Breast Imaging Reporting and Data System

BI-RADS ™

American College of Radiology Terms and Agreement and Disclaimer

Disclaimer

The ACR's Breast Imaging Reporting and Data System is the product of a collaborative effort between members of various committees of the ACR with cooperation from the National Cancer Institute, the Center for Disease Control and Prevention, the Food and Drug Administration, the American Medical Association, the American College of Surgeons, and, the American College of Pathologists. This reporting and data system is intended to guide radiologists and referring physicians in a decision-making process that facilitates the management of patients based on breast imaging.

All referring physicians and radiologists should be aware of the benefits and limitations of the application of imaging techniques. At this time, imaging modalities such as ultrasound (US) and magnetic resonance (MR) used as diagnostic adjuncts to mammography are not classified using BI-RADSTM. Imaging techniques classified as investigational by the FDA have not been considered in developing BI-RADSTM; however, study of new equipment and applications should be encouraged. The ultimate decision regarding breast imaging procedures and treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

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INTRODUCTION

The Illustrated BI-RADSTM, Third Edition is an extension of the second edition of the BI-RADSTM lexicon and includes illustrations of each feature described, a section on auditing a mammography practice, and sample reports. The lexicon of mammography terms and the reporting format is meant to standardize the language used in mammography reports. In particular the consistent use of the assessment categories will help clinicians understand disposition of their patients based on mammographic imaging and also aid in auditing your mammography practice. Knowing how we perform will help to highlight deficiencies, aid research and be of practical value in medicolegal cases. The new final regulations from the FDA will require a mini audit of all facilities engaged in mammography.

The features we use to describe mammographic findings are illustrated in the BI-RADSTM atlas. Each feature begins with a line drawing meant to depict the essence of the feature described. This is followed by several mammographic examples. The legend beneath each example will have the feature illustrated in capital letters. Many of the illustrations will obviously involve several features such as "ROUND circumscribed, high density mass." All the illustrations will be fully described using the lexicon terminology so that each example will serve to highlight more than one feature. However, the capitalized terms will indicate the feature the mammogram was chosen to illustrate. Where possible, pathology of what is described is included. The atlas itself is spiral bound for convenience and ease of use at the reporting station.

Sources of common confusion relate to the general usage of the lexicon and specifically to some of the features within the lexicon. It is often not possible to use a single descriptor to characterize a finding. This is most often true with calcifications and margin characteristics. Calcifications may contain several types of elements from punctate to pleomorphic. If one form predominates then a single term may be the best description or if this is not the case multiple descriptors may be used. One must remember that our recommendation will be based on the most worrisome of the features. Thus a cluster of pleomorphic, punctate and amorphous calcifications may use all terms needed to describe the calcification with a statement recommending biopsy be considered due to the presence of pleomorphic forms. One may also describe the finding as a cluster of microcalcifications with pleomorphic forms and biopsy should be considered. This flexibility should also be carried over when describing margins. Many margins will be partially obscured by glandular tissue. Some have considered 75% of a margin as the entire margin and use one descriptor. What is important is the action recommended based on the most suspicious feature. For example a partially circumscribed round mass with a partially spiculated margin should be handled differently from a partially circumscribed and partially obscured mass. Feel free to use more than one descriptor for a finding. This will generally occur with mass margins and calcifications. However, note that action should be based on the most worrisome feature.

Particular features have also proved bothersome as reflected in the comments received by the BI-RADSTM Committee. The differentiation between a mass and focal asymmetry is perhaps most problematic. Both a mass and focal asymmetric density may be seen in two views. A mass should demonstrate margins which are convex outwards while a focal asymmetric density often will not. Admittedly it may be very difficult to categorize a finding as a mass or focal asymmetry; however, I have found the presence of convex outward borders helpful in this distinction. Punctate calcification in the "typically benign" category deserves further explanation. While all other calcifications described in the typically benign category are benign regardless of their distribution, this is not the case with punctate calcification. A linear arrangement of punctate calcifications may require a short-term follow-up, or perhaps, even biopsy.

The section on the mammography audit was included as a response to the many questions the BI-RADSTM Committee received concerning definition of terms and their utilization. The section clearly describes what is considered a positive and negative mammographic exam and how truth is established for each. It also utilizes the assessment categories in the definitions. Practical examples of everyday situations are presented and then characterized using the definitions included in this section. Briefly, any mammogram characterized as BI-RADSTM Category 0, 4 or 5 is positive and any characterized by BI-RADSTM Category 1, 2 or 3 is negative. If malignancy is diagnosed within 12 months of the mammogram this is considered positive as far as proof is concerned and the lack of malignancy in the same time period is considered negative. Thus a mammogram coded as BI-RADSTM Category 0, for which cancer is discovered within 12 months would be a true positive exam.

The subjective interpretation of mammographic images is difficult to evaluate and therefore difficult to improve. The medical audit is the only way to measure mammographic performance in a manner that includes not only technical but also interpretive capabilities of the system. Individual mammography practices recording mammography results with the uniform terminology and format of BI-RADSTM facilitates the collection and analysis of medical audit data not only at individual mammography practices but also at a national level. A national mammography audit refers to collecting and analyzing medical audit data of individual mammography practices at a national level and is a critical step in improving the interpretive component of mammography.

This third edition of BI-RADSTM formally launches data collection for the ACR National Mammography Database (NMD). The ACR is eliciting participation and encouraging radiology practices to submit data to the NMD project. Potential benefits of the NMD are the improvement in interpretive skills of individual radiologists through collection, review, and comparison of their practice data with similar practices. Another advantage of the NMD is that the success or failure of the screening program to detect occult cancers at the expected rate could be evaluated and compared with regional and national norms. The overall goal of the NMD is educational and should result in the improvement of mammography quality.

Once a system for the collection of audit data has been established, it is our hope each practice would contribute at least minimal audit data to the ACR NMD. Although an extended data set is desirable, a minimal data set is encouraged for all facilities to initiate this important national project. Please see Section IV for instruction to submit minimal or extended data base material. The Illustrated BI-RADSTM atlas is arranged to be used in everyday practice and should make it possible to issue meaningful unambiguous mammography reports. The document is meant to be dynamic and the BI-RADSTM Committee welcomes any comments and/or suggestions, and request, they be addressed in writing to the ACR.

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THE ACR BREAST IMAGING REPORTING AND DATA SYSTEM (BI-RADSTM)

The American College of Radiology (ACR) Breast Imaging Reporting and Data System (BI-RADSTM) is the product of a collaborative effort between members of various committees of the American College of Radiology with cooperation from the National Cancer Institute, the Centers for Disease Control and Prevention, the Food and Drug Administration, the American Medical Association, the American College of Surgeons, and the College of American Pathologists.

This system is a quality assurance tool designed to standardize mammographic reporting, reduce confusion in breast imaging interpretations, and facilitate outcome monitoring. Through a medical audit and outcome monitoring, the system provides important peer review and quality assurance data to improve the quality of patient care. Because the information reported to the database will be used in peer review, the information is considered confidential and must be collected and reported in a manner that complies with applicable statutory and regulatory peer review procedures. The information submitted to the ACR and the ACR's analysis of this information are privileged and except in aggregate form will not be released to external sources. As a medical society engaged in peer review activities, the ACR will invoke state peer review laws to protect this peer review data.

There are two major categories of women who can benefit from breast imaging studies. All referring physicians and radiologists should be aware of the benefits and limitations of the application of imaging techniques.

SCREENING

The major role for mammography is the earlier detection of breast cancer in the asymptomatic woman. The efficacy of mammographic screening has been established by randomized controlled trials in which absolute mortality reduction has been achieved by the ability of mammography to find ductal carcinoma in-situ, and infiltrating cancers of a smaller size and earlier stage than in unscreened control groups. Although mammography can detect the majority of breast cancers, there are some that elude detection yet may be palpable. Thus, an important component of screening is physical examination. In addition, although mortality reduction has not been objectively shown, it would seem prudent that breast self-examination should also be encouraged. By definition, mammographic screening involves the performance of standard mammographic projections. These are usually the mediolateral-oblique and craniocaudal views. In some settings, additional images or studies will be undertaken immediately to solve a question raised on a screening image. In other settings, the patient will be recalled for further evaluation to answer a question raised on the screening study.

BREAST EVALUATION

Mammography and other breast imaging techniques such as ultrasound are useful in the evaluation of women who have a sign or symptom that may suggest breast cancer. However, there is no test or group of tests that can ever ensure that a woman does not have breast cancer. Physical examination evaluates different tissue characteristics than mammography and provides a unique set of information concerning the tissues being studied. Just as decisions must be made based on mammographic suspicion in the face of a normal clinical examination, management decisions must be made based on the clinical evaluation in the face of a negative mammogram. While it is a well established fact that mammography does not reveal all breast cancers, some of which may be palpable, a statement indicating diminished

accuracy of mammography in the extremely dense breast is often warranted. However, universal disclaimers are not recommended.

Despite the fact that a biopsy is to be undertaken for a palpable abnormality, mammography is still important to evaluate the area in question as well as to screen the remaining ipsilateral and contralateral breast tissues for clinically occult cancer. It is important for women and physicians to understand that negative screening is not determinative and that any non-cyclic breast change should be brought to the physician's attention regardless of how soon this occurs following a negative breast evaluation.

The ACR Breast Imaging Reporting and Data System is divided into five sections:

SECTION I: BREAST IMAGING LEXICON
SECTION II: REPORTING SYSTEM
SECTION III: FOLLOW-UP AND OUTCOME MONITORING
SECTION IV: ACR NATIONAL MAMMOGRAPHY DATABASE
SECTION V: APPENDICES

The following is a brief summary of each section.

I. BREAST IMAGING LEXICON

Terminology has evolved over many years, and the results have often led to confusion as to their meaning. The descriptive terms that follow are the terms and definitions that have been recommended by the ACR Task Force on Breast Cancer, and it is hoped they will be adopted by all those involved in breast imaging. It is believed that these terms provide a fairly complete categorization of lesions, but if there are any significant substantive changes, they may be submitted to the Task Force on Breast Cancer of the American College of Radiology for review and inclusion if accepted by the Task Force.

II. REPORTING SYSTEM

The reporting system is designed to provide an organized approach to image interpretation and reporting. It does not require a computer system, but the utilization of a computer in reporting is strongly encouraged. Not only does this facilitate reporting, but data are simultaneously collected for the maintenance of the recommended database for future review. This will permit individual radiologists or groups to monitor their own results and appraise accuracy in image interpretation, and adjust thresholds appropriately. There is no ideal computer system, but it is strongly recommended that the system used require a minimum of interaction. The radiologist's attention should be focused on the interpretation of the images. The simplest input utilizes a single screen with minimal interaction needed from the radiologist. The goal is to maximize the image viewing time, and minimize any distractions from the reporting.

REPORT ORGANIZATION

Use of approved terminology is encouraged. This system categorizes the overall composition of the breast and then describes lesions by their basic geometry, border characteristics, and density. Calcifications in the system are described according to size, morphology, and distribution. The findings are then interpreted and an assessment rendered that includes the degree of concern, and any pertinent recommendations. Thus, the breast imaging report should be divided into:

1. BREAST COMPOSITION
2. FINDING(S)
3. OVERALL ASSESSMENT

III. FOLLOW-UP AND OUTCOME MONITORING

This section on the mammography audit describes certain minimum data to be collected and utilized to calculate important derived data which allow each radiologist to assess his or her overall performance in mammography interpretation. In addition to the basic clinically relevant audit, more complete mammography audit data may also be collected and utilized to calculate derived data to provide other important information regarding mammographic performance. Practical examples of everyday situations are presented and then characterized using the statistical definitions included in this section.

IV. ACR NATIONAL MAMMOGRAPHY DATABASE

The maintenance of a database is an important quality assurance element of the ACR BI-RADSTM. Without monitoring the results of screening, it is impossible to know the success of the program. Each group should maintain the suggested data so that the accuracy of the individual screening programs and their success in diagnosing earlier stage breast cancers can be determined. This will allow each group to adjust its thresholds by comparison with pooled national data. This section provides technical information and instructions for collection of extended data for the ACR National Mammography Database. New to the 3rd Edition of BI-RADSTM is a short form for collection of minimal audit data for the ACR National Mammography Database.

I. BREAST IMAGING LEXICON

Terms in parentheses are acceptable, although not as desirable.

A. MASSES

A "MASS" is a space occupying lesion seen in two different projections. If a potential mass is seen in only a single projection it should be called a "DENSITY" until its three-dimensionality is confirmed.

1. SHAPE

a. Round : A mass that is spherical, ball-shaped, circular or globular in shape.
b. Oval : A mass that is elliptical or egg-shaped.
c. Lobular : A mass that has contours with undulations.
d. Irregular : The lesion's shape cannot be characterized by any of the above.

2. MARGINS [These modify the shape of the mass]

a. Circumscribed (Well-Defined or Sharply-Defined) Margins:
The margins are sharply demarcated with an abrupt transition between the lesion and the surrounding tissue. Without additional modifiers there is nothing to suggest infiltration.

b. Microlobulated Margins:
The margins undulate with short cycles producing small undulations.

c. Obscured Margins:
One which is hidden by superimposed or adjacent normal tissue and cannot be assessed any further.

d. Indistinct (Ill Defined) Margins:
The poor definition of the margins raises concern that there may be infiltration by the lesion and this is not likely due to superimposed normal breast tissue.

e. Spiculated Margins:
The lesion is characterized by lines radiating from the margins of a mass.

3. DENSITY [Attenuation]

This is used to define the x-ray attenuation of the lesion relative to the expected attenuation of an equal volume of fibroglandular breast tissue. It is important in that most breast cancers that form a visible mass are of equal or higher density than an equal volume of fibroglandular tissue. It is rare (although not impossible) for breast cancer to be lower in density. Breast cancers are never fat containing (radiolucent) although they may trap fat.

a. High density

b. Equal density (isodense)

c. Low density (lower attenuation, but not fat containing)

d. Fat containing - radiolucent. This includes all lesions containing fat such as an oil cyst, lipoma, or galactocele as well as mixed lesions such as the hamartoma or fibroadenolipoma. [When appropriate, histologic terms may be included]

B. CALCIFICATIONS

Benign calcifications are usually larger than calcifications associated with malignancy. They are usually coarser, often round with smooth margins and are much more easily seen. Calcifications associated with malignancy are usually very small and often require the use of a magnifying glass to see them well.

When a specific etiology cannot be given, a description of calcifications should include the morphology and distribution of the calcifications. Benign calcifications need not always be reported. They should be reported if the interpreting radiologist is concerned that they might be misinterpreted by other observers.

TYPES AND DISTRIBUTION OF CALCIFICATION:

1. TYPICALLY BENIGN -

a. Skin Calcifications: These are typical lucent centered deposits that are pathognomonic. Atypical forms may be confirmed by tangential views to be in the skin.

b. Vascular Calcifications: Parallel tracks, or linear tubular calcifications that are clearly associated with blood vessels.

c. Coarse or ("Popcorn Like") Calcifications: These are the classic calcifications produced by an involuting fibroadenoma.

d. Large Rod-Like Calcifications: These are benign calcifications forming continuous rods that may occasionally be branching, are usually more than 1 mm in diameter, may have lucent centers, if calcium surrounds rather than fills an ectactic duct. These are the kinds of calcifications found in secretory disease, "plasma cell mastitis", and duct ectasia.

e. Round Calcifications: When multiple, they may vary in size. They are usually considered benign and when small [under 1 mm], they frequently are formed in the acini of lobules. When under 0.5 mm the term punctate can be used.

f. Lucent-Centered Calcifications: These are benign calcifications that range from under 1 mm to over a centimeter or more. These deposits have a smooth surfaces, are round or oval, and have a lucent center. The "wall" that is created is thicker than the "rim or eggshell" type of calcifications. Included are areas of fat necrosis, calcified debris in ducts, and occasional fibroadenomas.

g. Eggshell or Rim Calcifications: These are very thin benign calcifications that appear as calcium deposited on the surface of a sphere. These deposits are usually under 1 mm in thickness when viewed on edge. Although fat necrosis can produce these thin deposits, calcifications in the wall of cysts are the most common "rim" calcifications.

h. Milk of Calcium Calcifications: This is consistent with sedimented calcifications in cysts. On the craniocaudal image they are often less evident and appear as fuzzy, round, amorphous deposits while on the 90° lateral, they are sharply defined, semilunar, crescent shaped, curvilinear (concave up), or linear defining the dependent portion of cysts.

i. Suture Calcifications: These represent calcium deposited on suture material. These are relatively common in the post-irradiated breast. They are typically linear or tubular in appearance and knots are frequently visible.

j. Dystrophic Calcifications: These are calcifications that usually form in the irradiated breast or in the breast following trauma. Although irregular in shape, they are usually over 0.5 mm in size. They often have lucent centers.

k. Punctate Calcifications: These are round or oval, less than 0.5 mm with well-defined margins.

2. INTERMEDIATE CONCERN CALCIFICATIONS -

a. Amorphous or Indistinct Calcifications: These are often round or "flake" shaped calcifications that are sufficiently small or hazy in appearance that a more specific morphologic classification cannot be determined.

3. HIGHER PROBABILITY OF MALIGNANCY -

a. Pleomorphic or Heterogeneous Calcifications (Granular): These are usually more conspicuous than the amorphic forms and are neither typically benign (see above) nor typically malignant (see below) irregular calcifications with varying sizes and shapes that are usually less than 0.5 mm in diameter.

b. Fine, Linear or Fine, Linear, Branching (Casting) Calcifications: These are thin, irregular calcifications that appear linear, but are discontinuous and under 0.5 mm in width. Their appearance suggests filling of the lumen of a duct involved irregularly by breast cancer.

4. DISTRIBUTION MODIFIERS -

These are used as modifiers of the basic morphologic description and describe the arrangement of the calcifications. Multiple similar groups may be indicated when there is more than one group of calcifications that are similar in morphology and distribution.

a. Grouped or Clustered [Although historically the term "clustered" has connoted suspicion, the term shall now be used as a neutral distribution modifier and may reflect benign or malignant processes]: Should be used when multiple calcifications occupy a small volume [less than 2 cc] of tissue.

b. Linear: Calcifications arrayed in a line that may have branch points.

c. Segmental: These are worrisome in that their distribution suggests deposits in a duct and its branches raising the possibility of multifocal breast cancer in a lobe or segment of the breast. Although benign causes of segmental calcifications exist such as "secretory disease" this distribution is of greater concern when the morphology of the calcifications is not specifically benign.

d. Regional: These are calcifications scattered in a large volume of breast tissue not necessarily conforming to a duct distribution that are likely benign, but are not everywhere in the breast, and do not fit the other more suspicious categories.

e. Diffuse/Scattered: These are calcifications that are distributed randomly throughout the breast.

Multiple similar groups may be indicated when there is more than one group of calcifications that are similar in morphology and distribution.

C. ARCHITECTURAL DISTORTION

The normal architecture is distorted with no definite mass visible. This includes spiculations radiating from a point, and focal retraction or distortion of the edge of the parenchyma. Architectural distortion can also be an associated finding.

D. SPECIAL CASES

1. Tubular Density/Solitary Dilated Duct: This is a tubular or branching structure that likely represents a dilated or otherwise enlarged duct. If unassociated with other suspicious clinical or mammographic findings it is usually of minor significance.

2. Intramammary Lymph Node: These are typically reniform or have a radiolucent notch due to fat at the hilum and are generally 1 cm. or smaller in size. They may be larger than 1 cm. and normal when fat replacement is pronounced. They may be multiple, or marked fat replacement may cause a single lymph node to look like several rounded masses. This specific diagnosis should be made only for masses in the lateral half and usually upper portion of the breast, although on rare occasions they may be in other areas of the breast.

3. Asymmetric Breast Tissue: Asymmetric breast tissue is judged relative to the corresponding area in the other breast and includes a greater volume of breast tissue, greater density of breast tissue, or more "prominent ducts." There is no focal mass formation, no central density, no distorted architecture, and no associated calcifications. Asymmetric breast tissue usually represents a normal variation, but may be significant when it corresponds to a palpable asymmetry.

4. Focal Asymmetric Density: This is a density that cannot be accurately described using the other shapes. It is visible as asymmetry of tissue density with similar shape on two views, but completely lacking borders and the conspicuity of a true mass. It could represent an island of normal breast, but its lack of specific benign characteristics may warrant further evaluation. Additional imaging may reveal a true mass or significant architectural distortion.

E. ASSOCIATED FINDINGS (Used with masses or calcifications or may stand alone as FINDINGS when no other abnormality is present.)

1. Skin Retraction: The skin is pulled in abnormally.

2. Nipple Retraction: The nipple is pulled in or inverted.

3. Skin Thickening: This may be focal or diffuse.

4. Trabecular Thickening: This is a thickening of the fibrous septae of the breast.

5. Skin Lesion: Commented on when it projects over the breast in two views and may be mistaken for an intramammary lesion.

6. Axillary Adenopathy: Enlarged non-fatty replaced axillary lymph nodes may be commented on. Mammographic assessment of these nodes is unreliable.

7. Architectural Distortion: As an ASSOCIATED FINDING it can be used in conjunction with a FINDING to indicate that the normal tissue structure is distorted or retracted surrounding the FINDING.

8. Calcifications: As an ASSOCIATED FINDING it can be used in conjunction with a FINDING to describe calcifications within or immediately adjacent to the FINDING.

F. LOCATION OF LESION:

A significant lesion must always be triangulated so that its three-dimensional location within the breast is known. This usually requires it to be visible on two mammographic projections. This is more precise if the lesion is visible on orthogonal views. The defined projection views from the ACR Mammography Quality Control Manual, Revised Edition, 1994 (page 82) are reproduced for reference in Appendix A.

The location of the lesion should be described using the clinical orientation extrapolated from the film location. The breast is viewed as the face of a clock with the patient facing the observer. Use of quadrants to describe location is an option. Use of both clockface and quadrant is encouraged. The side is given first, followed by the location and depth of the lesion. Depth divides the breast arbitrarily into anterior, middle and posterior thirds. Immediately beneath the nipple is the subareolar region.

1. Locations: Use clockface preceded by left or right or both for side.

Use upper outer quadrant, upper inner quadrant, lower outer quadrant, and lower inner quadrant.
Use subareolar, central, and axillary tail.

(Subareolar, axillary tail, and central do not require depth. Subareolar, central, and axillary tail do not require clockface location.)

2. Depth: Add Anterior, Middle, and Posterior.

II. REPORTING SYSTEM

A. REPORT ORGANIZATION

The reporting system should be concise and organized using the following structure. A statement indicating that the present examination has been compared to previous mammograms should be included. If this is not included, it should be assumed that no comparison has been made.

1. Breast Composition: A succinct description of the overall breast composition.

This is an overall assessment of the attenuating tissues in the breast to help indicate the relative possibility that a lesion could be hidden by the normal tissues. Generally, this includes fatty, mixed or dense.

Since mammography cannot detect all breast cancers, physical examination is always a key element of screening. It is important to alert the clinician that in the radiographically dense breast the ability of mammography to detect small cancers is reduced. Although mammography is still useful in these women, the physical examination (which is always important) is increased in importance. The available data do not support the use of mammographic patterns for determining screening frequency (i.e., risk for breast cancer).

If an implant is present, it should be stated in the report and an implant description code added as appropriate.

For consistency, breast composition should be included for all patients using the following patterns:

a. The breast is almost entirely fat.
b. There are scattered fibroglandular densities.
c. The breast tissue is heterogeneously dense. This may lower the sensitivity of mammography.
d. The breast tissue is extremely dense, which could obscure a lesion on mammography.

2. Findings

a. A clear description of any significant finding. (It is assumed that most significant findings are new.*)

i. Mass:

Size
Lesion type and modifiers
Associated calcifications
Associated findings
Location
*How changed, if previously present.

ii. Calcifications:

Morphology - type or shape and modifiers
Distribution
Associated findings
Location
*How changed, if previously present.

iii. Architectural Distortion:

Associated calcifications
Associated findings
Location
*How changed, if previously present.

iv. Special Cases:

Associated calcifications
Associated findings
Location
*How changed, if previously present.

The clinical location of the abnormality as extrapolated from the mammographic location (based on the face of a clock and/or quadrant).

b. An overall (summary) impression:

All final impressions should be complete with each lesion fully categorized and qualified. An indeterminate reading should only be given in the screening setting where additional imaging evaluation is recommended before a final opinion can be rendered.

In the screening situation a suggestion for the next course of action should be given if the study is not conclusive (magnification, ultrasound, etc.).

Interpretation is facilitated by recognizing that most mammograms can be categorized under a few headings. These are listed below, and suggested codes are included for computer use.

If a suspicious abnormality is detected, the report should indicate that biopsy should be considered. This is an assessment where the radiologist has sufficient concern that biopsy is warranted unless there are other reasons why the patient and her physician might wish to defer the biopsy.

3. Assessment Categories

a. Assessment Is Incomplete

Category 0 Need Additional Imaging Evaluation:

Finding for which additional imaging evaluation is needed. This is almost always used in a screening situation and should rarely be used after a full imaging work up. A recommendation for additional imaging evaluation includes the use of spot compression, magnification, special mammographic views, ultrasound, etc.

Whenever possible, the present mammogram should be compared to previous studies. The radiologist should use judgment in how vigorously to pursue previous studies.

b. Assessment Is Complete - Final Categories

Category 1 Negative:

There is nothing to comment on. The breasts are symmetrical and no masses, architectural disturbances or suspicious calcifications are present.

Category 2 Benign Finding:

This is also a negative mammogram, but the interpreter may wish to describe a finding. Involuting, calcified fibroadenomas, multiple secretory calcifications, fat containing lesions such as oil cysts, lipomas, galactoceles, and mixed density hamartomas all have characteristic appearances, and may be labeled with confidence. The interpreter might wish to describe intramammary lymph nodes, implants, etc. while still concluding that there is no mammographic evidence of malignancy.

Category 3 Probably Benign Finding - Short Interval Follow-Up Suggested:

A finding placed in this category should have a very high probability of being benign. It is not expected to change over the follow-up interval, but the radiologist would prefer to establish its stability. Data are becoming available that shed light on the efficacy of short interval follow-up. At the present time, most approaches are intuitive. These will likely undergo future modification as more data accrue as to the validity of an approach, the interval required, and the type of findings that should be followed.

Category 4 Suspicious Abnormality - Biopsy Should Be Considered:

These are lesions that do not have the characteristic morphologies of breast cancer but have a definite probability of being malignant. The radiologist has sufficient concern to urge a biopsy. If possible, the relevant probabilities should be cited so that the patient and her physician can make the decision on the ultimate course of action.

Category 5 Highly Suggestive of Malignancy - Appropriate Action Should Be Taken:

These lesions have a high probability of being cancer.

B. WORDING THE REPORT

When available, the present examination should be compared to previous studies, and this should be indicated in the report. Reports should be organized with a brief description of the composition of the breast, any pertinent FINDINGS, followed by the ASSESSMENT with any recommendations. The report should be succinct using terminology from the approved lexicon without embellishment. Definitions and descriptors of the lexicon terms do not appear in the report narrative. Following the impression section of the report, both the assessment category number and the lexicon terminology for the assessment category should be stated. Other aspects of the report data should comply with the ACR Standard on Communication.

III. FOLLOW-UP AND OUTCOME MONITORING

TO MAKE SURE THAT THESE DATA ARE PROTECTED AS PEER REVIEW INFORMATION, RADIOLOGISTS SHOULD CONSULT APPLICABLE STATE LAW AND REGULATIONS.

GLOSSARY OF STATISTICAL TERMS
Following is a glossary of statistical terms that are used for the basic and advanced audit of a mammography practice, both of which follow the glossary:

1. A screening examination is one performed on an asymptomatic woman to detect early, clinically unsuspected breast cancer.

2. A diagnostic mammographic examination is performed on a woman with clinical signs or symptoms that suggest breast cancer. A second type of diagnostic examination is that performed on a woman for whom further mammographic evaluation has been requested because of an abnormal screening mammographic examination. Two other types of special screening examinations, those performed in a woman with a personal history of breast cancer treated with breast conservation and those performed in a woman with breast augmentation, are often defined as diagnostic, but for audit purposes should be included in the screening group.

3. A positive screening mammogram is one for which a recall is initiated (BI-RADSTM category 0) or one that requires a tissue diagnosis without further assessment (BI-RADSTM category 4 and 5).

4. A positive diagnostic mammogram is one that requires a tissue diagnosis (BI-RADSTM category 4 and 5)

5. A negative screening examination is one that is negative or has a benign finding (BI-RADSTM category 1 and 2). Note: Although BI-RADSTM category 3 is negative, it is not included here since this assignment should be made after appropriate work-up of a finding detected at a screening examination, and would be included under negative diagnostic examination.

6. A negative diagnostic examination is one that is negative, has a benign or a probably benign finding (BI-RADSTM category 1, 2, and 3).

7. True Positive (TP): Cancer diagnosed within one year after a biopsy recommendation based on mammographic examination with abnormal findings (BI-RADSTM category 4 and 5).

8. True Negative (TN): No known diagnosis of cancer within one year of a mammographic examination with normal or probably benign findings (BI-RADSTM category 1, 2, and 3).

9. False Negative (FN): Diagnosis of cancer within one year of a mammographic examination with normal or probably benign findings (BI-RADSTM category 1, 2, and 3).

10. False Positive (FP): Three separate definitions:

a. (FP1): No known cancer diagnosis within one year of a positive screening mammographic examination (BI-RADSTM category 0, 4, and 5).

b. (FP2): No known cancer diagnosis within one year after recommendation for biopsy or surgical consultation on the basis of a positive mammographic examination (BI-RADSTM category 4 and 5).

c. (FP3): Benign findings at biopsy within one year after recommendation for biopsy on the basis of a positive mammographic examination (BI-RADSTM category 4 and 5).

Note: TP + TN + FP + FN = Total number of examinations.This note refers to definitions 7, 8, 9, and 10.

11. Positive Predictive Value (PPV): Three separate definitions:

a. (PPV1) (abnormal findings at screening): The percentage of all positive screening examinations (BI-RADSTM category 0, 4, and 5) that result in a diagnosis of cancer. An initial screening assessment of category 4 or 5 is unusual, but is possible.

PPV1 = TP /(number of positive screening exams)
OR
PPV1 = TP/(TP + FP1) [FP1 = see # 10a in glossary]

b. (PPV2) (biopsy recommended): The percentage of all screening or diagnostic cases recommended for biopsy or surgical consultation (BI-RADSTM category 4 and 5) that resulted in the diagnosis of cancer.

PPV2 = TP /(number of screening or diagnostic cases recommended for biopsy)
OR
PPV2 = TP/(TP + FP2) [FP2 = see # 10b in glossary]

c. (PPV3) (biopsy performed): The percentage of all known biopsies done as a result of positive screening or diagnostic examinations or additional imaging evaluations of a positive screening examination (BI-RADSTM category 4 and 5) that resulted in the diagnosis of cancer. PPV3 is also known as the Biopsy Yield of Malignancy or the Positive Biopsy Rate (PBR).

PPV3 = TP /(number of biopsies)
OR
PPV3 = TP/(TP + FP3) [FP3= see # 10c in glossary]

12. Sensitivity: The probability of detecting a cancer when a cancer exists, or the number of cancers diagnosed after being identified at breast imaging examination in a population within one year of their imaging examination, divided by all cancers present in that population in the same time period.

Sensitivity = TP /(TP + FN) [Remember that FN is actually a malignant case]

13. Specificity: The number of mammographically normal cases in a population divided by all normal cases in the population; or the number of true negative mammograms in a population divided by all actual negative cases (those who do not show pathologically proven breast cancer within one year of their screening mammogram) in the population.

Specificity = TN /(FP + TN)

14. Cancer Detection Rate: The number of cancers correctly detected by mammography per 1000 patients examined by mammography.

a) This is of greatest value when calculated for asymptomatic women only.

b) May also be calculated separately for PREVALENT cancers (those found on first-time mammographic examination), and for INCIDENT cancers (those found on subsequent mammographic screening examinations performed at the recommended screening interval).

c) May also be calculated by AGE GROUP (40-49, 50-59, etc.)

15. Abnormal Interpretation Rate: The percentage of patients undergoing screening mammographic examinations who are recommended for prompt further evaluation (coned compression view, magnification views, sonography, etc.). In rare cases a biopsy will be recommended directly from screen. However, one may wish to separate these biopsies and calculate a Recall Rate designed for only additional imaging evaluation.

16. Biopsy: Any procedure that produces a tissue diagnosis, including cytologic analysis, core biopsy, surgical biopsy.

17. Cancer Diagnosis: Tissue diagnosis, not imaging diagnosis.

Figure 1. Detachable References for Biopsy Results

BIOPSY RESULTS

		Positive (Biopsy demonstrated malignancy)	Negative (Biopsy is benign or no cancer discovered within one year)
SCREENING TEST FOR CANCER	**Mammogram positive (BI-RADS™ categories 0,4,5)**	**TP**	**FP**
	Mammogram negative (BI-RADS™ categories 1,2,3)	**FN**	**TN**

Sensitivity = TP/(TP + FN)
Specificity = TN/(TN + FP)
PPV = TP/(TP + FP)

THE BASIC CLINICALLY RELEVANT AUDIT

Certain minimum data should be collected and utilized to calculate important derived data which allow each radiologist to assess his or her overall performance in mammography interpretation. Some of these are now required under the Mammography Quality Standards Act (MQSA).*

Table 1. The basic clinically relevant mammography audit: the core data to be collected and calculated

A. Raw Data

1. Dates of audit period and total number of examinations in that period.
2. Number of screening examinations; number of diagnostic examinations (separate audit statistics should be maintained for each).
3. Number of recommendations for further imaging evaluation (recalls)
   [ACR BI-RADSTM category 0 - "Need Additional Imaging Evaluation"].
4. Number of recommendations for biopsy or surgical consultation
   [ACR BI-RADSTM category 4 -"Suspicious Abnormality" and category 5 - "Highly Suggestive of Malignancy"].*
5. Biopsy results: malignant or benign (keep separate data for fine-needle aspiration/core biopsy cases, and for surgical biopsy cases).*
6. Cancer staging: histologic type, size, nodal status, grade.

B. Derived Data (calculated from the raw data)

1. True-positives (TP)
2. False-positives (FP1, FP2, FP3)
3. Positive predictive value (PPV1, PPV2, PPV3)

   a. In a screening/diagnostic facility, PPV can be defined any of three ways:
      i. PPV1 - based on abnormal findings ("positive" exams) at screening examination (recommendation for recall or biopsy)
         [BI-RADSTM category 0, 4, 5]
      ii. PPV2 - based on recommendation for biopsy or surgical consultation
         [BI-RADSTM category 4, 5]
      iii. PPV3 - based on results of biopsy (otherwise known as positive biopsy rate, or PBR)

   b. If screening exclusively, can define only one way:
      i. PPV1 - based on abnormal findings ("positive" exams) at screening examination (recommendation for recall or biopsy)
         [BI-RADSTM category 0, 4, 5]

4. Cancer detection rate for screening cases
5. Percentage of minimal cancers found (Minimal cancer is defined as invasive cancer <1 cm, or in-situ ductal cancer).
6. Percentage of node-positive invasive cancers found
7. Recall rate for screening cases

* Collection of these data required under MQSA final rules

Collection of these data requires proper coding of the data elements for efficient retrieval, often requiring considerable effort. However, once collected and calculated, these data allow measurement of one's practice outcomes by providing quantifiable evidence in pursuit of the three major goals of screening mammography.

1. Find a high percentage of the cancers that exist in a screening population (measurement: cancer detection rate, sensitivity [if calculable]).
2. Find these cancers within an acceptable range of requests for recall and requests for biopsy, in an effort to minimize cost and morbidity (measurement: recall rate, positive predictive value).
3. Find a high percentage of small and node-negative cancers, which are more likely to be curable (measurement: rates of minimal cancers found, axillary lymph node positivity).

The numbers obtained for each of the data elements above can be compared to desirable goals recommended in Quality Determinants of Mammography Guidelines published in 1994 by the Agency for Healthcare Policy and Research (see Table 2 below) or other published recommendations.

Table 2: Analysis of medical audit data: desirable goals

(Bassett LW, Hendrick RE, Bassford TL, et al. Quality determinants of mammography. Clinical Practice Guideline No. 13. AHCPR Publication No. 95-0632. Rockville, Md: Agency for Health Care Policy and Research, Public Health Service, U.S. Department of Health and Human Services, October 1994: 83)

PPV_1 based on abnormal screening examination	5-10%
PPV_2 when biopsy (surgical, FNA, or core) recommended	25-40%
Tumors found-Stage 0 or 1	>50%
Tumors found-Minimal cancer [1]	>30%
Node positivity	<25%
Cancers found per 1,000 cases	2-10
Prevalent cancers found per 1,000 first-time examinations	6-10
Incident cancers found per 1,000 follow-up examinations	2-4
Recall rate	<10%
Sensitivity (if measurable)	>85%
Specificity (if measurable)	>90%

[1] Minimal cancer is invasive cancer <1 cm or ductal carcinoma in situ

However, due to the statistical variation in the comparatively small numbers collected in any individual practice audit, and the demographic differences in patient populations served by individual practices, such comparison is generally less valid than assessing the trend of one's own performance over time, or assessing this trend in comparison to that of other members of the same practice.

Whether data are being collected for the basic clinically relevant audit, or for the more complete audit as outlined in the next portion of this section, separate audit statistics should be maintained for screening and diagnostic examinations, as many of the audit data (e.g. cancer detection rate) have significance only for the screening (asymptomatic) population.

Biopsy data for FNA/ core biopsy may be kept separate from surgical biopsy results, but should be included as a biopsy with surgical excision for statistical calculations.

All audit data should be monitored for each radiologist and in the aggregate for the institution involved.

TO MAKE SURE THAT THESE DATA ARE PROTECTED AS PEER REVIEW INFORMATION, RADIOLOGISTS SHOULD CONSULT APPLICABLE STATE LAW AND REGULATIONS.

THE MORE COMPLETE MAMMOGRAPHY AUDIT

Although the basic clinically relevant audit provides nearly all the data needed to assess one's progress in reaching the previously stated goals, certain additional audit data may also be collected and utilized to calculate derived data to provide other important information regarding mammographic performance. The following comprise the data for such a complete audit:

Table 3. The more complete mammography audit: data to be collected

1. **Dates of audit and total number of examinations in that period (usually a 12-month period).**
2. Risk factors:
   - Patient's age at the time of the examination
   - Breast cancer history: personal or family (especially premenopausal cancer in first degree relative—mother, sister, or daughter)
   - Hormone replacement therapy
   - Previous biopsy-proved hyperplasia with cellular atypia or lobular carcinoma-in-situ
3. **Number and type of mammograms: screening (asymptomatic) examination, diagnostic (evaluation of symptoms or clinical/screening mammographic signs of breast cancer) examination, or 6 month follow-up examination.** [1]
4. First-time examination, or repeat (routine follow-up or 6-month follow-up) examination
5. Mammographic assessment and recommendation [BI-RADSTM categories]
   - **Further imaging evaluation (recall) [BI-RADS™ Category 0 = "Need additional imaging evaluation**
   - Routine follow-up [BI-RADSTM Category 1 = Negative and Category 2 = "Benign Finding"]
   - Short interval follow-up [BI-RADSTM Category 3 = "Probably Benign Finding"]
   - **Biopsy should be considered [BI-RADS™ Category 4 = "Suspicious Abnormality"]***
   - **Appropriate action should be taken [BI-RADS™ Category 5 = "Highly Suggestive of Malignancy"] ***
6. **Biopsy results: Benign or malignant (keep separate data for fine needle aspiration, core biopsy cases, and for surgical biopsy cases) ***
7. Cancer data:
   - Mammographic findings: mass, calcifications, indirect signs of malignancy, no mammographic signs of malignancy
   - **Palpable or impalpable tumor**
   - **Cancer staging (pathologic): histologic type (ductal [in situ or invasive] or lobular [invasive only]), size, nodal status, and grade (when available)**

Note: Bolded items indicate data desired for the basic clinically relevant mammography audit.

* Collection of these data required under the MQSA.

[1] Separate audit statistics should be maintained for screening examinations, diagnostic examinations, and 6-month follow-up examinations.

Table 4. The more complete mammography audit: derived data to be calculated

1. **True positives, false positives (three sub-definitions: FP1, FP2, FP3),** true negatives, false negatives
2. Sensitivity
3. **Positive Predictive Value**
   - **PPV1 - based on abnormal findings ("positive" exams) at screening examination (recommendation for recall or biopsy)**
     [BI-RADSTM category 0, 4, 5]
   - **PPV2 - based on recommendation for biopsy or surgical consultation**
     [BI-RADSTM category 4, 5]
   - **PPV3 - based on results of biopsy (otherwise known as positive biopsy rate, or PBR)**
4. Specificity
5. Cancer detection rate
   - **Cancer detection rate for screening cases**
   - Prevalent vs. incident
   - Overall
   - Rates within various age groups
6. **Percentage of minimal cancers found** (minimal cancers are invasive cancers < 1 cm, or in-situ ductal cancers)
7. **Percentage of node positive invasive cancers found**
8. **Recall rate for screening cases**

Note: Bolded items indicate data desired for the basic clinically relevant mammography audit.

AUDIT EXAMPLES

1. Woman has a screening mammogram that is read as negative and no cancer is diagnosed within one year of the exam.

   The mammogram is negative and since no cancer is diagnosed within the year, it is a true negative (TN).

2. Woman has a screening mammogram and is recalled for a finding. The diagnostic mammogram leads to a biopsy. The biopsy is benign.

   The screening mammogram is positive (BI-RADS™ Category 0). The diagnostic mammogram is positive (BI-RADSTM Category 4 or 5). Both the screening and diagnostic mammograms are false positives (FP) since no cancer is diagnosed within the year.

3. Woman has a screening mammogram for which a benign calcified fibroadenoma is described (BI-RADS™ Category 2). A palpable mass develops within a year and is biopsied, and is malignant.

   The screening mammogram is negative. However since malignancy is diagnosed within the year, it is a false negative (FN).

4. Woman enters for mammography because of a clinically suspicious area. The mammogram is read as probably benign (BI-RADS™ Category 3). The area of clinical suspicion is biopsied within one year and is malignant.

   The diagnostic mammogram is negative (BI-RADS™ Category 3). Since malignancy was found within the year, it is a false negative (FN).

   Please note the scientific literature which justifies mammographic surveillance for "probably benign" lesions, exclude palpable lesions from this assessment category.

5. Woman has a screening mammogram and is recalled (BI-RADS™ Category 0). The diagnostic mammogram is read as probably benign, short interval follow-up recommended (BI-RADS™ Category 3). At 6 months, the second diagnostic mammogram shows a change and the area is biopsied (BI-RADSTM Category 4). Malignancy is found.

   The screening mammogram is positive (BI-RADS™ Category 0). The first diagnostic mammogram is negative (BI-RADS™ Category 3). The second 6 month diagnostic mammogram is positive (BI-RADS™ Category 4 or 5). Malignancy is diagnosed within the year. Thus the screening exam is a true positive (TP), the diagnostic mammogram is a false negative (FN), and the second diagnostic mammogram is a true positive (TP).

6. Woman has a screening mammogram and is recalled (BI-RADS™ Category 0). The diagnostic mammogram recommends short term follow-up (BI-RADS™ Category 3). The second diagnostic mammogram at 6 months shows change (BI-RADS™ Category 4). Surgery is done and shows no evidence of malignancy.

   The screening mammogram is positive, the immediate diagnostic mammogram is negative and the 6 month diagnostic mammogram is positive. Since no malignancy is found the screening mammogram is false positive (FP), the immediate diagnostic mammogram is a true negative (TN) and the second diagnostic mammogram is a false positive (FP).

7. Woman presents with a palpable mass on the left. The diagnostic mammogram report recommends biopsy on the right. Both the palpable mass and mammographic findings are biopsied. The palpable mass is benign, the mammographic finding is malignant.

   The diagnostic mammogram is positive (BI-RADS™ Category 4 or 5) and malignancy is found on side of mammographic abnormality. The diagnostic exam is a TP and the radiologist interpreting the mammogram is credited.

8. Woman presents with a palpable mass on the left. The diagnostic mammogram is read as suspicious on the right. The palpable mass is biopsied and is malignant. The mammographic finding is biopsied and is benign.

   The diagnostic mammogram is positive. However, although malignancy is found, it is on the contralateral side of clinical concern. Thus this diagnostic mammogram is a FP but should also be counted as a false negative in two separate calculations.

9. Woman enters for a screening mammogram and is read as negative by Dr. A. She returns in 10 months for her "annual" screening mammogram. Dr. B. reads this exam as requiring a biopsy. Malignancy is diagnosed by biopsy within 12 months of the initial screening mammogram.

   The initial screening exam read by Dr. A. is a FN and the second "screen" read by Dr. B. is a TP, since malignancy is diagnosed within the year.

10. Woman enters for a screening mammogram. Dr. A. interprets the exam as negative. A second reader Dr. B. recommends a biopsy. The biopsy is benign.

    The screening exam should be calculated both as a TN and then as a FP. Dr. A.'s interpretation is a TN and Dr. B.'s is a FP.

AREAS OF CONFUSION IN THE DATA COLLECTION PROCESS

1. Double reading:

Which reader gets "credit" for interpreted cases?

A workable solution is to designate a primary and a secondary reader for every case, and then keep separate statistics for each type of reader. Therefore, if both successfully identify a cancer independently, each receives appropriate "credit," either in the "primary reader" category, or the "secondary reader" category. This solution requires the double readers to interpret independently and to initially record their impressions separately.

2. The "screener" versus the "further work-up" person:

If two different radiologists within a group are involved in these two separate activities for the same case, who gets "credit" for finding a cancer when it is correctly identified?

Since the person in charge of the "further work-up" of a screening-detected abnormality is the one who ultimately makes the decision on whether or not to send the patient to biopsy, that person should receive "primary credit."

However, since the "screener" detected the lesion initially, that person should also receive "credit." This can be accomplished by keeping separate statistics for the screener, thus documenting differences in the recommendations of screener and the work-up person, as well as situations when both recommendations are in agreement. For example, consider the following scenario: The screener detects a lesion as suspicious, and suggests further work-up. The work-up then is performed by a second individual, who finds no features of cancer and returns the patient to routine screening. A cancer then appears clinically within one year in the area of suspicion noted on the screening examination. Here, the original screener should be credited with a TP, and the work-up person who did not consider

the same lesion suspicious enough for biopsy should be charged with a FN. Proper assignment of "credit" can only be made by separating the individual screening and work-up statistics.

This question focuses our attention on the distinction between screening (perception of the lesion) and diagnosis (analysis of the lesion). These activities require vastly different skills, so it is altogether fitting that the measurements of success of these two activities be evaluated separately in the situation described above. We are in fact presented with a unique opportunity to distinguish between the skill levels in both screening and diagnosis for the individual radiologists involved, and to assess their relative strengths and weaknesses in both areas. In actuality, we are already separating screening skills from diagnostic ones when we calculate PPV1 (PPV for lesions detected at screening) versus PPV2 or PPV3 (PPV for lesions deemed worthy of biopsy after complete diagnostic evaluation).

3. **Cancer found on routine subsequent screening examination with cancer diagnosis LESS THAN ONE YEAR since the last normal screening examination:**

Is the person who "missed" it on the last normal examination charged with a FN, or is the person who detected it at the "early" routine screening examination credited with a TP?

For purposes of the audits of the two individuals involved, each should receive "credit," one for a FN, and the other for a TP.

4. **The group of patients being followed after having been placed in BI-RADSTM Category 3 (Probably Benign Finding-Short interval [6 month] follow-up) on their previous examination:**

Should they be separately audited?

If these data are available, as in the more complete audit (see Table 2), then category 3 patients, those returning for 6 month follow-up, should be evaluated as a separate category from those patients returning for routine screening, and those being evaluated for a clinical problem with a diagnostic study. Indeed, it would be of great value to establish whether those cases being placed in this extremely important "probably benign" category do continue to demonstrate benign findings. If too many (i.e., > 2%) of these lesions are found subsequently to be malignant, which would indicate incorrect assignment of truly suspicious findings as being probably benign, then such a trend could only be easily identified through a separate "category 3" audit. Only then could appropriate action be taken to modify the criteria being used to assign lesions to this category by the radiologist involved

Remember:
BI-RADSTM categories 0, 4 and 5 are positive mammograms; while BI-RADSTM categories 1,2, and 3 are negative. True or false final outcomes depend on whether malignancy is discovered within the year.

IV. NATIONAL MAMMOGRAPHY DATABASE (NMD)

The American College of Radiology's National Mammography Database (NMD) is a national comparative database of mammography reporting information for breast imaging facilities, regions and states. Mammography reporting information from individual practices will form the basis for a national mammography audit to analyze medical audit data from practices using the uniform terminology and format of the BI-RADS™ lexicon.

Building on a long and comprehensive effort of mammography quality assurance, the ACR seeks to improve the measurement of mammography performance through technical and interpretive practice. The National Mammography Database is an educational, nationwide quality assurance tool for radiologists. The overall goal for establishing the NMD is the improvement of mammography quality.

The technical objective is to establish a quality database in terms of design, conformance, and performance to assess mammography screening in the United States by promoting standardized reporting and data exchange. Potential benefits of the NMD are improvement in interpretive skills of individual radiologists through collection, review and comparison of their practice data with similar practices. Another advantage of the NMD is that the success or failure of the screening program to detect occult cancers at the expected rate could be evaluated and compared with regional and national norms.

You can find more information about NMD on the Web at:

http://home.earthlink.net/~rowberg/nmd or e-mail us at nmd@acr.org.