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**Evidence Summary 15-15  
Breast Screening for Survivors of Breast Cancer**

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<https://www.cancercareontario.ca/en/guidelines-advice/types-of-cancer/43306>

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## **ABSTRACT**

### **Background**

Annually, the number of women diagnosed with breast cancer in Ontario is approximately 9800. With an 88% survival rate among this population, the number of women with a personal history of breast cancer (PHBC) is large and growing within the province. Currently these women are not eligible for surveillance within the Ontario Breast Screening Program, which does invite average-risk women for screening every two years. There is also currently no guidance on surveillance mammography for women who have undergone breast reconstruction as part of treatment for breast cancer. An environmental scan of guidelines from other jurisdictions found that, with some exceptions, such as in the United Kingdom/Wales and Australia, women with PHBC were frequently deemed ineligible for organized screening programs. Women with a history of breast reconstruction were generally not mentioned in guideline recommendations.

### **Objectives**

To assess the evidence on the topic of surveillance mammography within an organized screening program for women with PHBC. To assess whether mammographic screening is appropriate for specific subpopulations of women with PHBC; specifically, those who have undergone breast reconstruction, or who have had specific types of surgery such as nipple- or skin-sparing mastectomies.

### **Search methods**

The Cochrane Central Register of Controlled Trials (CENTRAL Issue 6, 2015), OVID MEDLINE (January 2012 to June 22, 2015), and EMBASE (January 2012 to June 22, 2015) were searched for systematic reviews and primary studies of surveillance mammography (including within organized screening programs) in women who have previously received curative treatment for breast cancer. The search for studies of the subpopulation of women with breast reconstruction was conducted in the same databases to 2004.

### **Selection criteria**

All English-language articles that included imaging modalities for surveillance of the target population were considered eligible for inclusion.

### **Data collection and analysis**

One study author extracted data on study outcomes and risk of bias. Data extraction was audited by a project research assistant.

### **Main results**

A well-conducted systematic review was identified that met the inclusion criteria (current to March 2012) [1]. It included four other systematic reviews of studies of surveillance mammography and provided the basis for a recommendation of annual mammography for women after breast-conserving surgery. A second systematic review (current to August 2004) [2] assessed the role of surveillance imaging for women who had undergone breast reconstruction and concluded that, based on data from case series and case studies, there was insufficient evidence to recommend surveillance mammography in this population. The primary literature was searched for more recent studies and 11 results were eligible for inclusion. Five studies of various outcomes found that surveillance mammography may reduce breast cancer-specific mortality; that semiannual mammography is likely not of greater benefit, compared with annual mammography; and that screening women with PHBC within an organized breast screening program resulted in a significantly higher detection rate compared with women without PHBC, and that recall rates for both groups that were within Australian national standards. The six studies of surveillance of reconstructed breasts found that it was possible to detect recurrences using mammography; however, it was more likely to have utility in autologous, rather than implant-based reconstructions.

## **Authors' conclusions**

Limited evidence leads to the conclusion that surveillance mammography on an annual basis is reasonable for survivors of breast cancer who have undergone breast-conserving surgery. No evidence was found to indicate that this surveillance should or should not occur under the auspices of an existing organized screening program; however, it would be reasonable to assume that there may be organizational and procedural benefits to integration of surveillance within an existing organized program. There was insufficient evidence to recommend the use of mammography for surveillance of women who have undergone breast reconstruction; however, there may be a theoretical benefit in women who have received autologous tissue reconstructions and who have a moderate to high risk of recurrence.

## **PLAIN LANGUAGE SUMMARY**

Breast cancer is the most common cancer among Canadian women. Many women live for five or more years after diagnosis, so that there is a large and growing population of women who are survivors of breast cancer. These women are at higher risk of a second breast cancer event, either in the same or opposite breast, compared to the general population. In Ontario, women who have had breast cancer are not included in the Ontario Breast Screening Program (OBSP), and there is no agreement on using screening mammography for survivors who have had breast reconstruction. This review found that surveillance mammography every year is reasonable for survivors of breast cancer who have had breast-conserving surgery. No studies were found that showed that mammography for these women should or should not occur within the OBSP; however, there is agreement that women could benefit from the usual features of this program in a similar way to women who have not had treatment for breast cancer. Mammography for surveillance of women who have had breast reconstruction is not recommended based on the data that was found, but there may be a possible benefit in women who have had reconstructions using tissue from another place on their body (i.e. autologous reconstruction), and who have a moderate to high chance of breast cancer occurring again.

## **BACKGROUND**

### **Description of the condition**

Breast cancer is the most common cancer among Canadian women (excluding non-melanoma skin cancers) [3]. In Ontario in 2015, an estimated 9800 women will be diagnosed with breast cancer [4]. The chance of developing breast cancer over a woman's lifetime is approximately one in nine [5]. With a five-year relative survival rate of 88% [5], these figures translate to a large and growing population of women within the province who have a personal history of breast cancer (PHBC), estimated at 60,000 in 2008 [6]. Surgical treatment of breast cancer may include breast-conserving surgery (followed by radiation therapy) or mastectomy. Following treatment, women undergo surveillance for breast cancer recurrence, as outlined in a Cancer Care Ontario (CCO) position statement on well follow-up care [6].

Women with PHBC are at risk of local recurrence in the ipsilateral breast at a rate of 3% to 9% at five years and 14% to 20% at 20 years following breast-conserving surgery plus breast radiotherapy [7]. The annual hazard of recurrence peaks in the second year after diagnosis but remains at 2% to 5% in years 5 to 20 [8]. This translates to a combined risk of new or recurrent breast cancer that is constant over time [9]. PHBC women have increased underlying risk for breast cancer compared with women without PHBC [10]; for women older than 50 years of age, a personal history of in situ or invasive breast cancer is associated with a risk of second contralateral invasive cancer of 1.5 to 1.75 relative to women with a negative history. In a Swedish cohort study, the risk of contralateral breast cancer in women with PHBC was higher than the familial risk of primary breast cancer, and the interaction between the two was found to be multiplicative [11].

Breast reconstruction using prosthetic devices or autologous tissue is an option for women following a unilateral or bilateral mastectomy, or after breast conservation therapy. A recent study showed that 9% of women in Canada who undergo mastectomy for unilateral invasive breast cancer had reconstruction within one year, with 76% of these being performed at the time of surgery [12]. Although

the rate of reconstruction is lower in Canada than in other higher income countries [12], the number of women seeking reconstruction after treatment is increasing [2]. The expected site of local regional recurrences after mastectomy with autologous reconstruction is along the perimeter of the mastectomy site, and approximately 50% of recurrences might occur on the chest wall and 50% in the skin flap [13]. A large series evaluating transverse rectus abdominis myocutaneous (TRAM) flap reconstructions in 419 patients with mean follow-up of 4.9 years reported 16 (3.8%) locoregional recurrences with mean time to recurrence of 1.6 years [14]. According to clinicians in Ontario, there is currently variability of practice within the province regarding mammographic surveillance of survivors who have undergone a breast reconstruction.

### **Description of the intervention**

This review deals with mammography for the purpose of surveillance in the context of follow-up after curative treatment for primary invasive breast cancer or ductal carcinoma in situ (DCIS) in asymptomatic women with a PHBC. Diagnostic mammography, which is performed in the case of suspicion of recurrence, is outside the scope of this review. Surveillance is appropriate when it meets the basic principles for general population screening, which been established by the World Health Organization. These include: the disease must be a treatable and prevalent condition; the test must be sensitive, inexpensive, and well-tolerated; and early detection must change the patient's treatment or outcome [13].

### **How the intervention might work**

The intervention might detect ipsilateral recurrences or new ipsilateral or contralateral incidence of breast cancer at an earlier stage, when treatment is more likely to be effective. Observational data show potential benefit from early detection of second breast cancers in PHBC women [10].

### **Why it is important to do this review**

Currently, there is an organized program in Ontario for screening of average-risk women, and screening of high-risk women; however, guidance is needed for specific subgroups of the growing population of women who are survivors of breast cancer. Until now, the follow-up care for survivors of breast cancer has been guided by the position statement described above that endorses Canada's Steering Committee on Clinical Practice Guidelines for the Care and Treatment of Breast Cancer. At the present time in Ontario, many women with PHBC are not receiving the guideline-recommended frequency of mammograms [6].

This review is needed because recommendations contained in the CCO position statement of the endorsed Steering Committee guideline does not address specific subpopulations of survivors, such as women who have undergone breast reconstruction. It also does not address whether survivors should enter the provincial organized screening program for average-risk women, for which they are currently ineligible [15]; therefore, an evidence review on these topics is needed. At this time, high-risk survivors are eligible for inclusion in the Ontario Breast Screening Program (OBSP) [16].

### **Environmental scan: Eligibility of breast cancer survivors for existing organized breast screening programs**

A 1999 survey of organized screening programs and mammography registries that included 25 member countries of the International Breast Cancer Screening Network found that in most cases, women with a history of breast cancer were specifically not invited to screening [9].

Information on eligibility for breast screening programs in Canada was gleaned from provincial and territorial screening program web sites or published reports. Most breast screening programs within Canada, including those in Ontario [15], British Columbia [17], Nova Scotia [18], Manitoba [19], New Brunswick [20], Northwest Territories [21], Prince Edward Island [22], and Yukon [23] specifically state that individuals with a personal history of breast cancer are excluded from organized breast screening programs, although reasons for the exclusion of survivors is not provided, except for the Quebec program, which provides the reason that women who have previously had breast cancer "will need more frequent

checkups from a doctor.” By contrast, the organized program in Saskatchewan for women 50 years of age or older includes survivors who are not on active follow-up for breast cancer and have been cancer free for five years. In Newfoundland and Labrador, survivors are not specifically excluded, but rather the statement is made to patients that “the screening program may not be right for you if you have been diagnosed with breast cancer”. There is no specific statement about the eligibility of survivors for organized breast screening in Alberta [24]. In addition to regular screening mammography for average risk women, Ontario provides screening to women aged 30 to 69 years who are identified as being at high risk for breast cancer, including high-risk women with a PHBC, with annual mammography and breast magnetic resonance imaging (MRI) screening [16]. Women with PHBC are typically excluded from quality and statistical reports, as in a recent statistical report on screening programs in Canadian provinces, which states that while some provinces may include survivors in their programs, their report specifically excludes women with PHBC [25].

Most guidelines recommend annual mammography screening for survivors of breast cancer who have undergone breast-conserving surgery (Table 1). The option of screening in an organized program is not mentioned, aside from National Institute for Health and Care Excellence guidance, which states that survivors of early breast cancer may enter the national screening programs in England or Wales after five years of annual mammography follow-up or after reaching age 50 (Table 1) [26]. The recommendation for annual mammography in this program is qualified by a statement that these patients are at a higher risk than other patients in the national screening programs, and of at least equivalent risk as patients with a family history. Upon entry into the national screening programs, it is recommended that their screening frequency be stratified in line with patient risk category. This program excludes women who have undergone bilateral mastectomy [26]. Most guidelines do not address screening for women who have undergone breast reconstruction; however, Alberta guidance, based on a systematic review, states that women who have had breast reconstruction, including implant-based, autologous flap (i.e., deep inferior epigastric perforator, TRAM, superficial inferior epigastric perforator) and combination reconstructions (i.e., latissimus dorsi [LD] with implant), do not require any form of imaging surveillance. [27].

Table 1. Results of environmental scan of guidelines for mammographic surveillance of survivors of breast cancer.

Organization	Year	Target population	Recommendation for survivors who have undergone BCS	Recommendation for survivors who have undergone any type of breast reconstruction	Recommendation for inclusion in organized screening
NICE [26]	2009	Early and locally advanced breast cancer	Annual screening until entry in the organized screening program	Not mentioned	Women being followed-up after breast cancer return to the NHSBSCP or BTWSP after five years of follow-up or when they reach 50 years of age.
ASCO [1]	2013	Patients with breast cancer who have completed primary therapy with curative intent	First post-treatment mammogram no earlier than 6 months after definitive radiation therapy. Every 6 to 12 months subsequently for surveillance of abnormalities. Yearly if stability of mammographic findings is achieved after completion of locoregional therapy. (MRI not recommended)	Not mentioned (although Barnsley review included in evidence base, which concludes that there is insufficient evidence to make recommendations)	Not mentioned
NZGG [28]	2009	Survivors of early breast cancer	First post-treatment mammogram one year after her first diagnostic mammogram or 6 months after radiotherapy, annually thereafter	Not mentioned	Not mentioned
NCCN [29]	2015	Patients treated for invasive breast cancer or DCIS	Mammogram every 12 months (in women with DCIS – yearly diagnostic mammography and in patients treated with BCT, mammogram 6-12 months after the completion of breast-conserving radiation therapy).	Not mentioned	Not mentioned
ESMO [8]	2013	Survivors of breast cancer	Ipsilateral and contralateral mammography is recommended every 1 to 2 years. An MRI of the breast may be indicated for young patients, especially in the case of dense breast tissue and genetic or familial predispositions.	Not mentioned	Not mentioned
ACS [30]		Women who have been treated for breast cancer	Mammogram about 6 months after surgery and radiation are completed and then at least every year. (insufficient evidence to recommend for or against MRI)	Women who had a mastectomy should continue to have yearly mammograms on the <i>remaining</i> breast	Not mentioned



Organization	Year	Target population	Recommendation for survivors who have undergone BCS	Recommendation for survivors who have undergone any type of breast reconstruction	Recommendation for inclusion in organized screening
Cancer Care Alberta [24,27]	2011	Patients who have completed active medical or radiation oncology treatment for early-stage breast cancer	Diagnostic mammography performed annually at an accredited mammography facility	“reconstructed breasts (autologous tissue or implants or a combination) do not require any form of imaging surveillance”	Not mentioned
Grunfeld et al [31] (CMAJ)	2005	Women who have been treated for breast cancer	Frequency of visits may be adjusted according to individual patient’s needs. Annual visits should include mammographic examination	Not mentioned	Not mentioned

**Abbreviations:** ACS, American Cancer Society; ASCO, American Society for Clinical Oncology; BCS, breast conservation surgery; BCT, breast-conserving therapy; BTWSP, Wales Breast Screening Program; CMAJ, *Canadian Medical Association Journal*; DCIS, ductal carcinoma in situ; ESMO, European Society for Medical Oncology; MRI, magnetic resonance imaging; NICE, National Institute for Health and Care Excellence; NCCN, National Comprehensive Cancer Network; NHSBSCP, National Health Service Breast Screening Program; NZGG, New Zealand Guidelines Group

## **OBJECTIVES**

To determine whether breast cancer survivors can be included in an organized screening program, and to determine the appropriateness and feasibility of conducting surveillance imaging on specific populations of women with PHBC, including individuals who have undergone implant-based reconstructions, reconstructions using autologous tissue flaps, such as the TRAM flaps, or nipple-sparing or skin-sparing mastectomies, or women who have undergone unilateral or bilateral mastectomy without reconstruction.

## **METHODS**

### **Criteria for considering studies for this review**

#### ***Types of studies***

Systematic reviews, randomized controlled trials (RCTs), and other prospective or retrospective studies with a comparative design with at least 100 patients were eligible for inclusion. Case series were not included as a potential study type in the protocol; however, as the number of studies in patients with breast reconstruction in particular was very limited and these patients are rarely addressed in existing systematic reviews or clinical practice guidelines, the inclusion criteria were broadened after the initial search to include case series.

#### ***Types of participants***

Participants are defined as women who have completed active treatment for breast cancer, i.e., breast cancer survivors, also known as women with a PHBC. Survivors with a history of implant-based or autologous breast reconstruction are a subpopulation of interest in this study, as well as women who have undergone unilateral or bilateral mastectomy without reconstruction.

#### ***Types of interventions***

Studies were included that provided an assessment of the following aspects of surveillance: age of initiation or cessation of regular surveillance for recurrence or new cancers, comparisons of different surveillance modalities, including mammography, MRI or ultrasound, or comparisons of different screening intervals and outcomes with organized compared with opportunistic screening.

#### ***Types of outcome measures***

##### ***Primary outcomes***

- Breast cancer (invasive cancer and DCIS) incidence/detection rate
- Mortality
- Morbidity
- Years of life, quality of life, quality-adjusted life years
- Recall rates

##### ***Secondary outcomes***

- Number needed to screen
- Any other benefits or harms (e.g., false positives and unnecessary treatment)
- Change in stage of disease, change in treatment, number of reoperations

## **Data collection and analysis**

### ***Selection of studies***

A review of the titles, abstracts, and full text for articles that potentially met the inclusion criteria was conducted by EK. After the initial search was completed, the authors found that there were a limited number of studies in the population of patients who had undergone breast reconstruction. Thus, the

inclusion criteria were amended to capture studies in this patient population with less than 100 patients that did or did not include a comparison group.

### ***Data extraction and management***

A review author (EK) extracted data from the relevant studies. Data extraction was audited by a project research assistant. Data extracted included:

- Author, year of publication and journal citation
- Country;
- Setting;
- Inclusion and exclusion criteria;
- Study design and methodology;
- Participant characteristics (age, stage, other treatment-related variables);
- Number of patients
- Type of index and reference test
- Data related to risk of bias
- Duration of follow-up
- Primary and secondary outcomes of interest

### ***Assessment of risk of bias and applicability***

All new studies included from the search for primary literature were assessed for risk of bias and applicability. This included an assessment of the following domains related to risk of bias and/or applicability: patient selection, index test, flow and timing, and reference standard.

## **RESULTS**

### **Systematic reviews**

The most recent review to address follow-up of women after treatment for breast cancer was retained for inclusion in the evidence base [1]. An additional systematic review that specifically addressed the question of surveillance mammography in the subpopulation of survivors with breast reconstruction was also retained for inclusion [2]. These are described in further detail below.

### ***Breast cancer follow-up and management after primary treatment (American Society of Clinical Oncology, Khatcheressian et al, 2013 [1])***

The ASCO review assessed follow-up and management after primary treatment for breast cancer, including systematic reviews of the literature related to breast imaging and coordination of care, thus providing an update to the evidence-base for their 1997 guideline on these topics. Their review included 10 systematic reviews and/or meta-analyses on some aspect of breast surveillance, including physical examination, mammography, MRI, ultrasound, positron emission tomography (PET), PET/computed tomography and other tests such as bone scans. They found that there was significant heterogeneity in the quality of these studies, particularly in terms of sample characteristics and study designs.

There was no evidence for the recommendation of routine blood tests, imaging studies other than mammography, or tumour marker testing. Monthly breast self-examination, history and physical examination (every three to six months for the first three years after primary therapy, then every six to 12 months for the next two years and then annually), and mammography for women who had received breast-conserving therapy were recommended. Recommendations for mammography include a first post-treatment mammogram no earlier than six months after definitive radiation therapy. Subsequent mammograms should be obtained every six to 12 months for surveillance of abnormalities. Mammography should be performed yearly if stability of mammographic findings is achieved. These recommendations remained unchanged from the 1997 version of the guideline, and were based at that time on grade 1 (strong) evidence, although this evidence is not described in the 1997 manuscript. The 2013 guideline update

provides references to evidence, and an outline of the key findings from that review are presented subsequently [1]:

- In a review that included 10 studies of mammography for detection of ipsilateral breast cancer recurrence or contralateral breast cancer [32]:
  - there are limitations to the available evidence on the accuracy and benefit of breast screening in women with a prior history of breast cancer.
  - the proportion of ipsilateral breast recurrences detected with mammography ranges between 50% and 80% but is lower at 8% to 51% for mammography-only detection. For contralateral recurrences, the figure is 45% to 90% [32].
  - there is some evidence of a potential survival benefit for asymptomatic/early-detected second breast cancers (range of estimated hazard ratio [HR]: 0.10 to 0.86) relative to symptomatic or clinical detection, in various surveillance strategies [32].
- In a review that included eight studies of clinical effectiveness and nine studies of test performance published between 1990 and 2009 in women previously treated for primary breast cancer without detectable metastatic disease and who were undergoing routine or nonroutine surveillance [33]:
  - surveillance mammography was found to offer a survival benefit compared with a surveillance regimen that does not include mammography.
  - a more intensive follow-up of women with greater likelihood of ipsilateral breast tumour recurrence (IBTR) or metachronous contralateral breast cancer (MCBC) may be worthwhile. Conversely, for women with less likelihood of IBTR or MCBC, it may be more cost-effective to do surveillance less often (every two or three years) with mammography alone.
- In a meta-analysis that included 13 observational studies of women who were treated for primary breast cancer that examined routine follow-up strategies for the early detection of recurrences [34]:
  - early detection of breast cancer recurrences during follow-up has a statistically significant impact on survival compared with late detected recurrences.
  - Survival was better when the recurrence was found by mammography instead of physical examination or in patients without symptoms as compared with those with symptoms.
- In a systematic review with meta-analysis of 13 studies (one RCT and 12 retrospective or prospective observation studies) of women with primary operable invasive breast cancer [35]:
  - a total of 66.6% of contralateral breast cancers were detected by mammography and 24.4% by the patients themselves (very few were detected by clinical examination).
  - Patients with ipsilateral breast relapse detected clinically appear to do less well than those with relapse detected by self-examination or mammography.

### ***Mammographic surveillance of reconstructed breasts (Barnsley et al, 2007 [2])***

It has been suggested that mammographic surveillance may be appropriate for survivors who have undergone breast reconstruction. This question was explored in a systematic review by Barnsley et al [2], which includes eight case series or case reports of surveillance mammography of the ipsilateral breast in women who underwent treatment for breast cancer and breast reconstruction. A small number of recurrences were detected in these studies (range one to 13). In the five studies that included more than one case, between 17% and 100% of ipsilateral recurrences were detected by mammography alone. This included instances of detection in various implant-based and TRAM flap reconstructions. While Barnsley et al demonstrated that certain local recurrences are able to be detected by surveillance mammography alone, they concluded that due to limitations of the quality and study designs of included studies, more research in this field would be required before surveillance could be recommended. The table of studies included in Barnsley et al is reproduced below (Table 2).

Table 2. Studies on mammography following breast reconstruction (table reproduced from Barnsley et al 2007 [2] includes evidence from January of 1980 to August of 2004).

Source	Level of Evidence	No. of Cases in Series (no. with CBC or IR)	Stage at initial diagnosis	Initial Treatment	Type of Reconstruction	Years to Recurrence (median)	Mammography Regimen	Detection Rate by mammography alone
Dowden, 1992 [36]	Case series (III)	Approximately 180 (IR n=3)	Not reported	Modified radical mastectomy	Immediate submuscular implant	1 yr, 3 yr, 2 yr	Not described	3
Fajardo et al, 1993 [37]	Case series (III)	80 (IR n=1; silicone implant)	Not reported for reconstruction cases	Mastectomy	Implants (65), autologous (19), bilateral reconstruction s (4)	Not reported for reconstruction cases	Frequency not described	0
Mund et al, 1994 [38]	Case report	1	Stage II	Modified radical mastectomy	Delayed TRAM flap	7 yr	3 mammograms in 7 yr	1
Salas et al, 1998 [39]	Case series (III)	4	DCIS	Modified radical mastectomy (1), total mastectomy (3), contralateral prophylactic mastectomy (4)	Immediate TRAM flap	10 mo, 3 yr, 2 yr, 4 yr	Not described, surveillance mammography (1), diagnostic mammography (3)	1
Helvie et al, 1998 [40]	Case series (III)	6	DCIS	Mastectomy	TRAM flap	42 mo	Only 1 patient underwent mammographic surveillance	1
Clark et al, 1999 [41]	Case report	1	DCIS	Total mastectomy and prophylactic contralateral mastectomy	Delayed submuscular implant	3.5 yr	Semiannually	1

Source	Level of Evidence	No. of Cases in Series (no. with CBC or IR)	Stage at initial diagnosis	Initial Treatment	Type of Reconstruction	Years to Recurrence (median)	Mammography Regimen	Detection Rate by mammography alone
Helvie et al, 2002 [42]	Case series (III)	113 (IR, n=3)	Not reported, included prophylactic mastectomies	Mastectomy	Immediate or delayed TRAM flap	All 5 yr	None	2 of 3
Heinig et al, 1997 [43] <sup>†</sup>	Inadequate description of methods in abstract	169 (IR, n=13)	Not reported	Mastectomy	Silicone implant	Not reported	Not reported	Clinical examination and mammography detected 8 of 13 (not reported which were detected by mammography alone)

**Abbreviations:** CBC, contralateral breast cancer; DCIS, ductal carcinoma in situ; IR, ipsilateral recurrence; TRAM, transverse rectus abdominis myocutaneous. Level III evidence refers to evidence from opinions of respected authorities on the basis of clinical experience, descriptive studies or reports of expert committees (from Canadian Task Force on Preventive Health Care [1997]. CTFPHC history/methodology. Available at <http://www.ctfphc.org/> . accessed July 15, 2005).

<sup>†</sup>German language and data were abstracted from the translated abstract.

## INCLUDED PRIMARY STUDIES

### Results of the search

The search identified 5409 unique references. Articles that obviously did not meet the exclusion criteria were excluded after title and abstract screening by EK. Twenty-six full-text articles were retrieved and 10 of these met the inclusion criteria. One additional study was added from a search of reference lists of included articles. A detailed flow diagram is presented in Appendix 2.

### Included studies

A search for primary literature was conducted to update the evidence base of Barnsley et al [2] and Katcheressian et al [1], which were current to August 2004 and March 2012, respectively. Five studies [7,10,44-46] addressed some aspect of the frequency or organization of follow-up in the general population of women with PHBC. The update found five studies [47-51] that assessed surveillance mammography and one study [52] that assessed the role of MRI in surveillance of women who had undergone breast reconstruction. These studies are described subsequently. For further detail on study characteristics of included primary studies, see Appendix 3.

### Assessment of risk of bias and applicability

All new studies included from the search for primary literature were assessed for risk of bias and applicability. This included an assessment of the domains included in Figure 1. Most domains appeared to be at low risk or unclear risk of bias.

	Risk of Bias				Applicability Concerns		
	Patient Selection	Index Test	Reference Standard	Flow and Timing	Patient Selection	Index Test	Reference Standard
Arasu 2012	?	High	?	?	?	?	?
Gunia 2012	+	+	+	+	+	+	+
Houssami 2011	+	?	?	+	+	+	+
Kang 2005	+	?	?	High	+	+	+
Lee 2008	?	?	+	?	+	+	+
McNaul 2013	?	?	?	?	?	+	?
Sim 2012	?	?	?	?	High	+	+
Tan 2015	+	+	+	+	High	+	+
Yoo 2014	+	?	?	+	+	?	+

High
 Unclear
 Low

**Figure 1.** Risk of bias and applicability ratings for included studies.

## **Overall quality of the evidence**

In addition to an assessment of applicability and risk of bias, the 11 studies included in the primary literature were assessed for quality. As a whole, the body of evidence possessed several limitations due to being comprised of mostly smaller, retrospective observational studies that were based on administrative or hospital records. These types of studies can be more at risk of biased results compared with prospective RCTs, or which there were none included in the evidence base. In addition, most outcome data used the surrogate outcomes of recall rates and detection rates as surrogates for morbidity and mortality.

## **Study outcomes**

### ***Value of breast screening in older women (one study [45])***

One study assessed the value of mammographic surveillance in a cohort of 1235 older (>65 years) women with a history of early stage invasive breast cancer who had survived for at least five years. They were followed from year 6 through death, disenrollment or 15 years after diagnosis. The relative risk for breast cancer specific mortality in women who had received a surveillance mammogram in the preceding year compared with women who had not was 0.82 (95% confidence interval [CI], 0.56 to 1.19;  $p=0.29$ ) [45].

### ***Studies of frequency of surveillance mammography (semiannual versus annual) (three studies [7,44,46])***

In a population of patients who underwent lumpectomies, the institution's screening interval of every six months for two years for the ipsilateral breast and annual mammography for the contralateral breast was evaluated. Patients were considered to be noncompliant if they averaged equal to or less than one mammogram screen per year or compliant if they averaged more than one mammogram per year [46]. There was no difference between these groups regarding tumour recurrence. A study by Gunia et al corroborated this finding; there was a very low yield of ipsilateral breast tumour recurrence with semi-annual screening and additional imaging was required in 3% to 4% of patients [7]. A similar study looked at compliance versus noncompliance with semiannual versus annual ipsilateral mammography [44] and found that recurrences detected semiannually were more likely to be detected at stage I versus stage II ( $p=0.04$ ) than recurrences detected with annual screening. The same trend was found with stage 0 to I versus stage II ( $p=0.03$ ). A number of other measures evaluated in this study were found to have no significant association with frequency of mammography.

### ***Organized screening for women with a personal history of breast cancer (one study [10])***

One study evaluated screening outcomes in women with or without a PHBC who participated in an organized screening program in Western Australia [10]. In total, 713,191 screens were included in this study. The cancer detection rate was 95.5/10,000 screens in PHBC women, which was significantly higher than the rate of 57.2/10,000 in women without PHBC. This would be expected, as PHBC women have increased underlying risk for breast cancer and also because they are likely to have had more frequent screening (mostly annual) than women without PHBC (generally biennial). Recall rates were significantly lower for PHBC women (potentially because these screens were effectively arbitrated by additional reads); however, the rates were within Australian national standards at less than 5% for each group. Positive predictive value for recall was significantly higher for PHBC women than for women without PHBC.

### ***Surveillance of Reconstructed Breasts (six studies [47-50,52]) (Table 3)***

A study of surveillance MRI [52] (Table 3) included 20 patients who had undergone modified radical mastectomy with TRAM flap reconstruction. Eleven of these patients underwent follow-up MRI. On the MRI of the opposite breast, enhancing lesions were detected in seven patients, and in one of these patients DCIS was diagnosed. The MRI findings in this patient matched new microcalcification detected on mammography. Recurrent tumour at the TRAM site was not present in this study.



In five studies, mammographic surveillance was used to detect recurrences in the ipsilateral and/or contralateral breast. In Yoo et al [50], 16 recurrences were detected in 964 patients (1.7%). Thirteen were detected on self-examination and the remaining three recurrences were occult and revealed on unspecified “routine follow-up studies”. Fifty percent of the recurrent cancers looked like the imaging findings of benign lesions. The other 50% had imaging findings of malignancy. The site of 14 of these recurrences was the superficial skin and subcutaneous fat layer, two recurrences were in the deep chest wall, and none were in the TRAM flap itself. The false-positive rate of recurrences in this study was 0.67%.

In another study of 264 patients, there was a 1.4% recall rate for further testing and no nonpalpable malignancies identified. This study was on a cohort of women at an institution that had a policy of routine screening mammography of TRAM flap breast reconstructions. They used a decision analysis model to determine that screening women with reconstructions was less effective than screening asymptomatic women in their 40s for primary breast cancer [47]. A second study found no nonpalpable recurrences and a higher recall rate of 6.3% of women who underwent screening mammograms [51].

In two additional studies, one nonpalpable malignancy was detected per study, with recall rates of 4% (n=5) of 116 [48] and 2% (n=6) of 295 patients [49]. In the former study, the patient with a proven recurrent invasive breast carcinoma was diagnosed three years after reconstructive surgery with LD flap and implant. The initial pathology for this patient was grade II invasive, node negative, and estrogen-receptor negative.

Table 3. Retrospective cohort studies of surveillance using MRI or mammography of women who underwent breast reconstruction during treatment for breast cancer.

Study	Median age	No. of Cases in Series or Cohort (no. with CBC or IR)	Stage at initial diagnosis	Initial Treatment	Type of Reconstruction	Follow-up	Recall rate	MRI or mammography regimen	Detection by MRI or mammography alone
<b>MRI</b>									
Kang et al, 2005 [52]	Mean = 41	20	2 stage 0, 1 stage 1, 7 stage IIA, 3 stage IIB, one stage IIIA, 3 stage IIIB, 3 stage IV	Modified radical mastectomy	TRAM	MRI on 11 patients an average of 237 days after surgery. 3 had MRI at 583 days after surgery. 6 had MRI 415-605 days after surgery	Unclear	NA	MRI detected one case of DCIS in contralateral breast (also detected by mammography)
<b>Mammography</b>									
Freyvogel et al, 2014 [51]	49.9 (IQR : 43.6-52.7)	541 patients (27 recurrences)	Tumour size: Tis (16.3%), T1 (40.3%), T2 (27.0%), T3 (5.9%), T4 (3.9%)	SSM (18.3%), NSM (4.8%), MRM (59.5%), other (17.4%)	TRAM (79.9%), DIEP (20.1%)	Recurrences detected up to 10.6 years	6.3% of women who received screening mammograms	Not described	0 nonpalpable recurrences

Study	Median age	No. of Cases in Series or Cohort (no. with CBC or IR)	Stage at initial diagnosis	Initial Treatment	Type of Reconstruction	Follow-up	Recall rate	MRI or mammography regimen	Detection by MRI or mammography alone
			Unknown (6.6%)						
Lee et al, 2008 [47]	48 (32-71)	264 patients (554 screening mammograms, 8 with positive results, 3 BI-RADS cat4 lesions underwent excisional biopsy)	DCIS (32.5%), stage 1 (15.1%) stage 2 (24.9%) stage 3 (5.3%) stage 4, (0.4%)	Not described	TRAM flap	Median: 4.9 years	1.4%	Not described	0 nonpalpable recurrences (95% CI 0.0% to 1.4%)
Sim and Litherland, 2012 [48], Glasgow, UK	53 (33-76)	116 (5 with screening abnormalities) (1 with recurrence)	Not reported	Not reported	LDF and implant	3 years	4%	Not described	1 nonpalpable (detection rate of nonpalpable cancer on mammographic screening of reconstructed breasts: 0.86%)
Tan et al, 2015 [49]	50.5 (30-78)	295 surveillance mammograms (102 patients) (six recalled for further imaging and three proceeded to needle biopsy)	Not reported	VR-BCS	“partial breast reconstruction”: 39 LDMF and 63 CWPf (199 LDMF mammograms and 96 CWPf mammograms)	Median 5 years, range 0-11)	2%	One mammogram at one-year post-surgery and annually thereafter for at least 5 years	1 recurrent ipsilateral cancer (0.3%), unclear whether this was nonpalpable (1 interval cancer was noted in this series)
Yoo et al, 2014 [50]	Range (29-52)	964 patient, 16 local recurrences	Cases: 5 stage I, 6 stage IIA,	NASSM (5) or SSM (11)	TRAM flap	Average period until	Not stated	Annual mammography with or	Detected by breast self-exam in 13 pts,

Study	Median age	No. of Cases in Series or Cohort (no. with CBC or IR)	Stage at initial diagnosis	Initial Treatment	Type of Reconstruction	Follow-up	Recall rate	MRI or mammography regimen	Detection by MRI or mammography alone
			4 stage IIB, I stage 0			detection of local recurrence was 31.1 months (range 7-84 months)		without ultrasound at clinicians' discretion (also MRI for patients with <i>BRCA</i> mutation)	other three were clinically occult and revealed on routine follow-up studies, including ultrasound and PET/CT (utility of mammography unclear)

**Abbreviations:** BIRADS Breast Imaging-Reporting and Data System, CBC contralateral breast cancer, CT computed tomography, CWPf chest wall perforator flap, DCIS ductal carcinoma in situ, DIEP deep inferior epigastric perforator, IQR interquartile range, IR ipsilateral recurrence, LDF latissimus dorsi flap, LDMF latissimus dorsi mini-flap, MRI magnetic resonance imaging, MRM modified radical mastectomy, NASSM nipple and areolar skin-sparing mastectomy, NSM nipple-sparing mastectomy, PET positron emission tomography, SSM skin sparing mastectomy, TRAM transverse rectus abdominis myocutaneous, VR-BCS Volume replacement breast-conserving surgery.

## **DISCUSSION**

### **Effectiveness of surveillance mammography for women with PHBC**

Surveillance mammography is generally recommended as part of a follow-up plan for women who have undergone breast-conserving surgery as part of treatment for breast cancer; however, there are no RCTs that examine the impact of surveillance mammography on mortality rates for this population. Rather, the evidence for surveillance mammography is extrapolated from randomized studies showing a reduced mortality risk for women without a PHBC, and non-randomized studies that typically rely on retrospective data. Results from observational studies indicate that the effectiveness of mammography in women with PHBC appears to be higher for detection of new contralateral breast cancer compared with ipsilateral recurrence; 45% to 90% of contralateral recurrences and 8% to 51% of ipsilateral recurrences are detected by mammography alone [32]. It appears that the proportion of mammography-only detections may be increasing over time [32]. Other support for mammography in this population includes findings that patients with ipsilateral breast relapse detected clinically appear to do less well than those with relapse detected by self-examination or mammography [35].

In addition, early detection of recurrence appears to have a statistically significant impact on survival compared with late detection of recurrence. Screening mammography detects contralateral breast cancer at an earlier stage than when it is clinically detected through breast examination or patient-detected symptoms [32]. The estimated range of the associated HR for mortality for early or mammographic detection is 0.10 to 0.86 relative to symptomatic or clinical detection. One study that controlled for lead time and length time bias found an HR of 0.53 (95% CI, 0.36 to 0.78) [34] for asymptomatic versus symptomatic detection. A study relying on older data within the Ontario context found that, among those who had been treated for stage 1 and 2 unilateral primary breast cancer, there was a significant difference in adjusted HR for breast cancer death in women with at least one screening mammogram [53]. While there are limitations to the evidence base, such as differences in surveillance intervals, lead time and length time bias, and different definitions of mammographic detection across studies, guidelines have concluded that there is sufficient evidence to recommend surveillance mammography for women with PHBC [1,8,26,31].

The evidence base is even smaller for the question of optimal surveillance interval, and current recommendations are based on expert consensus. This review found three studies that retrospectively compared mammography every six months with annual mammography, and the majority found that it did not result in better outcomes. In the absence of strong evidence, an annual interval [1,31] or screening every one to two years has been recommended [8]. The more frequent interval relative to screening in the average-risk population is recommended because women who have had a primary breast cancer are at increased risk of developing a second breast cancer relative to the general population [11]. There are no recommendations or evidence for when to stop surveillance for women with a PHBC [45].

### **Organized screening for survivors of breast cancer**

Where the benefits of population-level screening outweigh the harms, it is usually desirable to conduct screening under the auspices of an organized, rather than an opportunistic program. The features of an organized breast program include invitations to screening and reminder letters when it is time to return for the next mammogram, tracking of participants within the program, and well-developed quality assurance at accredited sites [54]. The Ontario Breast Screening Program (OBSP) extends invitations to mammographic screening for women at average risk, usually at an interval of every two years. The OBSP has been in place in Ontario for average-risk women aged 50 to 74 years since 1990; however, this program has historically excluded women with a PHBC [15]. OBSP screening for women at high risk includes annual screening mammography and breast MRI for women who meet one of the following criteria: 1) gene mutation predisposing to a markedly elevated breast cancer risk; 2) untested first-degree relative of a carrier of such a gene mutation; 3) family history consistent with a hereditary breast cancer syndrome and estimated personal lifetime cancer risk >25%; or 4) radiation therapy to chest before age 30 and at least 8 years previously. High-risk survivors are eligible for the high-risk OBSP if they meet the criteria outline above [16].

As in Ontario, most other provinces in Canada exclude women with PHBC from participation in organized breast screening programs. This eligibility criterion is not evidence-based, as there are no studies showing that survivors cannot be screened successfully in an organized screening program [9]. An example of an organized program that includes survivors can be found in the United Kingdom (UK)/Wales, which offers screening every three years to average risk women, but invites survivors, after five years of recurrent-free follow-up or when they reach 50 years of age, at a frequency that is stratified to patient risk category [26]. Although not stated, it may be that the reason for five years of follow-up before entry into the UK/Wales organized program is to ensure an annual interval for surveillance mammography for at least that period of time (the organized program average-risk screening interval is every three years). Our review found only one primary study that compared women with PHBC with women without in a population-based screening program. The BreastScreen program in Western Australia found a significantly higher rate of cancer detection for women with a PHBC, compared with those without a PHBC, and these figures were similar to international estimates [10]; the recall rates were comparable and within national standards for both groups [10]. Their findings supported the role of mammography screening for PHBC women, and allowing these women (in target age groups for screening) to have nationally consistent access to mammography screening through BreastScreen.

One study estimates the overall risk of breast cancer among survivors to be constant over 15 years at 1% to 1.5% per year; that is, the risk of either an ipsilateral relapse, new ipsilateral breast cancer, or new contralateral breast cancer [9]. With this constant level of risk over a longer time period, the focus of many guidelines on waiting five years immediately after treatment to start surveillance appears to be inadequate. An option for this extended follow-up may be to conduct surveillance within an organized program that includes provisions for early rescreening or risk-tailored screening, with results being forwarded to the primary care physician who coordinates follow-up [9].

At the same time, it is difficult to establish the frequency of early rescreening after diagnosis, or whether it is desirable to lengthen this interval after 15 years have elapsed. Risk-tailored screening could take the form of more intensive surveillance of women with greater likelihood of recurrence or new breast cancer. Conversely, for women with less likelihood of recurrence or new breast cancer, it may be worthwhile to do surveillance less often (every two or three years) with mammography alone [33]. Presently, inclusion of high-risk survivors in the high-risk OBSP provides an example of risk-tailored screening that is already in place in Ontario.

Widespread access to mammography can improve the lost to follow-up rate for women under surveillance. However, an organized screening program has the potential to reduce the loss to follow-up among survivors and the prevalence of underscreening, as women may be more likely to attend if they are receiving reminders at appropriate intervals. In Grunfeld et al, the underuse of surveillance mammography was attributed to unclear allocation of responsibility for follow-up care among providers. They proposed survivorship care plans as a potential measure to improve coordination of care [55]. Allocating all surveillance mammograms to be carried out under the OBSP is another potential method for ensuring clarity regarding responsibility for surveillance mammography.

### **Surveillance mammography and breast reconstruction**

Various trends, such as an increase in the population of women who have a normal-appearing breast after mastectomy with reconstruction, have led to uncertainty among clinicians about whether to screen reconstructed breasts for recurrent cancer [13]. This review found a modest evidence base on this topic: one existing systematic review [2] that included eight articles [36-43], as well as six primary studies (one of MRI [52] and five of mammography [47-51]) that assessed the detection of recurrence in this subpopulation of survivors. Two studies specifically included women who had undergone nipple- or skin-sparing mastectomy [50,51]. Despite the limitations of these smaller retrospective studies, as a whole they demonstrate that it is possible to mammographically detect recurrence in a reconstructed breast. The most likely scenario in which a recurrence would be detected is in an autologous tissue transplant in the area of the chest wall [13]. However, while the detection of recurrence is technically possible in this population,

one study concluded that the detection rate of recurrent cancer in their study was too low to justify annual screening mammography for reconstructed breasts [48], while another found in a decision-analysis model that screening of TRAM flap reconstructions is less effective than mammographic screening of asymptomatic women in their 40s [47]. This finding was confirmed by a study published in 2014 [51].

Based on the limited evidence available to date, there are currently no existing guidelines that recommend surveillance mammography of reconstructed breasts; however, it may be possible to apply screening principles to determine whether there is a theoretical benefit of mammography in a subpopulation [13]. One narrative review article proposed a potential benefit in the scenario of autologous tissue reconstructions such as the TRAM flap, where women also have a moderate to high risk of recurrence and a favourable prognosis upon resection of an isolated locoregional recurrence; these women may be appropriate candidates for surveillance mammography. In this population of women who have undergone TRAM flap reconstruction, those at lowest risk may not develop enough recurrences along the chest wall to justify surveillance mammography and those at highest risk may not benefit from surveillance imaging, as they are likely to have associated distant metastasis [13]. The same review noted that postmastectomy surveillance with examination of the skin and chest wall in implant-based reconstructions should be sufficient to detect recurrences because the implant is placed behind the pectoralis major muscle; the chest wall is elevated and in contact with the skin [13].

### **Areas for future research**

Mammography is less sensitive among selected high-risk populations such as *BRCA* carriers, young women, and women with dense breast tissue. MRI has greater sensitivity than mammography in these populations. Using lifetime risk estimates, a study found that it would be appropriate to investigate the utility of MRI in the subset of survivors who, as the time of screening, have a high risk of developing a second breast cancer, a low risk of death from primary breast cancer, and a relatively greater sensitivity from MRI testing than mammography [56].

It may be of value to study surveillance imaging in the group of women with breast reconstructions identified above who could potentially benefit from the procedure: women with TRAM flap reconstructions and a moderate to high risk of locoregional recurrence after mastectomy.

### **AUTHORS' CONCLUSIONS**

Annual surveillance mammography for women who have been treated with breast-conserving therapy is supported by a modest evidence base and is recommended in several guidelines. There was no evidence found in the literature that would suggest that this mammographic surveillance could not be conducted within an existing organized breast screening program. At the present time, there is insufficient evidence to recommend routine surveillance mammography for women who have had implant-based or autologous breast reconstructions, although the application of screening principles indicates that there could be a theoretical benefit in a small subset of survivors: those with autologous tissue reconstructions and moderate to high risk of recurrence.

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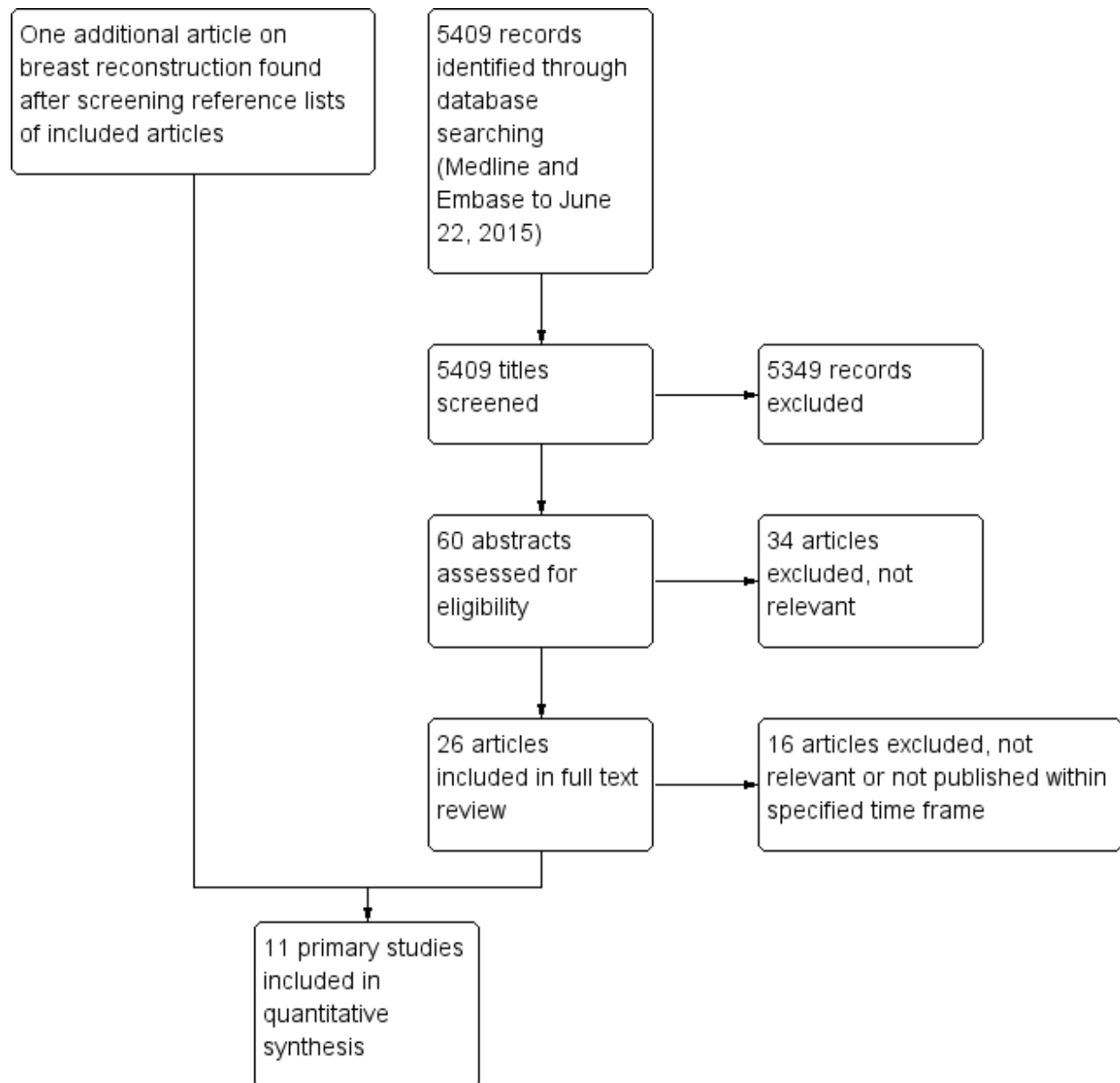
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## APPENDICES

### Appendix 1. Search strategy (Medline)

1. exp breast cancer/ or exp breast tumor/
2. (ductal carcinoma in situ or DCIS).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
3. (breast adj2 (reconstruction\$ cancer\$ or neoplasm\$ or adenocarcinom\$ or carcinom\$ or maligan\$ or tumo?r\$ or intraductal or noninfiltrating)).mp.
4. survivors.tw.
5. (1 or 2 or 3) and 4
6. (screening or organized screening or clinical breast exam or MRI or magnetic resonance imaging or ultrasound or mammography or tomosynthesis or screening interval or screening age).mp.
7. Animal/ not Human/
8. (5 and 6) not "7".mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
9. limit 8 to (english language and yr="1996 -Current")
10. 5 and 6
11. (1 or 3) and 6

## Appendix 2. Study flow diagram.



### Appendix 3. CHARACTERISTICS OF STUDIES

Characteristics of included studies (studies listed in alphabetical order).

Arasu et al, 2012 [44]

Study name or title	Benefit of semiannual ipsilateral mammographic surveillance following breast conservation therapy (BCT).
Clinical features and settings	Inclusion criteria: post-BCT surveillance mammograms in asymptomatic women Exclusion criteria: examinations with intervals greater than 18 months. First surveillance mammogram also excluded.
Participants	Study location: California, USA Study period: 1997-2008 Participants enrolled: 8234 post-BCT surveillance examinations in 1841 women Participants included in the analyses: 8234 post-BCT surveillance examinations in 1841 women
Study design	Retrospective review using an electronic mammography database
Target condition	Recurrence after BCT
Interventions	Mammography confirmed by biopsy at semiannual versus annual intervals
Outcomes	Stage at recurrence, tumour size, node negativity for ipsilateral cancers
Follow-up	Up to 5 years

Buist et al, 2013 [45]

Study name or title	Long-term surveillance mammography and mortality in older women with a history of early stage invasive breast cancer
Clinical features and settings	Inclusion criteria: women at least 65 years of age who had survived at least 5 years after diagnosis of early stage breast cancer and surgery
Participants	Study location: USA Study period: 1990-1994 Participants enrolled: 1235 women at least 65 years of age who had survived at least 5 years after diagnosis Participants included in the analyses: same as participants enrolled
Study design	Retrospective (medical records were used to collect surveillance mammography, demographics, treatment, longitudinal comorbid conditions, recurrence, and second primary breast cancers).
Target condition	Recurrence and second primary breast cancers
Interventions	Women were classified as exposed in years 6-15 if they had a surveillance mammogram in years 5-14, respectively (i.e., surveillance mammography receipt in previous year).
Outcomes	Breast cancer-specific mortality, other case-specific mortality
Follow-up	From year 6 through death, disenrollment, or 15 years after diagnosis.

Freyvogel et al, 2014 [51]

Study name or title	Screening mammography following autologous breast reconstruction: an unnecessary effort
Clinical features and settings	Inclusion criteria: invasive carcinoma or ductal carcinoma in situ (DCIS) or prophylactic mastectomies
Participants	Study location: Cleveland, Ohio Study period: 2000-2009 Participants enrolled: 541 women, median age at time of mastectomy was 49.9 years (IQR 43.6-52.7), 62.5% invasive ductal carcinoma Participants included in the analyses: 397 patients received screening mammography of the reconstructed breast
Study design	Retrospective cohort
Target condition	Recurrence of DCIS or invasive breast cancer
Interventions	Surveillance mammography confirmed by biopsy
Outcomes	Locoregional recurrence, yield of screening imaging.
Follow-up	Median follow-up from time of reconstruction was 7 years.

Gunia et al, 2012 [7]

Study name or title	Evaluation of appropriate short-term mammographic surveillance in patients who undergo breast-conserving surgery (BCS)
Clinical features and settings	Inclusion criteria: early stage breast cancer patients treated with BCS at a single institution Exclusion criteria: patients excluded if they did not have surveillance mammograms at a single breast care centre
Participants	Study location: Ohio, USA Study period: 2006-2008 Participants enrolled: 375 Participants included in the analyses: 375
Study design	Retrospective cohort
Target condition	Recurrent ductal carcinoma in situ or invasive breast cancer
Interventions	Digital mammography confirmed by additional imaging (diagnostic mammography, additional views, ultrasound, magnetic resonance imaging, stereotactic biopsy, ultrasound-guided biopsy, and pathologic assessment of a breast core biopsy specimen).
Outcomes	Additional imaging, yield for identifying ipsilateral breast tumour recurrence
Follow-up	24 months

Houssami et al, 2011 [10]

Study name or title	BreastScreen-based mammography screening in women with a personal history of breast cancer, Western Australian study
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Clinical features and settings	Inclusion criteria: screened as part of the BreastScreen WA program Exclusion criteria:
Participants	Study location: Western Australia (WA) Study period: January 1997 and December 2006 Participants enrolled: women who participated in screening through an organized screening program (BreastScreen WA) with or without a personal history of breast cancer (PHBC) Participants included in the analyses: 713,191 screens (12,358 in PHBC women and 700,833 in women without PHBC)
Study design	Retrospective cohort
Target condition	Target condition: breast cancer Reference test: further imaging or needle biopsy
Intervention	Two-view mammography of each breast read by two radiologists
Outcomes	Cancer detection and recall rates
Follow-up	None
Notes	This was a comparative study. BreastScreen WA has granted PHBC women access to breast screening since its statewide implementation in 1995.

Kang et al, 2005 [52]

Study name or title	Breast magnetic resonance imaging (MRI) findings after modified radical mastectomy and transverse rectus abdominis myocutaneous (TRAM) flap in patients with breast cancer
Clinical features and settings	Inclusion criteria: Patients who had been diagnosed with radical mastectomy followed by TRAM flap reconstruction
Participants	Study location: Seoul, South Korea Study period: Aug 2001 – Apr 2004 Participants enrolled: 20 patients, 11 patients underwent follow-up mammograms Participants included in the analyses: 11 patients who underwent follow-up mammograms
Study design	Retrospective
Target condition and reference standard(s)	Target condition: invasive cancer or ductal carcinoma in situ. Reference test: mammography and surgery.
Index and comparator tests	Index test: MRI performed either one, two or three times at an average of 153 days, 237 days and 583 days after surgery, respectively.
Follow-up	None

Lee et al, 2008 [47]

Study name or title	Detecting nonpalpable recurrent breast cancer: the role of routine mammographic screening of transverse rectus abdominis myocutaneous flap reconstructions
Clinical features and settings	Inclusion criteria: only women who had transverse rectus abdominis myocutaneous (TRAM) flap reconstructions Exclusion criteria: non-TRAM flaps, prophylactic mastectomies
Participants	Study location: Massachusetts, USA



	Study period: January 1, 1999 to July 15, 2005 Participants enrolled: stage at time of mastectomy: ductal carcinoma in situ (0): 32.5%, stage I: 15.1%, stage II: 24.9%, stage III: 5.3%, stage IV: 0.4%, 5.3% recurrent. Age range at mastectomy 32-71 (mean 49, median 48) years
Study design	Retrospective cohort
Target condition and reference standard(s)	Target condition: recurrent breast cancer Reference test: biopsy
Index and comparator tests	Index test: surveillance mammography
Follow-up	0.2-22 years (median 4.9 years)

McNaul et al, 2013 [46]

Study name or title	An evaluation of post-lumpectomy recurrence rates: is follow-up every 6 months for 2 years needed?
Clinical features and settings	Inclusion criteria: patients who had breast-conserving therapy and surveillance mammography at a single institution
Participants	Study location: Missouri, USA Participants enrolled: 399 Participants included in the analyses: 399
Study design	Retrospective review of electronic medical records
Target condition and reference standard(s)	Target condition: recurrence of early stage breast cancer Reference test: follow up imaging such as ultrasound or biopsy
Index and comparator tests	Index test: mammography
Outcomes	Mammography yield
Follow-up	Unclear

Sim and Litherland, 2012 [48]

Study name or title	The use of imaging in patients post breast reconstruction
Clinical features and settings	Inclusion criteria: asymptomatic patients who had undergone reconstructive breast surgery, with radiological imaging Exclusion criteria: breast reconstruction for inflammatory pathology
Participants	Study location: Glasgow UK Study period: January 2005 and October 2009 (yr of breast reconstruction surgery recorded between 1996 and 2008) Participants enrolled: 227 patients Participants included in the analyses: 187 reconstruction types were known: 119 autologous latissimus dorsi flaps (LD), 23 deep inferior epigastric perforator flaps, 6 transverse rectus abdominis myocutaneous flaps, 24 with LD flaps and implants, 15 with prosthesis implant. 116 had screening mammograms of the reconstructed breast. 111 had follow-up mammograms only of the contralateral breasts
Study design	Retrospective cohort
Target condition and reference standard(s)	Target condition: recurrent invasive breast carcinoma or second primary cancer

	Reference test: “additional investigations” including ultrasound, biopsy, magnetic resonance imaging
Index and comparator tests	Index test: mammograms
Outcomes	Detection rate, recall rate
Follow-up	Ranging between 1 to 13 years (median and mode 6 years)
Notes	This study also did not have a comparison group but looked at outcomes of asymptomatic patients with abnormal mammograms of reconstructed breast.

Tan et al, 2015 [49]

Study name or title	Qualitative mammographic findings and outcomes of surveillance mammography after partial breast reconstruction with an autologous flap
Clinical features and settings	Inclusion criteria: breast cancer patients who had volume replacement breast-conserving surgery (VR-BCS) Exclusion criteria:
Participants	Study location: Singapore Study period: November 2000 and August 2013 Participants enrolled: all patients who had VR-BCS performed by two oncoplastic surgeons. Reconstruction was either latissimus dorsi mini-flap (LDMF) or the fasciocutaneous chest wall perforator flap (CWPF). Average age was 50.5 years (range 30-78) Participants include in the analyses: Patients who had VR-BCS
Study design	Retrospective cohort
Target condition	Recurrent breast malignancy
Index and comparator tests	Mammography confirmed by further imaging (spot compression and/or magnification view mammography or ultrasound). Three proceeded to have needle biopsy of the mammographic abnormality. One diagnostic excisional biopsy.
Outcomes	Recall rates, biopsy rates
Follow-up	Median follow-up for patients who had LDMF surgery was five years (range 3-11 years), and it was two years (range 0-4 years) for those who had CWPF surgery. Twenty-four patients who had CWPF surgery did not have their first post-treatment surveillance mammogram.
Notes	This study has no comparison group, but has a description of 6 of 295 mammograms that had results that were indeterminate or suspicious for malignancy

Yoo et al, 2014 [50]

Study name or title	Local recurrence of breast cancer in reconstructed breasts using TRAM flap after skin-sparing mastectomy: clinical and imaging features
Clinical features and settings	Inclusion criteria: patients with pathologically confirmed recurrent cancer who had transverse rectus abdominis

	myocutaneous (TRAM) flap reconstructions after skin-sparing mastectomy (SSM) or nipple and areolar skin-sparing mastectomy (NASSM) and whose follow-up radiological studies were available.
Participants	Study location: South Korea Study period: January 2001 to December 2010 (March 2012 for nonrecurrences) Participants enrolled: 16 local breast cancer recurrences in 964 patients who underwent SSM (n=581) and NASSM (n=383). Participants include in the analyses: patients who had SSM or NASSM followed by TRAM flap and local recurrence
Study design	Retrospective cohort
Target condition and reference standard(s)	Target condition: recurrent breast cancer Reference test: surgery or biopsy
Index and comparator tests	Index test: surveillance mammography
Outcomes	Detection rate
Follow-up	Average: 31.1 months (range 7-84 months)

## **DECLARATIONS OF INTEREST**

The authors of this review have no conflicts of interest to declare.

## **SOURCES OF SUPPORT**

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## **DIFFERENCES BETWEEN PROTOCOL AND REVIEW**

The protocol for this review (<http://www.crd.york.ac.uk/PROSPERO/>) described a planned search for primary literature from 1996 to present. Early searches yielded two systematic reviews that covered the topics of interest; therefore, the search plan was modified to incorporate the findings of these reviews and to search for primary literature from their final search dates to the present (i.e., March 2012 to present for studies of surveillance mammography in survivors and August 2004 for studies of surveillance after breast reconstruction). The protocol also stated that articles were to have at least 100 patients to be eligible for inclusion. After initial searching we determined that the evidence-base on this topic was very small; therefore, we expanded the search to include any studies with no lower limit on number of patients.