., 1999). Thorne et al (1999) emphasize the “importance of access to appropriate and accurate information” (p.49) for women who are undergoing follow-up to an abnormal screen, which is likely applicable to any patient with a suspected disease.

Barton and colleagues (2004) conducted a study comparing interventions to reduce anxiety following an abnormal screening mammogram. They found that “rapid evaluation of mammographic abnormalities may be a more effective approach to decreasing women’s anxieties than trying to change emotional reactions to an abnormal mammogram” (Barton et al., 2004 p.536). A study by Pineault (2007) found that 98% of women surveyed after an abnormal screen considered reducing waiting periods to be a very important strategy to decrease anxiety during this period. Therefore, from the patient perspective, the research suggests that decreasing waiting times following an abnormal procedure will help to reduce the anxiety associated with this phase.

Olivotto (2000 p.115) suggests that a “delay of 6 to 11 weeks from abnormal mammogram to definitive diagnosis is not likely to affect ultimate survival,” but suggests this could still affect anxiety, personal productivity, family dynamics, and compliance with re-screening. In the same article, Olivotto reports recommendations reached by consensus and adopted by SMPBC and BC Cancer Agency that the

target maximum interval from screening to notification should be less than or equal to 3 working days; notification to completion of imaging should be less than or equal to 5 working days; imaging to surgical consultation should be less than or equal to 5 working days; and surgical consultation to biopsy less than or equal to 5 working days. (p.116)

This suggests that the target maximum interval between abnormal screen and biopsy should be no more than 4 weeks.

A final consideration of the emotional impact of screening rests with the fact that screening asymptomatic women brings the risk of detecting inconsequential disease— that which, if left undetected and untreated, would not have become symptomatic. The emotional cost of being diagnosed with a disease, and being treated for it, is a difficult one to measure. However, the actual rate of overdiagnosis is estimated to be small, around 1% of all cases diagnosed (Duffy et al., 2005). Therefore, the likely emotional impact of the detection of inconsequential disease seems outweighed by the benefit of screening, and the more likely detection of true disease.

Clinical Practice Implications

In most cases, in order to arrive at a definitive diagnosis, a tissue sample must be analyzed. In some cases where an imaging result clearly indicates a large and malignant tumour, a biopsy may not be required. Due to the invasiveness and discomfort associated with acquiring tissue samples, such acquisition should be reserved for cases where there is strong suspicion of a positive diagnosis. Given that 'low abnormal' mammograms are less suspicious and result in a diagnosis in a small percentage of cases, it can be expected that

these diagnostic trajectories would include a biopsy in fewer instances than 'highly abnormal' mammograms.

The current BC guidelines for diagnosing breast cancer state that if the detected lesion is thought, in the opinion of the diagnostic radiologist, to be benign, then ultrasound may be useful to distinguish between a cystic and solid lesion. If the lesion is thought to be cystic, then aspiration of the lesion can provide both a diagnosis and treatment, in many cases. If the mass is found to be solid, or further diagnostic processing is needed, then "in most cases a core biopsy is recommended to get adequate tissue for pathological diagnosis and to plan surgical intervention if necessary" (BC Cancer Agency; Poole et al., 2008).

Discussion about the relative benefit of core biopsy or fine needle aspiration has focused primarily on the sensitivity of each procedure (Sun, Li, Abreo, Turbat-Herrera, & Grafton, 2001; Westenend, Sever, Beekman-de Volder, & Liem, 2001), but studies have also shown that core biopsies "facilitate wider initial margins of excision, fewer positive margins, and fewer surgical procedures to accomplish definitive treatment than diagnosis by [the more invasive] surgical needle-guided biopsy" (White et al., 2001 p.769). It is important to recognize that, while accurate diagnosis is the primary goal of the process, acquiring enough information to appropriately guide treatment post-diagnosis, without having to conduct yet more invasive procedures, is also an objective.

To decide on a course of treatment for a given case, it is necessary to know whether the tumour is contained or spreading. The TNM staging system indicates the size, degree of nodal involvement, and metastasis status of the

cancer. Other important indicators for treatment are whether the cancer cells have receptors for certain hormones or proteins. These factors can affect the choice of treatment; therefore, it is necessary to gather the appropriate information as early as possible. Core biopsy is less invasive than surgical biopsies, and gathers the tumour characteristic information necessary to make treatment decisions.

Resource management Implications

The choice of diagnostic procedure sequence is important not only for the emotional well-being of patients and the need to gather appropriate information, but also for the fact that a large number of patients are undergoing a large number of diagnostic procedures every year, and any improvement to the efficiency of the process will help increase the flow of the system for the benefit of all participants.

As table 1 shows, BC physicians currently bill unilateral diagnostic mammograms at \$70.11 (Medical Services Commission, 2008). Unilateral breast sonograms (ultrasounds) are billed at \$55.74. Fine needle aspirations of breast lesions are billed at \$40.22, stereotactic or ultrasound-guided core needle biopsy are billed at \$74.55 for 1 to 5 samples and \$105.22 for 6 to 10 samples. Open biopsies where the entire tumour is removed (excisional) are billed at \$112.40, and those where the tumour is partially removed (incisional) are billed at \$105.22. Surgical consultations are billed at \$94.77, and general practice consultations are charged depending on the age of the patient, from \$70.68 to \$91.88.

Table 1: Costs for procedures in 2008

Procedure	Cost
Fine needle aspiration	\$40.22
Ultrasound	\$55.74
Diagnostic mammogram	\$70.11
General practice consultation	\$70.68 to \$91.88
Core biopsy	\$74.55 to \$105.22
Surgical consultations	\$94.77
Open biopsy	\$105.22 to \$112.40

The triple assessment, comprising clinical examination, imaging, and histology, is considered the gold standard for a complete diagnosis of breast cancer (Poole et al., 2008). If individuals receive a diagnostic mammogram and/or an ultrasound procedure, a physical examination, and a biopsy procedure, then most breast cancer diagnoses could be made within four procedures.

Effective delivery of population-based breast cancer screening programs involves huge cost. Currently, 50% of BC women between the ages of 50 and 69 participate in the SMPBC (BC Cancer Agency, 2007), and 42% of eligible women over 40 participate (Poole et al., 2008). Of all breast cancers diagnosed in 2005, 38% were discovered through screening (ibid.).

Given our literature review findings, we conducted a study to describe the situation in BC. The literature suggests that patient interests are focussed around prompt diagnosis, and clinical practice interests are best served by favouring core biopsy as the method of tissue acquisition wherever possible. In order to increase the benefit of screening programs at the population level, participation rates must increase. Resource management interests will be served by

enhancing quality of care without increasing costs. We analyzed available data descriptively from each of these perspectives.

RESEARCH STUDY

Objectives

We had three objectives: 1) to investigate the literature with regards to patient, clinical, and resource management implications of screening; 2) to describe the diagnostic trajectories associated with abnormal screening mammograms; 3) to consider the diagnostic trajectories in more detail, in the context of patient, clinical, and resource management implications.

Research Question

What do diagnostic trajectories look like following an abnormal screening mammogram; are they consistent within a diagnostic class of patients; and are they appropriate for gathering treatment information, while minimizing the number of needed follow-up procedures?

Methods

Data sources

With ethical approval from the BC Cancer Agency and Simon Fraser University, we gained access to SMPBC data for all screening mammograms performed during 2003-2005, stripped of identifying information. Information on the clients; screens; visit characteristics; testing procedures after abnormalities were detected on screens; and diagnoses and tumour characteristics, were contained within 5 separate datasets for all women who were screened by the

program between 2003 and 2005. There were a total of 585,215 screening mammograms performed on 427,494 people during this period. The end point in our final database is diagnosis; it does not include information about treatment or patient outcomes.

Using SAS (version 9.1) we merged these data in order to have a complete database with all relevant variables from each dataset. This was more complicated than a one-to-one merge, however, as a client had a separate entry for every screen or procedure conducted with her during the time period. Therefore, multiple observations for an individual could have been due to a) repeat screens, b) a series of diagnostic procedures following a given screen, c) diagnoses in both breasts, or d) some combination of these. As we wanted to be able to analyze the entire procedural path associated with each screen, it took some manipulation to organize the database in an appropriate way. We excluded those women who were diagnosed with breast cancer in both breasts, as we decided the path towards bilateral breast cancer was a different process, and should therefore be looked at in a separate analysis.

Analysis

After conducting the literature review, we spent considerable time thinking about how we were going to answer the questions we set out to answer, and how we would organize the database appropriately. We created a variable to capture the diagnostic trajectory, which contains information on the order and types of procedures related to each screen. Specifically, each procedure was coded numerically and then inserted into the trajectory variable so that each digit in the

variable represented the corresponding procedure, with zeros as placeholders where no procedure occurred. For instance, the variable 12510000000 indicates that a diagnostic mammogram was the first procedure, an ultrasound was the second, a core biopsy the third, and another diagnostic mammogram was the fourth and last procedure. Within our database, there were a maximum of 11 procedures before a diagnosis was reached, so the trajectory variable has 11 possible digits. We created many other variables from the existing data in order to design the database in a workable way. This process took more time and energy than any other phase of the research. This was a daunting task as there were innumerable conceivable ways of approaching the data. Each of the findings we calculated would suggest more questions, and new ways to look at the data. This iterative process was fruitful, but impossible to end. The analyses reported here demonstrate the potential of these data. These were chosen for inclusion as a starting point for discussion, while further analyses are underway.

Once the database was organized, we ran frequencies of the diagnostic trajectory variable to describe the range of actual trajectories following any abnormal mammogram. We ran cross-tabular frequencies of the observed trajectories by stratifying by several variables, including age; diagnosis; length of time from abnormal screen to diagnosis; rates of core biopsy versus fine needle aspiration or other biopsy; and total number of procedures. In considering the interests of the patient, we analyzed the length of wait from abnormal screen to diagnosis. We calculated the rates of different kinds of biopsy to determine

current practice from a clinical perspective. The total number of procedures was considered from the perspective of cost of the delivery of this health service.

Results

During the years 2003 to 2005, 585,215 mammography screens were performed. Of these, 40,232 (6.9%) were read as abnormal and followed-up with diagnostic testing.

Table 2 shows the resulting diagnoses by screen result. Ultimately, 1765 diagnoses of malignant breast cancer were made (4.39% of those followed-up), and 575 diagnoses of DCIS were made (1.43%). Of those screening mammograms read as low abnormal, 1.6% resulted in a malignant diagnosis (2.4% were malignant or DCIS); of those read as moderate abnormal, 15.8% resulted in a malignant diagnosis (21.0% were malignant or DCIS); and of those read as highly abnormal, 70.6% resulted in a malignant diagnosis (83.9% were malignant or DCIS). Interestingly, of all the malignant diagnoses, roughly one-third were originally identified by low (32.63%), moderate (35.75%), and high (31.56%) abnormalities on screening mammograms. In keeping with the main perspectives discussed earlier, the results presented here are organized by indicators of each perspective.

Table 2: Diagnosis by screen result

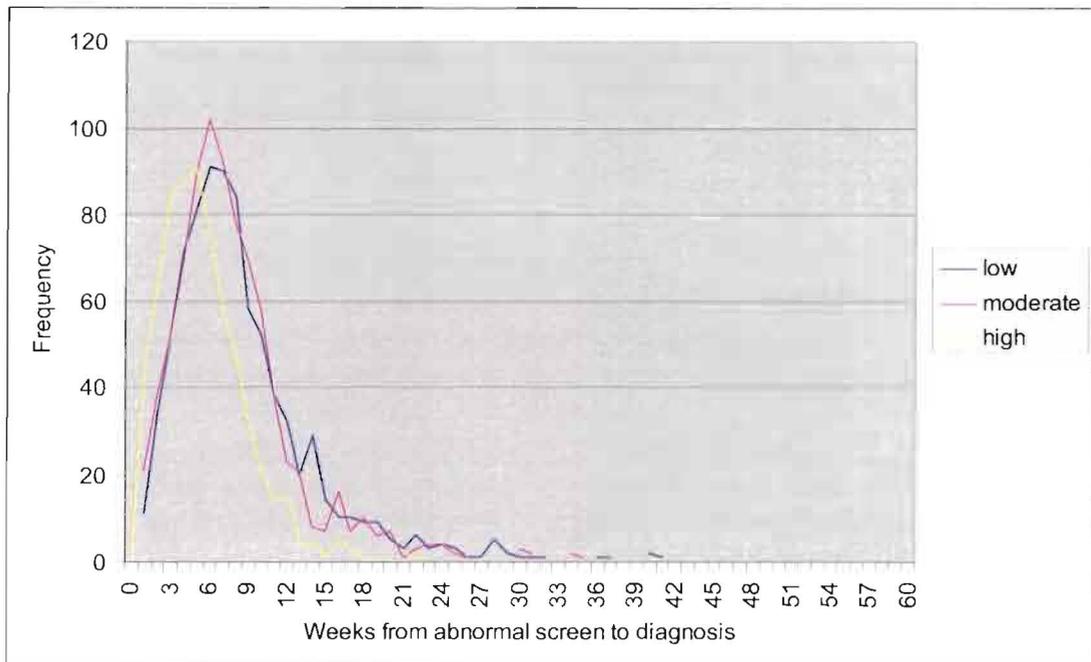
Screen result	Diagnosis					Total	Frequency Percent Row % Column %
	Benign	DCIS	LCIS	Malignant	Normal		
uncategorized abnormal	4	1	0	1	35	41	
	0.01	0	0	0	0.09	0.1	
	9.76	2.44	0	2.44	85.37		
	0.1	0.17	0	0.06	0.1		
low abnormal	2,966	261	24	576	31,587	35,414	
	7.37	0.65	0.06	1.43	78.51	88.02	
	8.38	0.74	0.07	1.63	89.19		
	77.36	45.39	64.86	32.63	92.85		
moderate abnormal	805	208	13	631	2,331	3,988	
	2	0.52	0.03	1.57	5.79	9.91	
	20.19	5.22	0.33	15.82	58.45		
	21	36.17	35.14	35.75	6.85		
high abnormal	59	105	0	557	68	789	
	0.15	0.26	0	1.38	0.17	1.96	
	7.48	13.31	0	70.6	8.62		
	1.54	18.26	0	31.56	0.2		
Total	3,834	575	37	1,765	34,021	40,232	
	9.53	1.43	0.09	4.39	84.56	100	

Patient Perspective

The main factor emerging from the discussion of patient implications of screening follow-up was timeliness. We would also expect the number of procedures to be related to patient impact. Of all malignant diagnoses, 31.0% were diagnosed within 4 weeks, and 72.7% were diagnosed within 8 weeks. By 12 weeks, 90.8% had been diagnosed, and 95.4% were diagnosed within 16 weeks. The mean waiting time between abnormal screening mammogram and final diagnosis, for all followed-up screens, was 39 days. The median was 27 days. The mode was 14 days. When the diagnosis was positive, the mean number of days between screen and diagnosis was 51 days, the median was 43

days, and the mode was 35. Figure 1 graphs the waiting time in weeks for a diagnosis after each level of suspicious mammogram.

Figure 1: Number of weeks from abnormal screen to diagnosis, by level of abnormality of the screen



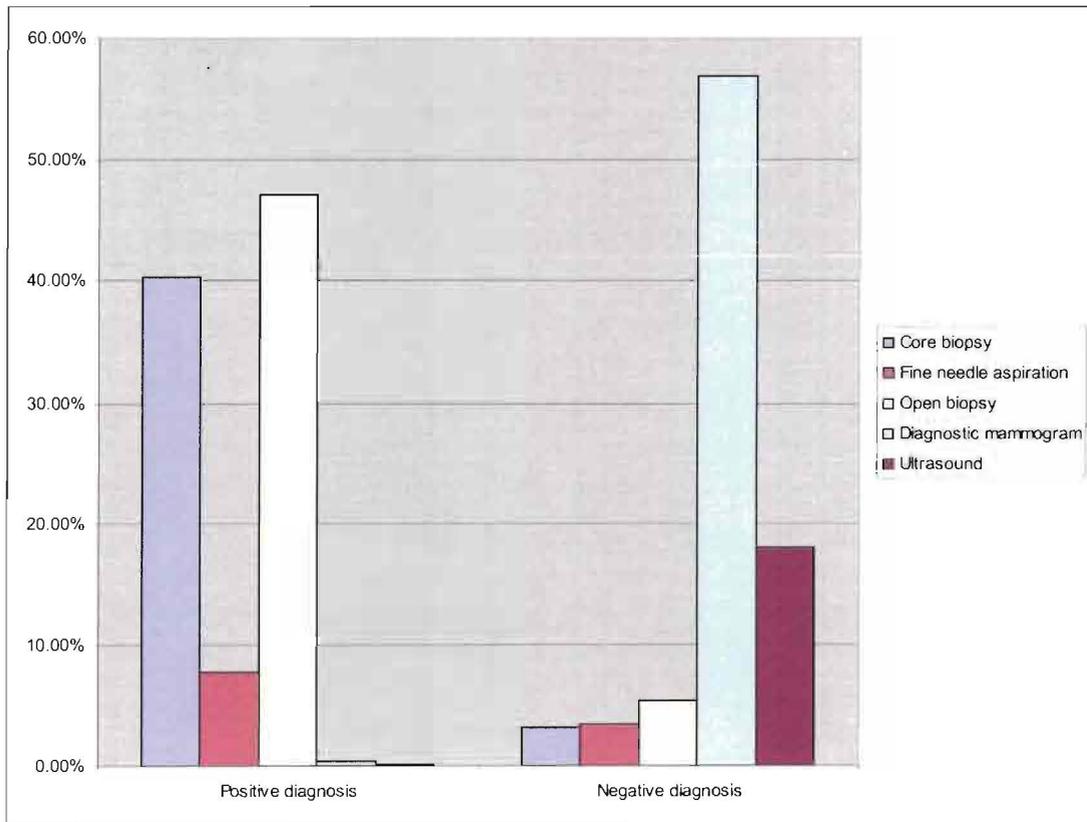
Clinical practice perspective

The main point from the clinical practice implication discussion was that core biopsies should be the preferred method of tissue acquisition in most cases, due to the wealth of information available from this procedure, and its minimal invasiveness.

As shown in figure 2, the final procedure in the trajectory was a core biopsy in 40.2% of cases that were diagnosed as positive for cancer. Fine needle aspiration was the last procedure in 7.7% of these cases, and 47.1% ended with open biopsy.

When the resulting diagnosis was negative for cancer, most (56.9%) ended with a diagnostic mammogram, 3.1% ended with a core biopsy, 3.4% ended with a fine needle aspiration, and 5.3% ended with open of biopsy. The rest ended with an ultrasound, physician consultation, or surgical consultation.

Figure 2: Final diagnostic procedure in positive and negative diagnoses



Fine needle aspirations were more likely to result in indeterminate, uncertain, or incomplete readings upon tissue analysis (7.8%), compared to core biopsies (1.3%).

Resource management perspective

The factors from this perspective overlap with those from the others, notably that the number of procedures will impact both the patient and resource management interests. Streamlining the diagnostic trajectory to the most ideal pathway will serve the interests of all stakeholders.

Of those patients who were given a positive diagnosis of breast cancer, 23.4% required more than four procedures. If an ideal trajectory is defined as involving four or fewer procedures in most cases, and taking no longer than 4 weeks, based on clinical practice and timeliness targets, then 53.6% of all trajectories in our dataset were ideal. When the screening mammogram was identified as low abnormal, 50.3% of the associated trajectories were ideal. When the screen was moderate abnormal, 39.3% of the trajectories were ideal, and when the screen was high abnormal, 37.4% of the trajectories were ideal.

Figures 3 and 4 illustrate the percentage of cases followed up by ideal trajectories, and resulting in negative and positive diagnoses, respectively. High abnormal screens were followed by an ideal trajectory in 36.3% of cases that resulted in a positive diagnosis, and 43.3% of those that did not. Moderate abnormal screens were followed by an ideal trajectory in 19.2% of positive cases and 44.6% of negative cases. Low abnormal screens were followed by an ideal trajectory in 17.6% of positive and 56.5% of negative cases.

Figure 3: Percentage of abnormal screens followed by ideal paths, by level of abnormality of the screen, when the diagnosis was negative

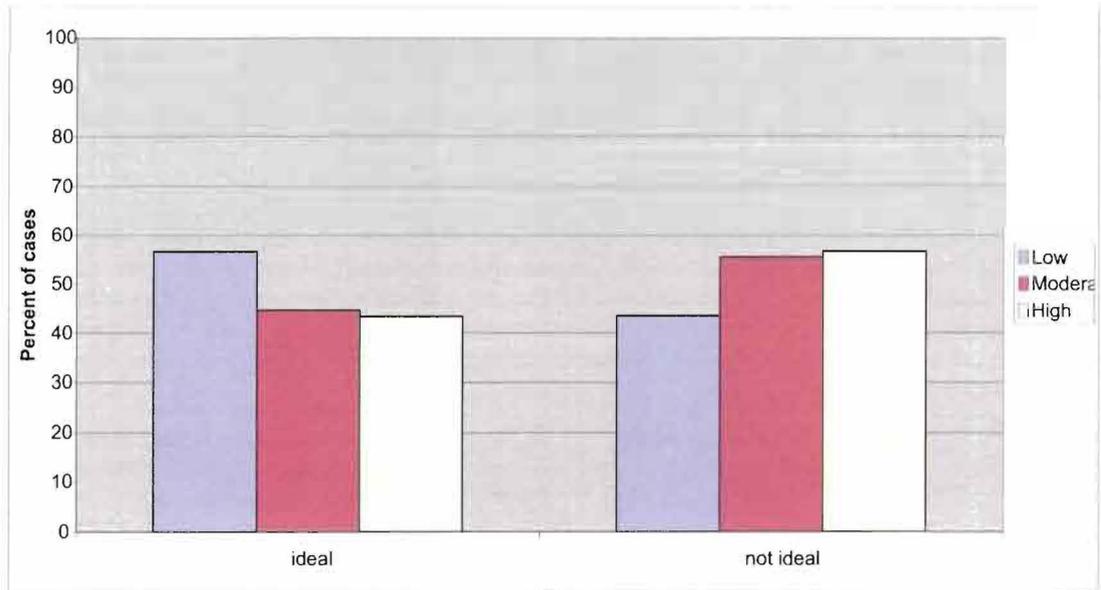
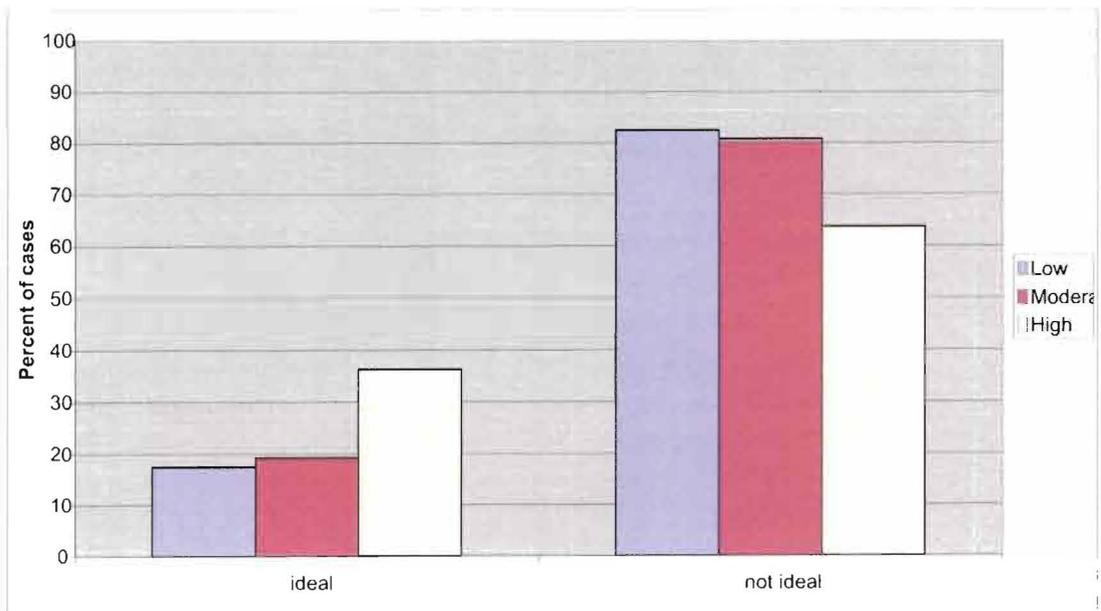


Figure 4: Percentage of abnormal screens followed by ideal paths, by level of abnormality of the screen, when the diagnosis was positive



The median size of diagnosed malignant tumour was 12 mm. Seventy-five percent were 18 mm or smaller.

The median cost billed of all diagnostic trajectories was \$125.85. The median cost for all diagnostic trajectories that resulted in a positive diagnosis was \$281.69, using the most current MSP fee schedule. If the ideal trajectory were followed (comprising a diagnostic mammogram, a (surgical) consultation, and a core biopsy) the total cost would be \$239.43. Based on the 40,232 abnormal screens that were followed up, this results in a total difference between observed and ideal cost of trajectories of \$1,700,204.32. This is a rough estimate and should not be taken as the actual costs based on our dataset, but does give an indication of the amount of money involved in *potentially unnecessary* procedures.

DISCUSSION

The efforts of the Screening Mammography Program of BC have improved population health in the province. Although more women are being diagnosed with breast cancer, fewer women are dying because of this disease. The results presented here suggest that there is room for improvement in order to optimize the benefit of this program.

These results from the years 2003 to 2005 suggest that diagnoses are taking longer than intended to be finalized. More procedures are involved in the diagnostic trajectories than should be necessary. Reducing the number of procedures would be expected to decrease stress caused to individuals, and would save the system resources which could be reallocated or used to improve the timeliness with which patients are seen. Our results suggest differences in trajectories based on the suspicion level of the mammogram. Follow-up of low abnormal screens in particular is not managed as efficiently as could be. The lowest suspicion mammograms are the least likely to result in a positive diagnosis, and yet account for one-third of diagnosed cancers caught through screening. These are associated with the longest wait times, but these results suggest that they are still important to follow-up quickly. Higher suspicion mammograms should clearly have priority for follow-up assessment, given the large percentage of these that result in positive diagnoses, but it is important to

recognize the importance of following the less suspicious mammograms swiftly and appropriately as well.

The general rule for effective screening programs is that a health issue must be detectable in the pre-symptomatic stage and there must be a reasonably effective intervention available. Breast cancer meets these criteria, and screening programs are worthwhile population health programs. However, in order to derive the most benefit, such large-scale programs should be as efficient as possible. One aspect of that is being vigilant about the procedures conducted during the diagnostic phase, so as to minimize the number of procedures conducted unnecessarily. Especially because British Columbia, as a province within Canada, operates under a publicly funded system, diligent resource allocation is a very important priority.

Guidelines are used to direct professional practice and guide care delivery. They are based on available evidence and indicate best practices. They are generally not binding, allowing due room for professional discretion. The current knowledge in this area suggests that core biopsies are the most appropriate way to diagnose breast cancer, which in turn suggests that a current rate of 40% being diagnosed this way could be improved. There are several interests at stake here. The primary goal should always be delivering high quality, safe patient care. Population health programs exist in the context of available resources, public opinion, and political interest. While guidelines exist around the diagnostic phase of breast cancer care, the data presented here suggest there is still a great deal of variation in practice. Determining how much

of that variation is appropriate or innocuous is a subject for subsequent investigation. This is an exploratory presentation of the available data, discussed here for the purpose of considering the role of breast cancer screening in population and public health, and for promoting discussion around the opportunities for and barriers to improving the delivery of this health service.

The opportunities include the fact that the interests of both the patients and the funding bodies could be addressed by a common goal – reducing the number of unnecessary procedures involved in diagnostic trajectories. Similarly, from both the perspective of individual patients and wider population health, increasing the number of core biopsies as the ultimate tissue sampler can improve diagnostic information gained from the diagnostic process, which is hypothesized to improve outcomes as treatment can begin more quickly and involve fewer invasive procedures in the event of positive diagnoses.

Finding ways to capitalize on opportunities that serve the interests of multiple stakeholders will promote innovation and, if thoughtfully analyzed, support improved ways of delivering health services without the addition of significant new funds. Centralizing the coordination of diagnostic trajectories could help achieve this goal. Patient navigators could be assigned to coordinate diagnostic procedures following abnormal screening mammograms; these clinical advocates would be responsible for ensuring timeliness targets are met and appropriate procedures requisitioned. While some cost would be involved in developing centralized coordination capacity and hiring patient navigators, the potential improvement in efficiency would easily justify these costs over time.

From the policy perspective, it would be worthwhile to streamline the diagnostic phase for breast cancer. Performing fewer procedures to reach a diagnosis would benefit the patient and create capacity to increase the flow. Waiting times are a function of many factors, and are rarely straightforward to improve. However, two of the most influential factors are demand and capacity. It is in the population's interest for demand for the screening program to increase, as breast cancer screening improves population health. Currently, only 38% of diagnosed breast cancers originated through the screening program; the remaining 62% were detected by other means (Poole et al., 2008). The benefit of early detection of breast cancer is clear given the decreased mortality rates, attributed to organized screening programs. Therefore, successful marketing of the program in an effort to continue to improve the health of the population will increase demand for diagnostic services. The other side of the equation is thus to increase capacity. As the public purse is always being stretched in multiple directions, creating capacity from within will be beneficial. This can potentially be achieved by minimizing the number of procedures involved in diagnostic trajectories which would free up resources and time to be redirected back toward increasing participation in the program.

It is important to consider the risks as well as the opportunities associated with streamlining a service. An increase in efficiency of the diagnostic process will need to be coordinated with available treatment resources. Increased volume and efficiency in diagnosis will be of little benefit if women are still waiting to receive treatment. Similarly, increasing the number of women who participate in

screening programs must be aligned with available capacity to diagnose disease. Any such effort in improvement should be rooted in best practice and available evidence. The evidence supports a shift to increasing numbers of core biopsies performed where biopsies are warranted in order to acquire adequate tissue to begin treatment should it be required. Experience also suggests that two imaging procedures, a clinical examination and one biopsy should be all that is required to reach a definitive diagnosis, in most cases (Poole, 2008, May 8). Certainly, some cases will be more difficult than others, but we would expect to see the vast majority of cases resolved within four procedures.

Limitations

This discussion is limited by the fact that we do not know the source of delays. These could be due to patient, provider, or system factors. However, by identifying the existence of delays and inefficiencies, we are in a better position to approach the next step of identifying the sources. Intervention efforts will be guided by these subsequent findings: should patient factors be identified as the main source of delay we could introduce public education programs; if physicians are seen to be the primary cause we will focus our efforts on them in order to better understand the situation; and if system factors are causing the delay, we will look towards re-organization projects, for example. We also do not have access to the judgment process of the clinicians— we do not know how or why specifically they made the clinical decisions that they made. Follow-up qualitative research would be better able to address these limitations, and would help

explain the picture described here. Further analyses, by region, and even physician, would help to explain whether the observed differences are attributable to rural/urban locations or specific physicians. The latter could indicate differences in training or preference, and would help direct interventions to improve the efficiency of the service.

Another limitation is that the data analyzed here are several years old. We did not have access to the most current data, which could potentially tell a different story. The use of secondary data can provide a wealth of information not available otherwise, but can also impose difficulties in a research project where the purpose of collection is different than the purpose for which it is used.

Eventually we would like to create a probability tree that will help individuals navigate through the diagnostic process. We had initially hoped to be able to do this, but soon realized that the trajectories needed to be more standardized before any probabilities could be accurately derived from the process.

Conclusion

Public health programs designed to improve population health must take into account the interests of the various stakeholders to be the most appropriate and efficient possible. As the second leading cause of cancer death among Canadian women, breast cancer impacts the lives of many families. Organized screening programs reduce mortality attributed to breast cancer, and are therefore a major ally in the fight against this disease. In 2005, The Public Health Agency of Canada reported that "several mature programs are reaching the limits

of their capacity at a plateau of approximately 50% participation” (p.1). One way to increase capacity is to streamline the diagnostic trajectory, without compromising the quality of care given to patients. The discussion in this paper suggests that this is feasible. Further study could add understanding to the processes involved in diagnosing breast cancer, and help explain the best points of intervention to improve the delivery of this important health service.

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