BCSC Glossary of Terms, Version 2

This document details key terms and definitions used by the Breast Cancer Surveillance Consortium (BCSC).

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BCSC DEFINITIONS FOR BREAST IMAGING EXAMS

Screening mammography

Mammograms, including digital breast tomosynthesis, are performed for either screening or diagnostic purposes. To determine whether a mammogram was for screening, different criteria may be applied depending on the population of interest. The following conditions may be used to define a screening mammogram. **Conditions 1-8** comprise the standard strict definition of a screening mammogram in women without a history of breast cancer (BCSC variable *scrmam_c*) often used in BCSC papers.

At a minimum, the exam must meet the following conditions:

- **Condition #1: The examination is a mammogram with an indication of "screening"**
  The indication is usually provided by the radiologist or technologist.
- **Condition #2: First mammogram of the day**
  Because multiple exams may occur on the same day, we typically only include only the first exam in the sequence.

One or more of the following conditions may also be applied, to eliminate possible non-screening exams:

- **Condition #3: Unilateral views were not taken**
  Unilateral exams may indicate that the woman had a previous unilateral mastectomy or that the exam was done for diagnostic purposes.
- **Condition #4: No mammogram in prior 9 months**
  A mammogram within the prior nine months may indicate a diagnostic exam since screening exams are not typically done at intervals less than 9 months.

The following four conditions may also be used to select screening mammograms among a population of women without a history of breast cancer.

- **Condition #5: No history of breast cancer**
  History of breast cancer is based on the database or self-report.
- **Condition #6: No history of mastectomy**
  Prior mastectomy is based on the database or self-report and may indicate a prior breast cancer diagnosis.
- **Condition #7: No breast augmentation**
  Breast augmentation is based on self-report and exams usually include diagnostic views.
- **Condition #8: Exam assessment is not BI-RADS® 6**
  BI-RADS 6 (known biopsy-proven malignancy) indicates prior breast cancer. [1]

The definition of a screening mammogram may vary depending on the analysis. For example, an analysis may require no self-reported breast symptoms. The analyst can exclude women with symptoms by using the BCSC computed variable *symp_c* (ordered by level of concern: lump, nipple discharge, other symptom not including pain, pain, other symptom not specified, and none). Studies focused on screening/surveillance in women with a personal history of breast

cancer may apply other conditions, defined on page X below. When an analysis includes both screening and diagnostic mammograms, the researchers may prefer to use only the radiologist's indication for exam to classify the mammogram as screening or diagnostic.

Appendix 1 provides BCSC variable names and file names pertaining to the definition of a screening mammogram without history of breast cancer.

Screening MRI

The BCSC collects up to three indications for magnetic resonance imaging (MRI) exams. The computed variable for indication applies a hierarchy (see **Appendix 2**) that keeps a screening indication only if no other indication is given.

The following conditions define a screening MRI (variable *scrmri_c*)**:**

- **Condition #1: The examination is an MRI with an indication of "screening"**
- **Condition #2: First MRI of the day**
- **Condition #3: Bilateral views taken**
- **Condition #4: No MRI in prior 9 months**
- **Condition #5: No history of breast cancer**
- **Condition #6: No history of mastectomy**
- **Condition #7: Exam assessment is not BI-RADS 6**

Screening/surveillance mammography/MRI with history of breast cancer

Women with a personal history of breast cancer (**PHBC**) are recommended to have breast imaging exams for screening, also referred to as **surveillance exams**. These can be identified by the variable *scrmambc_c* for surveillance mammography and the variable *scrmribc_c* for surveillance MRI. The BCSC definition of a surveillance exam differs in a few respects from the screening definition in women without PHBC, as summarized in this table:

	Screening mammograghy/MRI without PHBC	**Screening mammography/MRI with PHBC (Surveillance)**
Date of exam	No breast cancer history	≥6 months after breast cancer diagnosis, to allow the initial work-up and treatment period to end
Indication for exam	Screening	Screening; this is conservative as some screening exams are coded as diagnostic in the first few years after diagnosis
No prior imaging (of same exam type) time window	9 months	60 days, to allow for shorter screening intervals
BI-RADS assessment	Exclude BI-RADS 6	Exclude BI-RADS 6
Other	Not a unilateral exam No prior mastectomy (self-report at that exam or prior report in pathology, regardless of laterality)	No prior bilateral mastectomy (self-report at that exam or prior report in pathology or cancer registry)

Appendix 3 provides BCSC variable names and file names pertaining to the definitions of a screening mammogram and screening MRI in women with a history of breast cancer.

Diagnostic mammography

The computed variable *dxmam_c* indicates whether a diagnostic mammogram, including digital breast tomosynthesis, was performed. A diagnostic mammogram is defined as a mammogram with an indication of additional evaluation of recent mammogram, short-interval follow-up, or evaluation of a breast problem or concern (variable *indicate* = 2, 3, or 4). Sometimes multiple diagnostic mammograms may be performed to fully work-up a finding or concern; therefore, only the first diagnostic mammogram performed within 90 days is included in analyses to avoid double counting of exams performed for the same work-up.

Note that performance characteristics differ among the different indications for diagnostic mammogram. [2-5] We do not recommend combining performance results across the different diagnostic indications.

Overall assessment

The BCSC currently uses the classification systems described in the BI-RADS Atlas Fifth Edition (2013) from the American College of Radiology for both mammography and MRI. [1]

Assessment categories in the BI-RADS manual:

- 0 indicates that additional imaging evaluation is needed (i.e., incomplete assessment)
- 1-5 indicate the level of suspicion for malignancy
  - 1: negative
  - 2: benign finding
  - 3: probably benign finding
  - 4: suspicious abnormality
  - 5: highly suggestive of malignancy
- 6 indicates a known biopsy-proven malignancy

Each exam contains fields for the left assessment, right assessment, and overall assessment, though not all facilities submit breast-level assessments. The overall assessment (*assmtot_c)* reflects the most serious assessment between the left and right breast. The "highest" assessment between the left and right breast follows a hierarchy ordered from high to low association with cancer risk: 5 > 4 > 0 > 3 > 2 > 1. A BI-RADS 6 assessment should not appear in analyses of screening exams (and thus, should be excluded).

The BCSC computes the overall assessment from the left and right assessments. If left and right assessments are missing, we use the existing overall assessment.

Initial assessment (before any work-up)

The overall assessment may include results from additional work-up, which should not be included in most measures of screening performance. Instead, the initial assessment (*assminit_c*), which is made before any additional imaging is performed, should be used. Additional imaging includes diagnostic views or ultrasound done on the same day or used to help make the assessment (BCSC SCC detail: II.18 *diagview* = 1-5, II.20 *useaddv* = 1, II.21 *ultrasnd* = 1-5, II.22 *useultra* = 1, or a second diagnostic imaging exam.)

If additional imaging was done, the initial assessment is set to BI-RADS 0 (needs additional imaging evaluation). Otherwise, the overall assessment is considered to be the first recorded assessment in the imaging series.

We do not code initial assessment for diagnostic mammograms because performance is based on the final assessment.

End-of-day assessment (after same-day work-up)

The end-of-day assessment is the BI-RADS assessment at the end of the day and includes any same-day imaging work-up (*assminit_eod_c*). The end-of-day assessment should be used for most performance measures of surveillance mammography, because diagnostic views are often done as part of a surveillance exam and the SCC cannot distinguish these from exams performed to work-up of a new finding. The initial assessment and end-of-day assessment are the same for MRI because same-day additional work-up is not typically done.

Final assessment (after all work-up)

The final assessment (*assmfnl_c*) is made after all work-up is completed. Exams with a BI-RADS 0 initial assessment or missing assessment with another exam on the same day are resolved for final assessment. For all other exams, the final assessment is taken to be the overall assessment (*assmtot_c*). The BCSC methods for resolving BI-RADS 0 has been refined over time.

This follow-up algorithm for final assessment was implemented in 2016 (0315b data):

Follow-up algorithm for final assessment (applies to mammography and MRI)
Resolve if initial assessment is BI-RADS 0 or missing assessment with another exam on the same day
Look at all breast imaging exams occurring up to the earliest of 90 days, first biopsy, or breast cancer diagnosis (see note 1 below)
Use first non-zero BI-RADS from Radiology file or non-missing normal/abnormal result from the Imaging Follow-up file. (BCSC detail: if Imaging Follow-up file used, BI-RADS assessment will be missing but result can be coded)
Use BI-RADS based on recommendation from last follow-up exam: BI-RADS 4, if biopsy recommendation BI-RADS 3, if short-interval follow-up BI-RADS 2, if normal interval follow-up

If biopsy done, code as BI-RADS 4
Use BI-RADS based on recommendation from original exam: BI-RADS 4, if biopsy recommendation BI-RADS 3, if short-interval follow-up BI-RADS 2, if normal interval follow-up
If none of the above: Final assessment = missing

Note the following points:

1. Some cancer registries define the diagnosis date as the date of first evidence of breast cancer. If an abnormality is noted on a screening mammogram and the radiologist gives an assessment of 0, the mammogram date may be used as the diagnosis date even if additional imaging is performed on a later day. Therefore, we may be truncating the follow-up period for final assessment too soon.
2. If the exam used for the final assessment is from the Imaging Follow-up file, the BI-RADS assessment is missing but the mammogram result may still be classified as positive or negative based on the imaging result (*imgrslt*) or recommendation (*imgrec*).
3. The definition of final assessment may be modified depending on the analysis. Also, analyses performed in 2015 and before may have used a modified definition based on earlier decisions. Please see the prior version of the BCSC Glossary of Terms.

Positive and negative result

We use the BI-RADS assessment to define an exam result as positive or negative.

For the **initial result** (*resinit_c*) and **end-of-day result** *(resinit_eod_c),* BI-RADS assessments 1 and 2 are considered negative and 0, 3, 4, and 5 are positive. BCSC began to consider assessments of 3 as positive starting in 2014 to be consistent with changes in the BI-RADS 5th edition. In earlier BCSC studies, BI-RADS 3 was considered positive only if immediate additional imaging (instead of short interval follow-up) was recommended. Please see the prior version of the BCSC Glossary of Terms. According to BI-RADS guidelines, the **initial result** is used with screening exams for these performance measures: sensitivity, specificity, false-positive recall rate, false-negative recall rate, recall rate, cancer detection rate, and PPV1 (see PERFORMANCE MEASURES). The **end-of-day result** is used for all screening MRI and screening surveillance mammography.

For the **final result** (*resfnl_c*), BI-RADS assessments 1, 2, and 3 are negative; 4 and 5 are positive. Typically, unresolved BI-RADS 0s are excluded; however, one should consider a sensitivity analysis that treats zeros as (a) all positive and (b) all negative, to ensure that exclusion does not bias the results. (Some women with an unresolved BI-RADS 0 exam may have had a biopsy that was not captured by BCSC. Excluding these exams may underestimate the percentage with a biopsy or biopsy recommendation.) According to the BI-RADS guidelines, the **final result** is used with screening exams for these performance measures: false-positive biopsy recommendation rate, PPV2, and PPV3 (see PERFORMANCE MEASURES) and for all performance measures with diagnostic mammograms. Note that PPV1 is not defined for diagnostic mammograms; in that case, it is the same as PPV2.

BCSC DEFINITIONS FOR BREAST CANCER DIAGNOSES

Breast cancer cases

We usually define breast cancer as invasive carcinoma or ductal carcinoma *in situ* (DCIS). Some analyses restrict to invasive breast cancer. Lobular carcinoma *in situ* (LCIS), lymphoma, and sarcoma (including cystosarcoma phyllodes) are excluded from the BCSC definition of breast cancer.

For a woman's first breast cancer diagnosis, we identify the earliest diagnosis of invasive breast cancer or DCIS using the cancer registry and pathology files and for one site, the biopsy follow-up file. If a woman has diagnoses of both invasive cancer and DCIS separated by more than 60 days, we take the earliest result as her first breast cancer. If the invasive cancer and DCIS diagnoses are within 60 days of each other, we use the invasive result, but retain the earlier date as the diagnosis date. For cancer characteristics (e.g., size, stage, nodal status) we use the most severe result from cancer registry records with the same cancer type (invasive or DCIS) within 60 days of diagnosis. We fill in missing values using the most several result from pathology, or, for one site, biopsy follow-up.

Follow-up period for breast cancer diagnosis after a breast imaging exam, for performance

For calculating performance measures, screening mammograms are followed for one year (365 days) unless the next screening mammogram occurs within 270-365 days, in which case the follow-up period is truncated at that next screening mammogram (*Acad Radiol*, 2000). Non-screening exams done <270 days after the initial mammogram do not truncate the follow-up period. This definition differs from the American College of Radiology (ACR) BI-RADS definition, which uses a strict 365-day follow-up period. Cancer diagnosed within the follow-up period is indicated by the variable *cancscrfu1yr_c* with truncation and the variable *cancfu1yr_c* without truncation.

Screening MRI exams are followed for one year for cancer diagnosis. Truncation at the next screening exam if less than one year does not apply. Cancer diagnosed within the follow-up period is indicated by the variable *cancfu1yr_c*.

For diagnostic mammograms, the follow-up period for cancer diagnosis is from 30 days before to one year after the exam. Cancer diagnosed within the follow-up period before the exam is indicated by *cancdxfu1yr_c.* We include a short period before the diagnostic exam because diagnosis dates assigned by cancer registries often reflect the first evidence of cancer, which can occur on a clinical exam before the diagnostic exam. If multiple cancer diagnoses exist during follow-up then one is chosen using this hierarchy:

1) If one or more cancers are diagnosed within 0-60 days after the exam, then the cancer closest to the exam is chosen.
2) Otherwise, if one or more cancers are diagnosed within 1-30 days before the exam, then

the cancer closest to the exam is chosen.

3) Otherwise, if one or more cancers are diagnosed within 61-365 days after the exam, then the cancer closest to the exam is chosen.

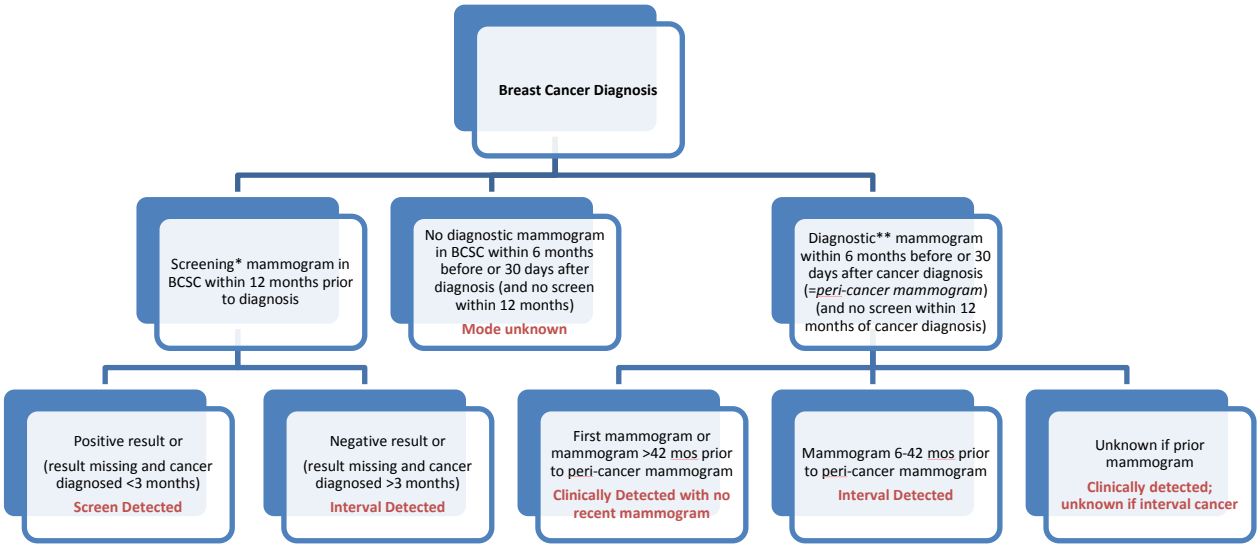
Mode of detection for breast cancer cases

The BCSC computed variable for mode of detection (*mode_of_detection*) is recommended for studies conducted among breast cancer cases. Mode of detection is computed for a woman's first breast cancer diagnosis.

The following figure illustrates the decision flow and definitions for *mode_of_detection*, coded as:

1	Screen Detected
2 & 4	Interval Detected (diagnosed within screening interval)
3	Clinically Detected, Not Interval
5	Clinically Detected, Unknown if Interval cancer
Otherwise	Unknown Mode

Figure. Decision Tree for Classifying Mode of Detection (*mode_of_detection*)



* *Screening mammogram*: indication is routine screen and (>9 months have elapsed since last screen, or time since last mammogram is missing)
** *Diagnostic mammogram*: indication is diagnostic

PERFORMANCE MEASURES

Definitions for performance measures often used in BCSC papers are provided in this section.

Positive and negative imaging results

Exam Type	Imaging Result	Cancer diagnosis within follow-up period	
		Yes	No
SCREENING	Positive (BI-RADS 0, 3, 4, 5)	TP	FP
	Negative (BI-RADS 1, 2)	FN	TN
DIAGNOSTIC	Positive (BI-RADS 4, 5)	TP	FP
	Negative (BI-RADS 1, 2, 3)	FN	TN

Table adapted from 5th Edition BI-RADS Manual, Follow Up and Outcome Monitoring Section, Fig. 1, page 20.

TP = true positive: a positive exam with DCIS or invasive breast cancer diagnosed within the follow-up period.

FP = false positive: a positive exam with no breast cancer diagnosed within the follow-up period.

TN = true negative: a negative exam with no breast cancer diagnosed within the follow-up period.

FN = false negative: a negative exam with DCIS or invasive breast cancer diagnosed within the follow-up period.

Definitions from BI-RADS 5th Edition: Follow Up and Outcome Monitoring [6]

Sensitivity = TP / (TP + FN)

Sensitivity is the proportion of cancers diagnosed during follow-up that had a positive mammography result.

Specificity = TN / (FP + TN)

Specificity is the proportion of non-cancers during follow-up that had a negative mammography result.

Abnormal interpretation rate = All positive exams / All exams. See note 1 below.

Positive Predictive Value (PPV) has three definitions:

PPV_1 (abnormal finding at screening) = TP / (TP + FP1), where FP1 = No known tissue diagnosis within 1 year after positive screening exam (initial assessment of 0, 3, 4, 5).

PPV_1 is the proportion of exams with a positive initial assessment that had a cancer diagnosis during follow-up. PPV_1 should be computed using the initial assessment. If no other PPV definitions are used, PPV_1 may be referred to as PPV.

The 5th edition of BI-RADS does not include PPV_1, but we have chosen to include it as a performance measure since PPV_1 was included in earlier BI-RADS editions.

PPV_2 (biopsy recommended) = TP / (TP + FP2), where FP2 = No known tissue diagnosis within 1 year after recommendation for tissue diagnosis (final assessment of 4, 5).

PPV_2 is the proportion of exams with a recommendation for biopsy or surgical consult (i.e., positive final result) that had a cancer diagnosis during follow-up.

PPV_3 (biopsy performed) = TP / (TP + FP3), where FP3 = Concordant benign tissue diagnosis (or discordant benign tissue diagnosis and no known tissue diagnosis of cancer) within 1 year after recommendation for tissue diagnosis. See note 3 below.

PPV_3 is the proportion of exams with recommendation for biopsy or surgical consult (i.e., positive final result) and biopsy performed within 1 year of the exam that had a cancer diagnosis during follow-up.

Negative Predictive Value (NPV) = TN / (TN + FN)

NPV is the proportion of exams with a negative assessment that did not have a cancer diagnosis during follow-up.

False Positive Rate (FPR) = FP / (FP + TN)

FPR is the proportion of non-cancers during follow-up that had a positive mammography assessment. FPR equivalent to 1- Specificity.

Cancer Detection Rate (CDR) = 1000 * TP / (TP + FP + FN + TN)

CDR is the proportion of exams with both a positive assessment and a cancer diagnosis during follow-up. It is usually computed per 1000 mammograms:

Notes

1. BI-RADS 3 is positive at screening, but negative at diagnostic exam. BI-RADS 3 was not intended to be applied to screening exams.
2. The BCSC does not necessarily capture every biopsy that occurs. Therefore, the denominators for PPV_2 and PPV_3 may differ. For PPV_3, the denominator is the number of biopsies for which there is a record in the pathology file and the numerator is the subset of those biopsies that result in a cancer diagnosis.

Note about follow-up time

The length of follow-up can affect screening mammogram classifications. For example:

Date	Event	Assessment	Classification (BCSC)
Jan 1, 2000	Screening mammogram	Negative	True negative
Nov 1, 2000	Screening mammogram	Positive	True positive
Nov 1, 2000	Cancer diagnosed		

Using the ACR definition, the first mammogram would be classified as false negative because breast cancer was diagnosed within 365 days after a negative exam. According to the BCSC definition, however, the follow-up period ended October 31, 2000 because of the November 1, 2000 screening exam—so the first mammogram would be classified as true negative. This results in increased sensitivity compared to the ACR definition.

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APPENDICES

APPENDIX 1

BCSC variable and file names pertaining to the definition of a screening mammogram
See "Screening mammography and digital breast tomosynthesis" section for context.

Condition	Definition
1	The examination must be a mammogram with an indication of "screening" by the radiologist or technologist (*scrcrit_c1*). This determination is based on: • Records known to be mammograms (*scrcrit_c12*), based on the II.15 *mammtype* variable (= 1—film, 2—digital, or 3—mammogram NOS) in the Radiology file AND • Variable 11.13 (*indicate* = 1—routine screening) in the Radiology file
2	Because multiple exams may occur on the same day, we typically only include only the first exam in the sequence (*scrcrit_c2*), based on II.5 *examseq* = 1 variable in the Radiology file. When the exam sequence is unknown, SCC guidelines are to sort first by *indication* (ordered 1,3,4,2: 1—Routine screening, 3—Short interval follow-up, 4—Evaluation of breast problem, 2—Additional evaluation of recent mammogram), then by overall assessment *assmtot_c* (ordered 0-5: 0—Needs additional imaging evaluation, 1—Negative, 2—Benign finding, 3—Probably benign finding, 4—Suspicious abnormality, 5—Highly suggestive of malignancy).
3	We may require that bilateral routine views be performed (*scrcrit_c4*), based on II.17 *routview* (= 4—Bilateral or 5—Yes, woman-level information only) in the Radiology file. If *routview* is missing we require that II.16 *mammlat* (= 4—Bilateral or 5—Yes, woman-level information only). Unilateral exams may be excluded because this may indicate that the woman had a previous unilateral mastectomy or that the exam was done for diagnostic purposes.
4	We may exclude screening exams that are preceded by a mammogram within the prior nine months, based on examinations in the database (*scrcrit_c7*) from the following: • The Radiology and Imaging Follow-up files, 1. The woman's self-report of a previous mammogram (Patient file I.20 *lastdate*), 2. The radiologist's report of a previous mammogram (Radiology file II.12 *prevdate*), OR 3. A comparison film date (Radiology file II.27 *compdate*). The combination of these last three sources of information indicating a mammogram within the prior nine months is inclusion criterion #8 in the computed variables (*scrcrit_c8*).
5	We may exclude exams from women with a history of breast cancer, based on either: • Self-report (*scrcrit_c5*). We base self-report on these variables in the Patient file: • I.23 *bchist* = 1-5, or • I.25 *ageatdx* = age given, or • I.26 *dxdate* = date given OR • A breast cancer diagnosis found in the cancer registry or pathology file (inclusion criterion #6 in computed variables (*scrcrit_c6*). We base this on ***newdxdt*** (date of first breast cancer from cancer registry or pathology) occurring before the exam date.
6	We may exclude exams from women with a prior mastectomy (*scrcrit_c11*), based on either self-report (Patient file I.31 *mastect*) or records in the cancer registry or pathology file.
7	We may exclude women who report breast implants at the time of exam (*scrcrit_c9*), based on the Patient Information file I.35 *brstaugm* (= 1-5).
8	We may exclude exams with a left, right, or overall assessment of 6 (known biopsy-proven malignancy). This assessment was added in the ACR BI-RADS ® Atlas 4th Edition.

APPENDIX 2

Indication for MRI without history of breast cancer: hierarchy used in computed variable

MRI exams can have up to three indications. The computed variable for indication applies a hierarchy that keeps a screening indication only if no other indication is given. The first indication that appears in the list below is used in the computed variable:

Indication for exam, raw data (*indic1, indic2, indic3*)	**Raw code**	**Indication for exam, computed variable (CV) (*indicate_c*)**	**CV code**
Evaluation for extent of disease of recent breast cancer diagnosis	10	Evaluation for extent of disease or Axillary adenopathy (malignant), unknown primary	6
Response to chemotherapy	21	Other procedures	5
Axillary adenopathy (malignant), unknown primary	31	Evaluation for extent of disease or Axillary adenopathy (malignant), unknown primary	6
Additional evaluation of recent imaging	41	Additional evaluation of recent breast imaging exam	2
Breast problem	30	Evaluation of breast problem (symptomatic)	4
Recurrence vs. scar	42	Evaluation of breast problem (symptomatic)	4
Short interval follow-up	32	Short interval follow-up	3
Diagnostic, not otherwise specified	70	Diagnostic, not otherwise specified	7
Implant evaluation*	40	Other procedures	5
Screening	10	Routine screening (asymptomatic)	1
Other	50	Other procedures	5
Unknown	99	Unknown	9
Structural missing	88	Structural missing	8

* MRI exams done on women with implants can be for screening if the exam includes contrast administration. This cannot be determined in BCSC data so implant evaluation is excluded from screening because some non-contrast exams are performed to evaluate for implant rupture and are not for cancer screening or surveillance. Do not exclude if there is only self-report of breast implants.

APPENDIX 3

In progress - forthcoming Nov 2016