VALIDITY OF BI-RADS SYSTEM MAMMOGRAPHY IN DETECTING BREAST CANCER AT KENYATTA NATIONAL HOSPITAL

A dissertation submitted in part fulfillment for the degree of:

MASTER OF MEDICINE IN DIAGNOSTIC RADIOLOGY

UNIVERSITY OF NAIROBI

BY

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DECLARATION

I, **Dr Leena Samay Singh**, declare that the work contained herein is my original idea and has not been presented at any other place to the best of my knowledge.

Signature:…………..…………..   Date:……………………

APPROVAL BY SUPERVISORS:

This dissertation has been submitted for examination with my approval as a University supervisor.

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<u>DEDICATION</u>

Dedicated to my family; Papa, Mum, Amma, Nanagaru, Bethune, Shalu, Hanu and Little Deetya.

Your encouragement, patience and support in all manners, big and small, helped me reach here.

Thank you.

ACKNOWLEDGEMENT

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ABBREVIATIONS

ACR   American College of Radiology

BI-RADS   Breast Imaging-Reporting and Data System

CC   Cranio-Caudal

DCIS   Ductal Carcinoma In-Situ

FNA   Fine Needle Aspiration

FNAC   Fine Needle Aspiration Cytology

K.N. H   Kenyatta National Hospital

MLO   Medio-Lateral Oblique

MRI   Magnetic Resonance Imaging

QA   Quality Assurance

QC   Quality Control

TDLU   Terminal ductal Lobular units

UoN   University of Nairobi

ABSTRACT

INTRODUCTION: In Kenya, breast cancer is the most common cancer reported among women at 17.5%[1]. In Nairobi, the incidence among women was reported at 23.3%, among all cancers for the period 2000-2002[2].

The diagnosis of breast cancer may be established by the physical and imaging examinations, but the definitive diagnosis is ascertained by morphologic study (histopathology or cytology).

Within the various imaging modalities, mammography is an easy, non-invasive imaging method to detect breast cancer with good accuracy[3]. Previous studies done in Kenya concluded that the radiological accuracy of mammography in detection of breast cancer is high[3], and another probed the usefulness of mammography in the investigation of symptomatic patients less than 30 years of age[4]. However, it was found that the mammographic reports were not standardized, lacked uniformity and there was inconsistent use of imaging terminology. Also there was no mandate to provide further patient management recommendations based on imaging findings[5]. Keeping this in mind, in 1993 the American College of Radiology (ACR) first developed the Breast Imaging-Reporting and Data System (BI-RADS), in an effort to provide a quality assurance tool that would standardize mammographic reporting, facilitate outcome monitoring and reduce the ambiguity surrounding breast imaging reports[5]. This study was done to assess the accuracy of the ACR BI-RADS categories in detecting breast cancer in Kenyatta National Hospital.

OBJECTIVE: To classify mammographic lesions using BI-RADS and correlate with morphologic findings (on histology or cytology), so as to know the sensitivity, specificity, positive and negative predictive values of the system in diagnosing breast cancer.

STUDY DESIGN: Cross-sectional descriptive study

METHODOLOGY: Mammographic examination was carried out on all patients referred for the same to KNH Radiology Department. Films were reported and classified according to BI-RADS morphological descriptors. Those that were BI-RADS categories 4 and 5 required to have a morphologic follow up underwent the same, either via fine needle aspiration (FNA) or biopsy (core-biopsy or excision-biopsy). Mammographic BI-RADS and histopathology or cytology reports were recorded in data collection forms. Data entry and statistical analysis was carried out using microcomputer SPSS/PC+ program.

RESULTS: A total of 64 patients were studied. They were all female, with ages between 23 and 80 years. The mean age was 47.5 years with a standard deviation of 11.1. Carcinoma was present in all of the 64 lesions (100%). Of these lesions, a BI-RADS final assessment category was 3 in one lesion (1.6%), category 4 in 26 (40.5%), category 5 in 28(43.8%) and category 6 in 9(14.1%). While no benign or risk lesions were identified on histopathology, the single BI-RADS 3 lesion yielded a high sensitivity of 98.4%. In this study, the features with the highest predictive value for carcinoma were ovoid shape (46%), spiculated margins (64%), suspicious calcifications (75%) and focal asymmetry (89%). The most common histopathological type of malignancy was infiltrating ductal carcinoma (85.9%)

CONCLUSION: Categorization of mammographic morphological descriptors into BI-RADS has a high accuracy in predicting the likelihood of cancer.

RECOMMENDATION: All radiologists involved with breast imaging should use the standardized BI-RADS lexicon. There should be further education of referring physicians about the BI-RADS assessment categories and the correlation between the various categories and outcome so that tissue diagnosis is reserved for those lesions that are indeterminate (BI-RADS category 4) or highly suggestive of malignancy (BI-RADS category 5). A

short interval follow up of patients categorized BI-RADS 3 as a means of surveillance of malignancy is also recommended.

INTRODUCTION

Breast cancer is the most common cancer in women worldwide, representing 22.9% of all female cancers[1]. In Kenya, it is the commonest cancer in women, at an incidence of 17.5%[1]. Breast cancer is strongly related to age with only 5% of all breast cancers occurring in women under 40 years old[9]. In 2004, breast cancer caused 519,000 deaths worldwide (7% of cancer deaths; almost 1% of all deaths) [8]. In the Kenyan setting, with the lack of a screening program, the deaths are mostly due to late diagnosis and treatment.

The diagnosis of breast cancer is established through a combination of medical history and physical examination, imaging through mammography, ultrasonography and MRI, with the gold standard being a histological specimen diagnosis. Mammography is a common procedure for breast cancer screening because of its capability to detect the presence of cancer in an asymptomatic population. It is also the first choice of investigation in the age group of 40years and above. Coincidentally, this is also the age that breast cancer commonly occurs in.

Mammography involves the use of specialized x-rays, which are of a low kilo- voltage (kV), which helps in the better soft tissue differentiation of the breast. This necessitates the use of a specialized x-ray unit (mammographic unit).

The reporting of the mammogram needs a darkened room with dark filters on the view-box to block out unnecessary light. These measures ensure the reporting of an image with better contrast. Also additional equipment such as a magnifying glass will be utilized to scrutinize the images better.

The format of the mammographic report however was not standardized. The diversity in the readings of the mammograms themselves used to result in doubts on the findings, interpretation and recommendation of breast

cancer management. In many instances, reports could not be clearly categorized as either positive or negative.

When the ACR BI-RADS was introduced in 1993, it was lauded for providing a standardized lexicon and reporting format. This system allowed the radiologist to relate the degree of concern for malignancy through a concise description, using approved terminology and to give clear management recommendations.

There have been multiple studies done elsewhere demonstrating that the ACR-BIRADS assessment categories and lexicon have good correlation with the risk of breast malignancy. In 2008, Lehman CD et al found that in community practice, patient and lesion mammographic characteristics can be predictive of the likelihood of a subsequent cancer diagnosis of mammographic lesions designated as probably benign[10]. In June 1999, Orel et al found that placing mammographic lesions into BI-RADS categories is useful for predicting the presence of malignancy[7]. In 2002, Berg et al found that BI-RADS training resulted in improved agreement with the consensus of experienced breast imagers for feature analysis and final assessment[11].

However the validity of this system of breast mammographic image reporting with respect to morphological correlation (via histopathology or cytology) has not been evaluated at KNH. This is the intended focus of the study.

BREAST ANATOMY

The breast lies between the pectoralis major muscle and skin on the anterior chest wall. It is a hemi-spherical structure with an axillary tail. It consists of fat and a variable amount of glandular tissue. The pigmented area and its position is variable, but usually over the 4th intercostal space in the non-pendulous breast.

The internal structure of the breast is arranged in 15-20 lobes, each of which is drained by a single major lactiferous duct that opens on to the nipple.

The main duct branches repeatedly within the breast. The most distal branches of the duct system are called the terminal ducts. The terminal ducts consist of extra-lobular and intra-lobular portions. The acinus (pleural acini) is the blind ending saccule into which milk is secreted during lactation. The intra-lobular portion along with the acini forms a lobule.

The extra-lobular terminal duct and the lobule form the terminal ductal lobular unit (TDLU). The TDLU is the site of origin of most malignant and benign diseases of the breast.

Besides these glandular structures, the rest of the breast is made up of stromal tissue. This in turn is constituted by fat surrounding parenchyma and fibrous framework of the breast (Cooper's ligaments).

The relative abundance of parenchyma and stroma varies according to:
- age
- parity
- lactation
- hormonal status

Figure 1[(15)] – Breast Anatomy
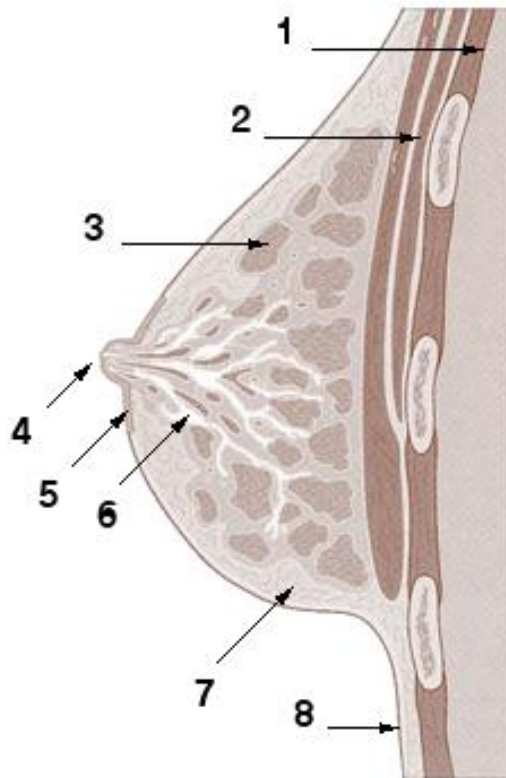
1	Rib cage – intercostal muscle
2	Pectoral muscle
3	TDLU
4	Nipple
5	Areola
6	Lactiferous duct
7	Fat
8	Chest wall

AGE/PARITY/LACTATION- RELATED CHANGES:

- During adolescence, the growing breast becomes increasingly glandular
- During pregnancy and breast-feeding, the number of acini increase with glandular tissue predominating
- When lactation stops, the glandular tissue involutes so that the breast is even less glandular than it was prior to the pregnancy. Therefore the breast of a parous woman is even less glandular than that of a nulliparous woman of the same age.
- Apart from the situation during pregnancy and lactation, parenchymal atrophy starts in early adulthood and is accelerated at menopause, with diminishing amounts of glandular tissue and an increasing amount of fat.

MAMMOGRAPHIC PATTERNS

The mammographic pattern depends on the relative composition of ductal, fatty and fibrous or glandular tissue in the breast.

Normal ducts are seen radiating out from the nipple and may be seen centrally if dilated. They increase in caliber as they converge on to the nipple.

When fat predominates (as in late adulthood) the ducts may be seen. When fibrous and glandular tissue predominate, the ducts are difficult to see

Blood vessels may be seen even on the normal mammogram and are distinguished from ducts as they run more haphazardly through the breast and have a more uniform caliber

Other normal structures visible on the mammogram include skin, Cooper's ligaments (suspensory ligaments) and pectoral muscles.

Figure 2[16] – Mammography procedure, x-ray picture and correlate
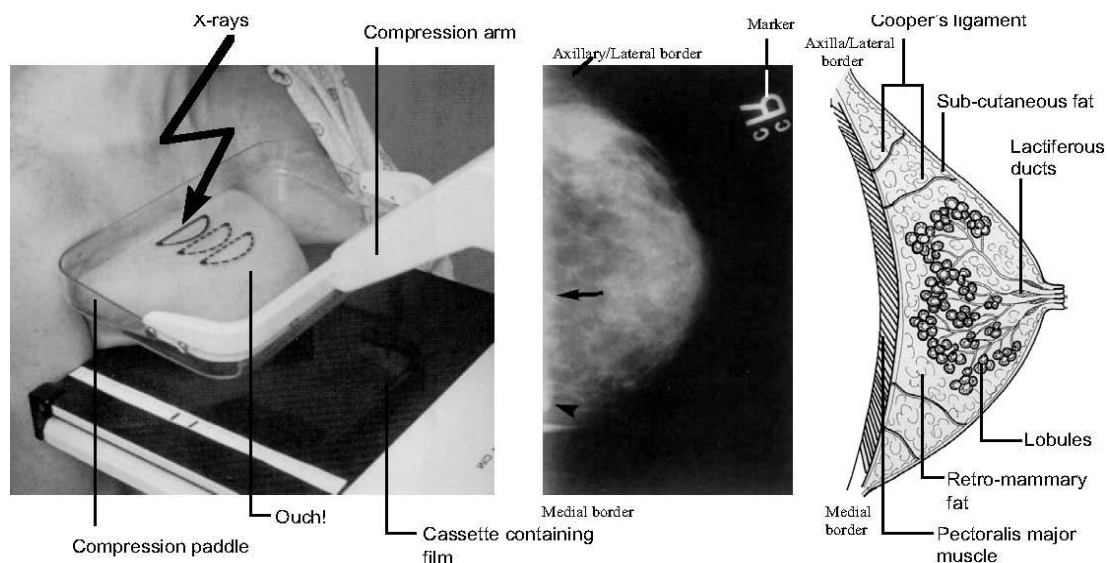
PATHOLOGY

In mammography, non-standard reporting and inconsistent use of imaging terminology lead to the ambiguity of the breast imaging report.

However, since the introduction of the Breast Imaging-Reporting and Data System by the ACR, a more concise report with standardized and approved terminology is achievable.

According to the BI-RAD system, a standard mammographic report should include:

A. **Clinical history**
B. **Indication for the examination**
C. **Comparison with previous studies (if deemed necessary)**
D. **Breast composition**
E. **Findings on the mammogram**
F. **Overall assessment and management recommendation**

A. **CLINICAL HISTORY :**

Clinical history includes in the least; the age of the patient, chief complaints of the patient and duration of symptoms. Additional information such as history of breast surgery and family history of breast cancer is also useful.

B. **INDICATION:**

This may be either a screening or a diagnostic evaluation. Screening is when the mammography is performed on asymptomatic women in order to detect early, clinically unsuspected breast cancer. Diagnostic mammography is one that is done on a woman who presents with clinical signs and symptoms. In Kenya, there is no

screening program set up, so most often it is the symptomatic woman who undergoes mammography.

C. **COMPARISON WITH PREVIOUS STUDIES (IF DEEMED NECESSARY)**

If previous breast imaging has been carried out, these are also assessed using BI-RADS and included in the current report.

D. **BREAST COMPOSITION**

Breast composition: this may be

- fatty
- scattered fibroglandular
- heterogeneously dense
- extremely dense

When the breast tissue is either heterogeneously dense or extremely dense, mammography has relatively low accuracy and a disclaimer statement can be added to the report regarding the decreased sensitivity of the study[5].

E. **MAMMOGRAPHIC FINDINGS**

These are described in terms of:

1. Mass lesion
2. Asymmetry
3. Calcification
4. Associated findings (such as architectural distortion, skin retraction, skin thickening, nipple retraction, trabecular thickening and axillary lymph nodes)

1. **Mass Lesion**

This is a space occupying lesion, seen in 2 different projections

It can be further characterized by:

1.01   <u>Shape</u>

a. Round

b. Oval

c. Lobular

d. Irregular

1.02   Margins

a. Obscured

b. Indistinct (ill-defined)

c. Spiculated (radiating, sharp edged)

d. Micro-lobulated

e. Circumscribed (well-defined, or sharply defined)

1.03   Density(describes the x-ray attenuation pattern of the lesion relative to expected attenuation of surrounding fibro-glandular tissue)

a. High-density

b. Equal density

c. Low-density/ fat-containing

2. **Asymmetry**

This may be a potential mass, but seen only in a single projection.

It is planar, and lacks convex borders

It usually contains interspersed fat

Asymmetry can be characterized as global or focal;

2.01   – Global asymmetry

- Involves at least a quadrant of the breast.

- Can be judged by comparison to a corresponding area on the contralateral breast.

- There is **NO** mass, distorted architecture or associated suspicious calcification.

2.02 – <u>Focal asymmetry</u>
- this is a confined asymmetry
- lacks borders and conspicuity of a true mass

3. **<u>Calcifications</u>**

These can be described by their;
- size
- morphology
- distribution

3.02 – <u>Morphology</u>

a. Benign morphology descriptors include
- large round calcification(>1mm)
- dermal
- vascular
- coarse
- rod-like
- lucent center
- egg-shell/ rim
- milk of calcium (sedimented calcification in cysts)
- sutural calcification
- dystrophic (as that seen in the post-irradiated breast or post-traumatic.)

b. Intermediate morphology
- smaller (<1mm)
- amorphous
- indistinct
- clustered

c. Suspicious

- punctate (<0.5mm)

- fine, pleomorphic

- fine, linear

- fine, linear branching

3.03 – Distribution of calcification

a. Grouped / clustered (when at least 5 calcifications occupy a small volume -1cc of tissue)

b. Segmental

c. Regional

d. Diffuse/Scattered

4. **Associated findings**

These may occur in conjunction with masses, asymmetries or calcifications or may be stand-alone findings.

They include;

a. Architectural distortion

b. Skin/nipple retraction

c. Trabecular thickening

d. Skin lesions

e. Axillary lymph-nodes

4.01 – Architectural Distortion

Term used when normal breast tissue architecture is distorted but there is no definite mass

It is seen in the form of:

- Spiculations radiating from a point, or

- Focal retraction, or

- Focal distortion of edges of parenchyma

F. <u>**OVERALL MAMMOGRAPHIC ASSESSMENT AND MANAGEMENT RECOMMENDATIONS :**</u>

<u>**ACR BI-RADS FINAL ASSESSMENT CATEGORIES**</u>

BI-RADS categories	Assessment	Clinical management
0	INCOMPLETE	Additional mammographic views, comparison films, ultrasound or MRI are required. Once additional studies are completed, a final assessment can be formed.
1	NEGATIVE	Completely negative exam, no significant lesions, masses, architectural distortion, suspicious calcifications etc. Normal interval follow-up
2	BENIGN FINDING	Normal assessment. Benign lesion present that carries no malignant potential and requires no intervention. Normal interval follow-up.
3	PROBABLY BENIGN FINDING	Almost certainly benign lesion, carries <2% risk of malignancy Biopsy not required Short interval follow up (<1 year)
4	SUSPICIOUS ABNORMALITY	Some form of intervention is required, either aspiration or biopsy 4A- low suspicion for malignancy 4B – Intermediate probability for malignancy, only truly benign if both radiological and pathologic follow up are benign

		4C – Moderate concern for malignancy, but lesion is not classic for cancer, a malignant result is expected on biopsy
5	HIGHLY SUGGESTIVE OF MALIGNANCY	Almost certainly malignant, >95% probability of cancer Classic characteristics for cancer Percutaneous tissue sampling required for oncologic management
6	KNOWN BIOPSY PROVEN MALIGNANCY	Breast findings already proven by biopsy to be cancer but pending definitive treatment Appropriate for patients seeking a second opinion, monitoring responses to neo-adjuvant chemotherapy or for patients who require further staging.

CHALLENGES WITH CYTOLOGY AND HISTOLOGY OF BREAST LESIONS

Fine needle aspiration cytology (FNAC) is the study of cellular samples obtained through a fine needle under negative pressure.Core needle biopsy, also known as wide-core needle biopsy or cutting core biopsy, involves the use of a large-bore needle to remove a piece of tissue. FNA cytology and core biopsy were originally used to diagnose palpable breast lesions. Both methods have a high degree of sensitivity and specificity. FNA cytology is an excellent method for diagnosing palpable lesions; its sensitivity has been reported to be between 89% and 98%[19] and its specificity between 98% and 100%[20].

In the setting of mammographic screening, FNA cytology and core biopsy are now also used to diagnose impalpable breast lesions.The sensitivity and specificity of stereotactic FNA cytology with impalpable lesions have been reported to be 77–100% and 91–100% respectively[20].

FNA cytology and core biopsy are complementary procedures[20, 21].

INDICATIONS FOR THE USE OF FNA[22]:

FNA cytology may be indicated in the following clinical situations:

- Investigation of palpable masses, regardless of whether they are considered benign or malignant
- Investigation of impalpable image-detected masses that are considered likely to be benign or with typically malignant features
- Investigation of suspected local recurrence of breast cancer, as suggested by the presence of palpable masses, impalpable image-detected masses, or lymph node involvement
- Evaluation of cystic lesions with atypical imaging features
- Confirmation of a diagnosis of breast cancer when core biopsy is not available, not possible or contraindicated.

INDICATIONS FOR CORE BIOPSY[22]:

Core biopsy may be indicated in the following clinical situations:

- Investigation of lesions with suspicious features identified on imaging that cannot be identified on ultrasound
- Further evaluation of a benign cytological pattern in the presence of a suspicious lesion on imaging
- Further evaluation of a lesion for which cytology results are atypical or suspicious
- When a single surgical procedure is the desired outcome (for example wide excision and axillary dissection).
- Evaluation of microcalcifications that are radiologically indeterminate, suspicious or typically malignant. In such cases core biopsies should be radiographed prior to histological processing to confirm adequate sampling of the lesion
- Evaluation of suspicious architectural distortion at a site of previous

malignancy

- Evaluation of an area that has been treated with radiation.

The **decision** to use either FNA cytology, core biopsy or both will be influenced by various factors, which may include the following:

- the size of the lesion

- the clinical characteristics of palpable lesions

- the characteristics of the lesion identified on imaging, eg mass, architectural distortion, asymmetric density, microcalcifications.

The **relative advantages** of FNA cytology, compared with core biopsy, include:

- the sampling procedure for FNA cytology is quicker to perform

- in most instances FNA cytology does not require local anaesthetic

- FNA cytology is generally less traumatic than core biopsy

- FNA cytology is associated with a low complication rate

The **relative disadvantages** of FNA cytology include:

- It requires training and expertise in the preparation of quality smears and interpretation of cytology

- FNA cytology is generally inappropriate for the assessment of microcalcifications

- it does not enable the pathologist to distinguish between DCIS (Ductal Carcinoma in-situ) and invasive carcinoma

- Definitive diagnosis of some lesions can be difficult to make on the basis of FNA cytology.These include atypical ductal hyperplasia

(ADH), low- grade DCIS, some tubular carcinomas and some invasive lobular carcinomas.

- FNA cytology may not be the sampling technique of choice for lesions that are relatively hypocellular.These include sclerotic fibroadenomas, sclerosing ductal carcinoma, and infiltrating lobular carcinoma.

The **relative advantages** of core biopsyinclude:

- It is the investigation of choice in the evaluation of microcalcifications[23]

- Core biopsy can be used when FNA cytology fails to correlate with clinical findings or imaging studies

- Core biopsy yields tissue fragments allowing architectural features of the lesion to be identified to determine whether DCIS or invasive carcinoma is present

- Core biopsy is useful in the evaluation of lesions likely to be low histological grade and in those presenting as architectural distortions, for which FNA cytology may fail or has failed to provide a diagnosis

- Tissue is usually available for adjunctive tests (Hormone Receptor)

Potential disadvantages of core biopsy include:

- The reliability of core biopsy depends on the skill of the operator

- False negatives may result from a 'clear miss', that is, the lesion not being sampled

- It is not always possible to immediately assess the adequacy of core biopsy performed for a mass lesion or architectural distortion.

- Compared with FNA cytology, core biopsy is associated with an

increased risk of complications, including haematoma, hemorrhage and needle tract implantation of tumor cells. These are more likely to occur if a large number of core biopsies are performed

- Core biopsy requires the use of a local anesthetic

- The mammographic lesion may not be identified in subsequent open biopsy, due to complete removal of the lesion or in the presence of inflammation and fibrosis due to biopsy.

- Core biopsy may interfere with the interpretation of the subsequent excision biopsy, particularly with grading and the estimation of the size of the lesion.This is particularly relevant in the case of small lesions

- Core biopsy requires adequate fixation and processing.

- It is generally more expensive than FNA cytology.

COMPLICATIONS OF FNA CYTOLOGY AND CORE BIOPSY

COMPLICATION		STRATEGY TO MINIMISE/AVOID
Pain	Discomfort is common but pain is typically minimal	Can be minimized by: - fully explaining procedure - using local anesthetic, as required with FNA and routinely with core biopsy - using analgesics
Bruising	Minimal bruising is common	This may be difficult to avoid entirely, especially in older women
Haematoma	Uncommon. (history of anticoagulant use is important)	Can be minimized by compressing biopsy site in between sampling and at completion of the procedure.
Infection	Rare	Can be avoided by careful skin cleansing and by use of sterile disposable items and equipment
Pneumothorax	Rare but	Can be avoided by taking care

serious complication. Risk is increased in thin women or if lesion is close to chest wall.	not to angle sampling needle towards chest wall, but rather parallel to it.
POTENTIAL COMPLICATIONS	
Needle tract implantation	Fragments of breast carcinoma implanting in the needle tract, especially after using large bore needles (like those in core biopsies)
Displacement of epithelium	Displacement of benign or malignant epithelium into other structures like stroma, other ducts, skin, vascular or lymphatic spaces, may have diagnostic or therapeutic implication. Again this is more common with the larger gauge needles.

OBJECTIVES

GENERAL OBJECTIVE

To determine the accuracy of BI-RAD system mammography in detecting breast cancer in KNH.

SPECIFIC OBJECTIVES

- ➢ Assess patterns of breast disease in patients presenting at KNH for mammography
- ➢ Compare and contrast findings of breast lesions in BI-RADS categories 4, 5 and 6 with histopathology and/or cytology.
- ➢ Additional factors that will be compared are
  - ▪ Age
  - ▪ Parity
  - ▪ Family history

STUDY JUSTIFICATION

- The diagnosis of breast cancer can be established through physical examination, sonography and mammography with the gold standard being histology to reach a definitive diagnosis

- Mammography is a common first line imaging modality for breast cancer screening because of its capability to detect the presence of cancer in asymptomatic women.

- Mammography is also the diagnostic test of choice in women older than 45 years of age or post-menopausal women. This also happens to be the age where the prevalence of breast cancer is the highest.

- Mammographic reporting can be a very subjective procedure if done without guidelines, resulting in doubts about interpretation and way forward.

- With the current advances in reporting by the use of BI-RADS, the standardization is achieved, but its accuracy in terms of histological correlation remains unanswered.

- This study will try to establish the same and also aid in improving the management of patients.

RESEARCH QUESTION

How accurate is the evaluation of breast lesions on mammography using BI-RAD system in terms of sensitivity, specificity, positive and negative predictive values?

METHODOLOGY

STUDY AREA

The study was conducted at the Department of Radiology, KNH and Pathology Department, UoN.

STUDY POPULATION

All patients referred for mammography to Radiology Department, KNH. Those patients found to have BI-RADS 4, 5 and 6 on mammography, thereafter underwent an FNA or tissue sampling through core biopsy or excisional biopsy of breast pathology.

Tissue obtained was taken to Pathology Department, UoN for analysis.

STUDY DESIGN

This was a cross-sectional descriptive study

SAMPLING PROCEDURE

All consecutive patients referred to Mammographic Unit, Radiology Department, KNH, for mammography were recruited for the study.

SAMPLE SIZE

Sample size was derived using Fisher's Formula :

$$N = \frac{T^2 \times P\,(1\text{-}P)}{M^2}$$

N = Required sample size

T = Confidence level at 95% (standard value of 1.96)

P= Estimated prevalence of breast cancer = 0.0392

The Nairobi cancer registry has estimated the age-standardized rate (ASR) for women with breast cancer to be 39.2 per 100,000 for the years 2003-2006.[14]

M = Margin of error at 5% (standard value of 0.05)

Therefore:

$$\frac{1.96^2 \times 0.0392\,(1 - 0.0392)}{0.05^2} = 57.875$$

Minimum number of patients as calculated using this formula was 58.

DATA ANALYSIS

Data was entered into a microcomputer using SPSS/PC + for windows version 10 data entry program, validated and analyzed using the statistical package for social scientists(SPSS/PC+) program. To determine concordance, cross tabulation between mammographic and histopathology findings was done.

Mammographic and histopathological findings was tabulated as per the guidelines in Appendix C

INCLUSION CRITERIA

1) Patients who had undergone mammographic examination in KNH.
2) Patients who had biopsy or surgery done and had a histopathological or cytological exam result.
3) Patients who had given informed consent

EXCLUSION CRITERIA

1) Incomplete data of mammographic or histopathological or cytological examination
2) If patient's BI-RADS score was 0.
3) Patients who had not given informed consent.

EQUIPMENT

- Mammography was performed using the Hologic – Loredo machine in Radiology Department, KNH.
- Positions employed were cranio-caudal (CC) and medio-lateral oblique (MLO)
- In the CC view, the patient stood facing the unit and the breast was put on the table, compressed from above, as shown in the following illustration.

3[17] – Mammographic technique; Cranio-caudal view

X-RAY TUBE UNIT	
X-RAY BEAM	
FILM CASSETTE	
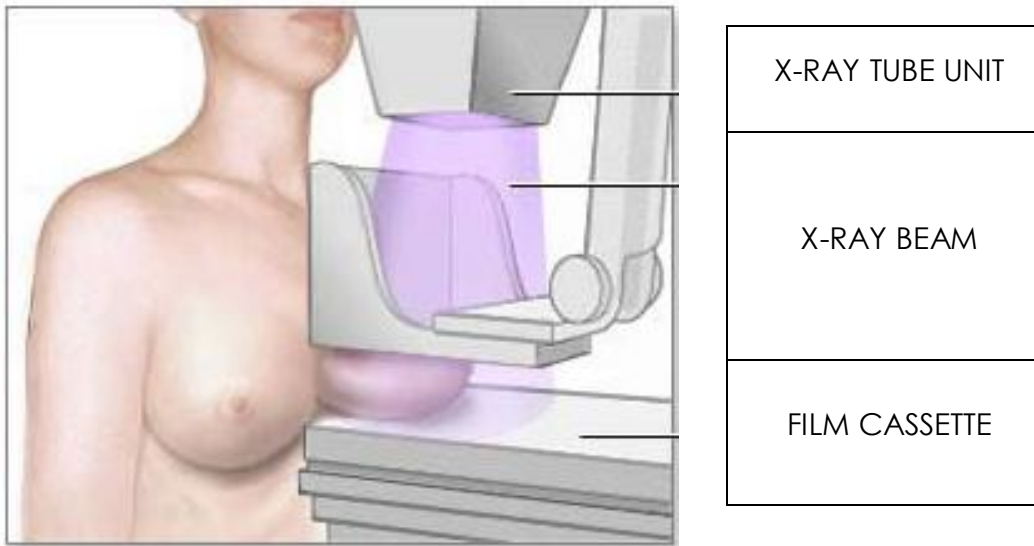
In mammography, each breast is compressed horizontally then obliquely and an xray picture is taken in each position.

In the MLO view, the mammography unit was positioned at 30 degrees or thereabout depending on patient's habitus, such that the x-ray beam passed from the cranio-medial to the caudo-lateral.

Figure 4[18] – Mammographic technique; Medio-lateral oblique view
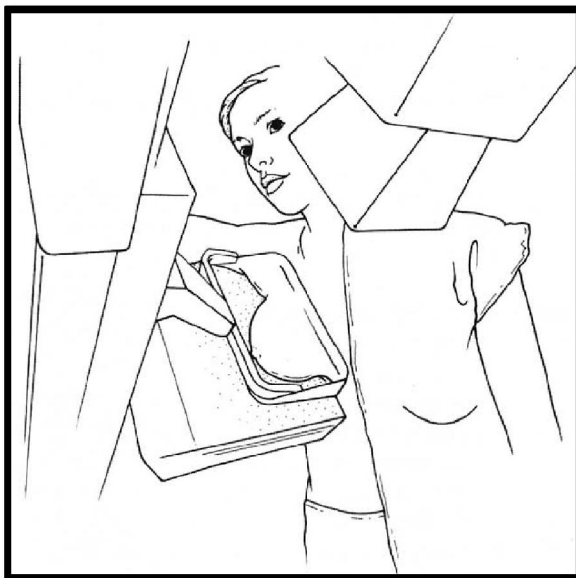
- Additional imaging views were done as per the need, e.g. coned or magnified views etc
- The image was recorded on a film which was within the appropriate cassette
- The film was processed using an automatic film processor
- The image was interpreted using BI-RAD system, under appropriate conditions for reporting (darkened room, use of magnifying lens etc)
- Data and lesion characteristics were collected in a form as shown in the Appendix C .
-

LABORATORY METHODOLOGY

- COLLECTION OF SPECIMEN

  For those lesions graded as BI-RADS 4 or 5, an FNAC or core-biopsy or excision biopsy of the lesion was required as part of management.

  STEPS

  - Relevant history, clinical details and radiological findings, with a provisional diagnosis were entered in the requisition form. Site of FNA/ biopsy was clearly stated.
  - Procedure was explained to patient and consent ensured. In the case of biopsy, written consent was obtained from the patient.
  - Depending on the requisite, FNA or core biopsy was carried out with universal precautions taken.
  - Hemostasis was achieved.
  - Biopsy specimen obtained was stored in formalin. The specimen was clearly labeled. In case of FNAC, the aspirate was smeared thinly on a labeled slide. This is fixed with 95% alcohol. Labeled slide was then placed in a slide carrier to be transported to the laboratory.

- ANALYSIS AND REPORTING

Pathologist analyzed samples obtained. The information obtained from the pathology report was entered in the form shown in Appendix C

QUALITY ASSURANCE IN RADIOLOGY

In mammography, quality assurance refers to all systematic activities undertaken by the breast imaging staff to ensure high quality mammography. Quality control more specifically refers to the technical aspects of mammography[25]. The radiologist oversees all aspects of the QA program and is ultimately responsible for clinical image quality and standard of patient care[26].

Evaluation of mammograms for artifacts is essential for mammographic quality assurance. An artifact is defined as any variation in mammographic density not caused by true attenuation differences in the breast[24].

Factors that create artifacts may be related to the processor, the performance of the examination by the technologist, the mammographic unit or the patient[25].

TYPE OF ARTIFACT	MEASURES TO COUNTERACT ARTIFACTS
1) PROCESSOR ARTIFACTS	
- Static artifacts (humidity, improper film handling)	- humidity control in processing room - static reducing countertop materials
- processor related roller marks	- Adequate processor cleaning and chemical replenishment - Proper mechanical adjustment of processor
2) TECHNOLOGIST RELATED ARTIFACTS	
- Improper film handling /loading - Inadequate screen	- washing of hands, careful handling of films - proper cleaning of film

cleaning procedures - Errors in use of mammographic unit /positioning, darkroom errors	screens, ensuring good screen-film contact(no air) - daily darkroom cleaning, and weekly cleaning of mammographic intensifying screens
3) ARTIFACTS RELATED TO MAMMOGRAPHIC UNIT	Needs a service call to repair malfunctioning component
4) PATIENT RELATED ARTIFACTS	
- Motion - Superimposition of objects, jewellery, hair, foreign bodies etc	- repeat of mammogram with motion artifact - identify superimposed object and repeat after correction

Other QC responsibilities entrusted to **the technologist** include:

- Darkroom cleanliness
- Processor quality control
- Screen cleanliness
- View box cleanliness
- Phantom images (radiographs of phantoms obtained to assess image density, contrast and uniformity)
- Repeat or reject analysis (to establish number of films discarded in order to identify source of recurrent deficiencies)
- Darkroom fog (unwanted development of unexposed film to light)
- Screen film contact
- Compression

Quality assurance must also be maintained in
- Patient positioning for the two standard views
- image labeling

The **medical physicist** is and integral part of the QA team and performs annual tests that are designed to detect problems that interfere with the diagnostic capabilities of the equipment or that increase the dose of radiation to the patient. Additionally they ensure that the view boxes are in optimal conditions for the evaluation of the mammographs (to see the high contrast and fine detail). These view boxes have;

- viewing spaces adapted to the height of current mammograms

- sliding panels that block extraneous light from the sides
- box lights of adequate intensities

The responsibilities of **the radiologist** amongst others include;

- Selecting a QC technologist
- Ensuring adequate training and continuing education for technologists (providing feedback regarding image quality etc)
- Effectively communicating and reporting results of mammographic examinations
- Ensuring adequate patient follow up when indicated
- Assessing outcome data

QUALITY ASSURANCE IN THE LABORATORY

In a laboratory setting, QA encompasses all the processes whereby the quality of laboratory results and the subsequent laboratory reports can be guaranteed. Those processes may include monitoring raw materials and supplies, controlling sample collection, transport, storage and processing, instrument calibration, record keeping, proficiency testing (external quality assessment) and training of all personnel. It is important to note that quality assurance is not limited to the technical procedures performed in the laboratory but includes all the pre and post examination activities (e.g. filling of requisition forms etc, report dispatch etc)

The practice of pathology involves the subjective interpretation of objective data. The objective data, contained in the characteristics of the cells, organization of tissues, and relationship to the organ on the whole, are preserved for the initial examination on histological slides, within paraffin blocks, and, more recently in digital image archives. As pathology material is retained in a continuously observable format (the histological slide or digitized image), an important method of assessing the quality of pathology services is the use of second opinion "quality assurance"

consultation. The consistent utilization of intra- and extra-departmental consultation to assess and report the diagnostic accuracy, completeness of information (clinical history and reporting of prognostic features), and consistency of terminology conveyed within each pathology report to clinicians and patients is a part of the measurement of quality performance in pathology. Another would be the timeliness of result reporting (turnaround time in the laboratory). For a surgical pathology report to be useful to the clinician, results should be available in a timely fashion[27].

TRAINING TO REDUCE INTEROBSERVER VARIANCE

Despite the structured or itemized reporting with standard language (i.e. defined terms from a standard lexicon) used in BI-RADS to make the report information more accessible and reusable, variability in interobserver agreement exists. The reason seems to be that radiologists have their own personal interpretation of BI-RADS, varying thresholds and different cut off points in determining the best fit descriptors and categories [5, 11, 28]. Revisions of the ACR BI-RADS have been guided in part by studies demonstrating intra- and interobserver variability[5, 28]. Implicit in the ACR BI-RADS system is the fact that the lexicon and assessment categories are to be used consistently among radiologists, even if it requires additional training to become familiar with the system[5].

ETHICAL CONSIDERATIONS

After approval from the Ethical Review Committee (ERC), permission was also sought from the KNH management.

Confidentiality was maintained in that, only the hospital number and / or investigation number and not the name was used to identify the patient. Patient's name, religious background or ethnicity was not required in this study.

The ALARA principle; that is keeping the radiation exposure As Low As Reasonably Achievable, was maintained for all the patients. Additional exposures were only made if justifiable by the need for better clarification of the lesion.

Fine –needle aspiration cytology or biopsy was done as part of patient management.

A written consent had been obtained from the patient for the biopsy.

The patient was informed about the study and its purpose. They were also informed that all the examination details will be used for research purposes and that the name will not appear in any research document.

Patient characteristics

A total of 64 females between the age of 23 and 80 years presenting with breast lesions at KNH mammography unit were recruited into this study. The mean age of the participants was 47.5 years (SD ± 11.1). As shown in Table 1 only 2 (3.1%) patients with breast lesions were aged below 30 years and the age groups that most commonly presented with breast lesions were 40-49 years (31.3%) and 50-59 years (28.1%).

Table 1: Percent age distribution of females attending KNH mammography unit with breast lesions

	Frequency (n)	Percent
Age group		
20 to 29 years	2	3.1
30 to 39 years	14	21.9
40 to 49 years	20	31.3
50 to 59 years	18	28.1
60 to 80 years	10	15.6
	64	100.0

Obstetric history

The obstetric history obtained from the patients indicated that none of the women presenting with breast lesions at KNH and referred to the mammography unit for investigations had a current pregnancy while 2 (3.1%) were lactating mothers (Table 2). Thirty-five (54.7%) women were premenopausal. The range for both the number of previous pregnancies and live births was between zero and 8. Four (6.3%) women were nulliparous while 6 (9.4%) had never had a live birth. Twenty-six (40.6%)

women reported that they had 2 to 3 previous pregnancies and most women 26 (40.6%) also reported having 2 to 3 live births (Table 2).

Table 2: Obstetrical history of females attending KNH mammography unit with breast lesions

	Frequency (n)	Percent (%)
Menopausal state		
Premenopausal	35	54.7
Peri menopause	4	6.3
Post menopause	25	39.0
Currently lactating		
Yes	2	3.1
No	62	96.9
Number of pregnancies		
None	4	6.3
One	9	14.0
2-3	26	40.6
4 and above	25	39.1
Number of live births		
None	6	9.4
One	8	12.5
2-3	26	40.6
4 and above	24	37.5

Clinical findings in breast cancer patients

The findings of clinical examination of the 64 female patients with breast cancer are shown in Table 3. Overall, the two most common presentations were breast lumps in 63 (94.8%) of patients and breast discomfort in a similar number of patients. Lumps involving both breasts occurred in 7.8% of patients while left-sided breast lumps were the most common in 33 (51.6%) patients. Skin thickening occurred in 37 (57.8%) patients and right

(26.6%) and left (31.3%) sided thickening showed an almost similar distribution.

Other less commonly seen presentations of breast cancer shown in Table 3 included: skin retraction (26.6%), nipple retraction (25%), discharge (21.9%) and breast enlargement (21.9%).

Table 3: Clinical examination of women presenting with breast lesions at KNH Mammography unit

COMPLAINT/ FINDINGS	Right, n (%)	Left, n (%)	Both breasts, n (%)	Total, n/64 (%)
Lump	25 (39.1)	33 (51.6)	5 (7.8)	63 (98.4)
Discomfort	26 (40.6)	30 (46.9)	7 (10.9)	63 (98.4)
Skin thickening	17 (26.6)	20 (31.3)	0	37 (57.8)
Skin retraction	9 (14.1)	8 (12.5)	0	17 (26.6)
Nipple retraction	8 (12.5)	8 (12.5)	0	16 (25)
Discharge	7 (10.9)	6 (9.4)	1 (1.6)	14 (21.9)
Breast enlargement	8 (12.5)	6 (9.4)	0	14 (21.9)

Among the 64 patients in this sample, 11 (17.2%) had history of breast surgery or biopsy and 3 (4.7%) reported family history of breast cancer.

Diagnostic investigations

None of the patients reported having had previous mammograms. All the 64 patients, however, had a recent mammogram taken at the KNH radiology unit. The findings of the mammograms shown in Figure 1 indicated that most 38 (59.4%) patients had breasts with heterogeneously dense composition. Fatty composition breasts were seen in 6 (9.4%) patients.
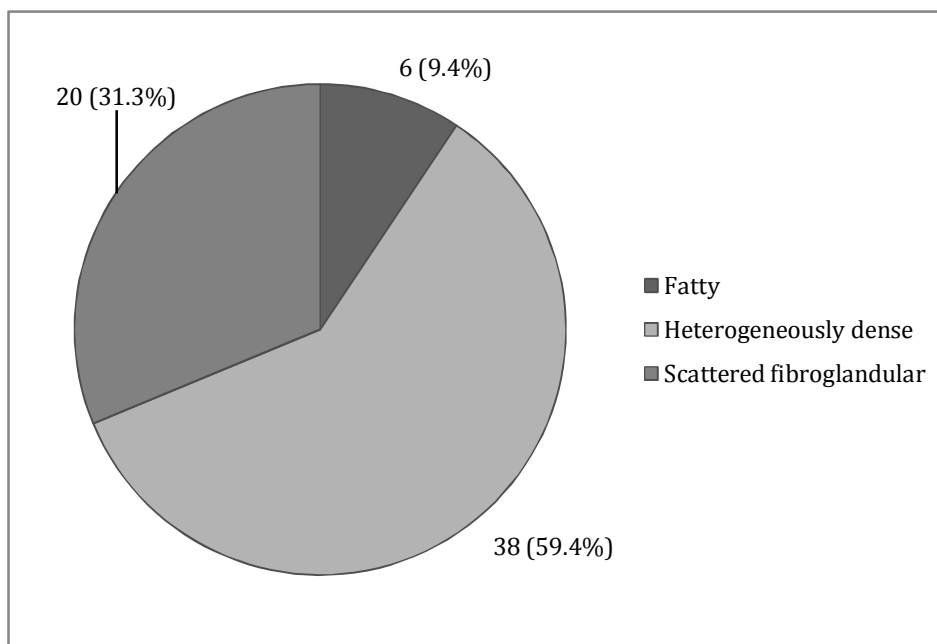

Figure 5: Mammogram findings among patients with breast cancer at KNH

Details of mammographic findings are shown in Table 4. Most mass lesions 29 (45.3%) were oval in shape and margins were commonly either spiculated (46.9%) or indistinct (35.9%). Masses were commonly of high density 53(82.8%). Focal asymmetry was noted in 54 (84.4%) mammograms and global asymmetry in 4 (6.3%).

Table 4:Mammographic findings among 64 breast cancer patients at KNH

	Frequency (n)	Percent
A. Masses		
Shape		
Round	5	7.8
Oval	29	45.3
Lobular	14	21.9
Irregular	16	25
Margin		
Obscured	2	3.1
Indistinct	23	35.9
Spiculated	30	46.9
Microlobulated	2	3.1
Circumscribed	7	10.9
Density		
High	53	82.8
Isodense	10	15.6
Isodense and radiolucent	1	1.6
B. Asymmetry		
Global	4	6.3
Focal	54	84.4
Missing	6	9.3
C. Calcification		
Morphology		
Benign	2	3.1
Intermediate	20	31.3
Suspicious	39	60.9
Distribution		
Grouped/ clustered	35	54.7
segmental	7	10.9
Diffuse/ scattered	2	3.1
Missing	20	31.3

The morphological characteristics and distribution of calcifications if present were also investigated. With regard to morphology the findings were as follows: 39 (60.9%) mammograms with calcification were classified as suspicious, 20 (31.3%) were intermediate and 2 (3.13%) were benign. There was a significant association between patient age and morphology with suspicious lesion occurring more commonly in older patients (mean age = 50.3 versus 43 years, p = 0.01).

Table 5: Morphology of suspicious calcification compared to mean age

	Mean age (SD)	**Mean age (SD)**	P value
Morphology	YES	NO	
Suspicious	50.3 (11.7)	43 (8.7)	0.01
Intermediate	45.9 (10.4)	48.2 (11.5)	0.44

For distribution of the calcifications, grouped/ clustered lesion were the most common, occurring in 35 (54.7%) of cases. Seven (10.9%) lesions had a segmental distribution and 2 (3.13%) showed diffused or scattered distribution.

Associated findings

Apart from findings presented above related to breast mass lesions, a significant number of mammograms had associated findings. Architectural distortion was present in 53 (82.8%) of cases. The most common type of architectural distortion was focal retraction in 30(46.9%) of mammograms. Other common associated findings are shown in figure below and commonly included axillary lymph node involvement (n = 45, 70.3%) and skin lesions (n = 45, 70.3%).
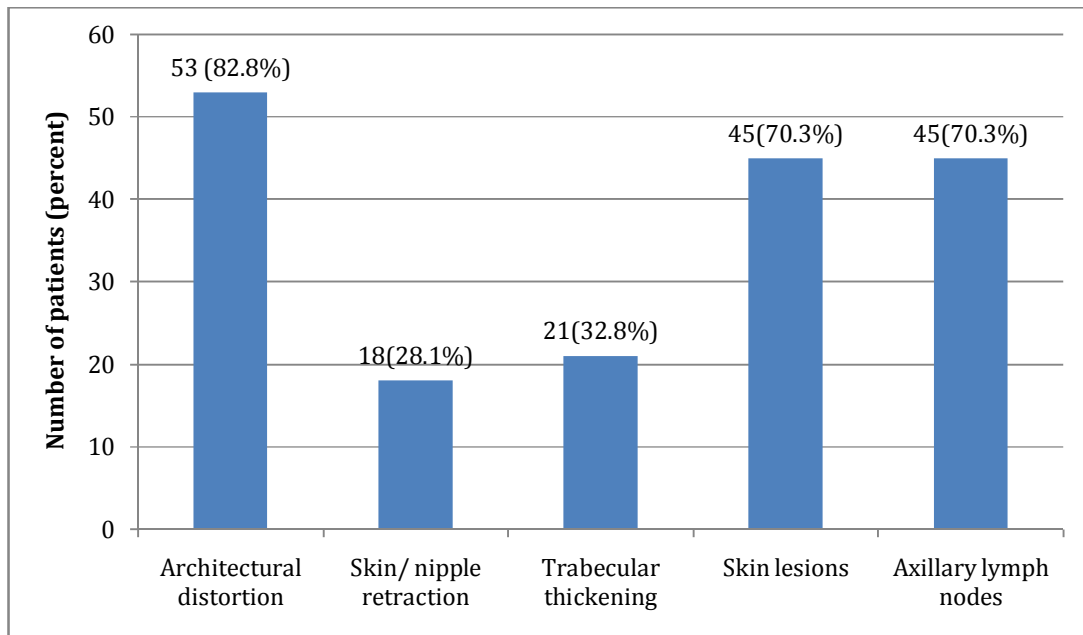

Figure 6: Percentage of patients with associated findings on mammograms

BI-RADS assessment category

The BI-RADS system mammography classification of the breast cancer lesions at KNH is shown in Figure 2. Twenty-eight (43.8%) lesions were highly suggestive of malignancy (BI-RADS category V) and 26 (40.6%) were classified as suspicious abnormality (BI-RADS category IV). There was no evidence of a statistically significant association between BI-RADS classification and age of patients for patients with BI-RADS categories IV, V or VI (ANOVA F = 1.55, p = 0.114)

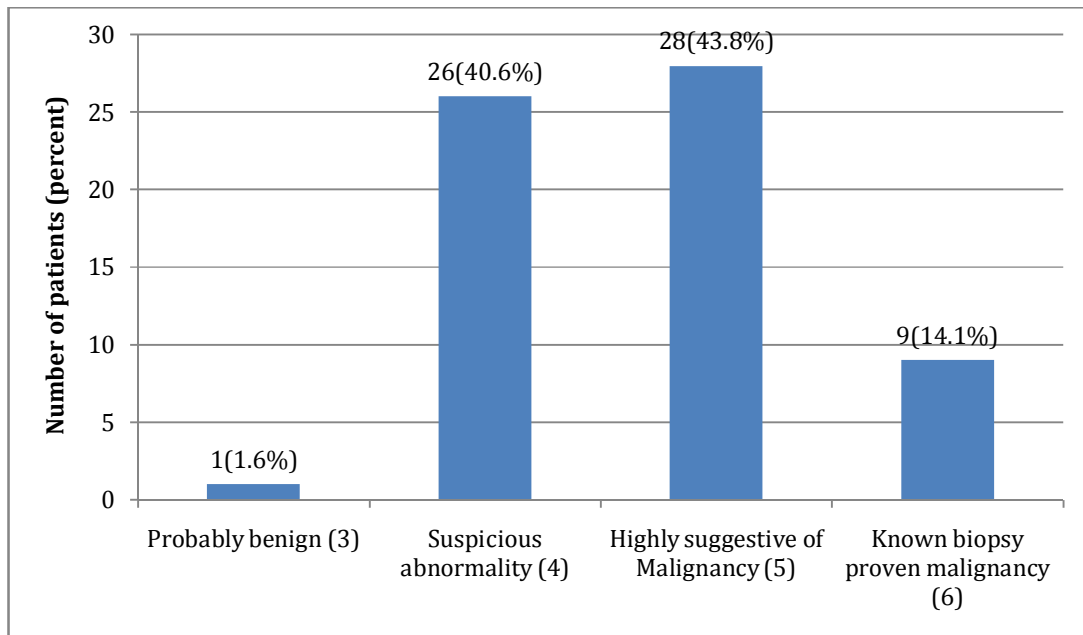Figure 7: Percentage of patients in BI-RADS categories 3 – 6.

Histopathological findings

The histopathological investigations conducted on the specimen from patients in this study showed that all the 64 patients had malignant breast cancer lesions. The specific classification of the malignancies in the sample is shown in Table 6. Ductal carcinomas were the most dominant type of carcinomas accounting for a total of 59 out of the 64 breast cancers in the study. Among the ductal carcinomas, the most common breast cancer histopathologic finding was infiltrating ductal carcinoma identified in 55 (85.94%) patients.

Table 6: Histo-pathologic findings on investigation of breast cancer specimen among female patients at KNH mammography unit

	Frequency	Percent
Ductal carcinoma in-situ	4	6.25
Infiltrating ductal carcinoma	55	85.94
Infiltrating lobular carcinoma	2	3.13
Invasive papillary carcinoma	1	1.56
Others	2	3.13
Total	**64**	**100**

Correlation between Mammographic BI-RADS and histopathology findings

Histopathology was used as the gold standard diagnosis for breast cancer in this study. Table 7 compares the findings of mammographic BI-RADS to histopathology findings. All the 64 (100%) lesions were identified to be malignant using histopathology. While no benign or risk lesions were identified on histopathology, the single (1.6%) lesion classified as BI-RADS category 3 proved to be malignant on histopathology, yielding a high sensitivity (98.4%, n = 63 out of 64) of the BI-RADS categorization for diagnosing breast cancer.

The 63 cases of breast cancer classified as suggestive or confirmed malignancy according to BI-RADS are shown in Table 6 and were: 26(40.6%) suspicious abnormality, 28 (43.8%) highly suggestive of malignancy and 9(14.1%) histopathological confirmed malignancies.

Table 7: Correlation between BI-RADS category and histopathology findings

	Histopathology findings				
	Ductal carcinoma in situ	Infiltrating ductal carcinoma	Infiltrating lobular carcinoma	Invasive papillary carcinoma	Others
BI-RADS					
3	-	1	-	-	-
4	4	20	1	1	-
5	-	25	1	-	2
6	-	9	-	-	-

The absence of benign breast lesions using histology (gold standard) testing in this study implies that it is not feasible to calculate specificity of BI-RADS for diagnosing breast cancer in the current study. However in Table 8 below positive predictive values of BI-RADS classification for different mammographic findings on breast cancer films are presented.

Correlation between mammographic descriptors and BI-RADS categorization

The frequencies of breast carcinoma according to BI-RADS classification for the different mammographic findings are shown in Table 8 below. These morphological descriptors were not present for all the patients and many had overlapping descriptors. Hence the numbers (n) in the table aren't summative across the categories. The single BI-RADS category 3 lesion in the study was lobular and had an indistinct margin. Twelve (46%) of the 26 BI-RADS 4 category lesions in which histopathology was performed had indistinct margins, 13 (50%) were oval, 12 (46%) represented suspicious calcification. The Positive predictive value of BI-RADS category 4 for focal asymmetric density and architectural distortions were relatively high at 77% and 73%, respectively.

BI-RADS category 5 and 6 also had high PPV for architectural distortion and focal asymmetric density. 89% of BI-RADS category 5 lesions showed focal asymmetric mammographic findings compared to 100% for BI-RADS category 6, which had similar findings. For architectural distortion, category 5 had PPV of 93% compared to PPV of 89% in category 6. The PPV of these BI-RADS categories for the remaining mammographic findings were relatively low except for suspicious calcification for which category 5 showed a PPV of 75%.

Table 8: Correlation between mammographic descriptors and BI-RADS categories.

Mammographic finding	BIRADS category			
	3	4	5	6
Mass				
Round (n = 5)		3/26 (12)*	1/28 (4)	1/9 (11)
Oval (n = 29)		13/26 (50)	13/28 (46)	3/9 (33)
Lobular (n = 14)	1/1 (100)	5/26(19)	6/28 (21)	2/9 (22)
Irregular (n = 16)		6/26 (23)	8/28 (29)	3/9 (33)
Margin				
Indistinct margin (n = 23)	1/1 (100)	12/26 (46)	8/28 (29)	2/9 (22)
Spiculated margin (n = 30)	0	8/26 (31)	18/28 (64)	4/9 (44)
Calcifications				
Benign (n = 2)			2/28 (7)	
Intermediate (n = 20)		5/26 (19)	12/28 (43)	3/9 (33)
Suspicious (n = 39)		12/26 (46)	21/28 (75)	6/9 (66)
Asymmetric density				
Global (n = 4)		2/26 (8)	2/28 (7)	
Focal (n = 54)	0/1 (0)	20/26 (77)	25/28 (89)	9/9 (100)
Architectural distortion (n = 53)	0/1 (0)	19/26 (73)	26/28 (93)	8/9 (89)

* - all values within parentheses are representative of positive predictive values.
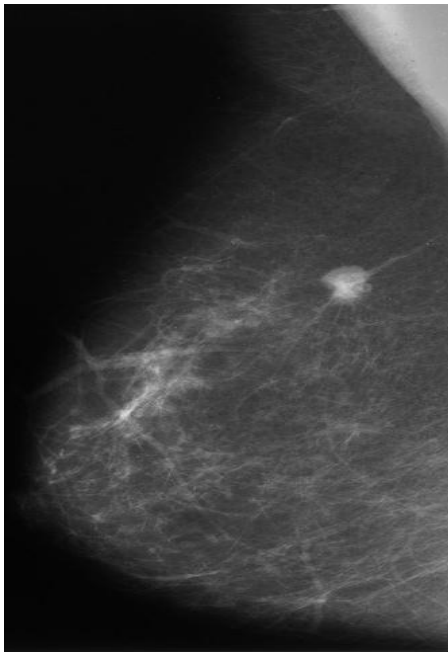
ILLUSTRATIONS

PLATE 1

a)
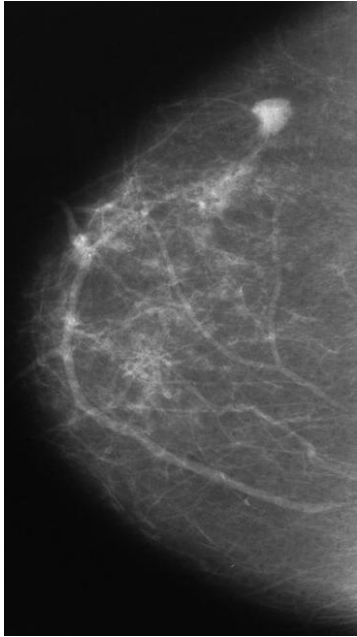
Right breast - CC View.

Fatty composition with a dense mass with spiculated margins in the outer compartment.
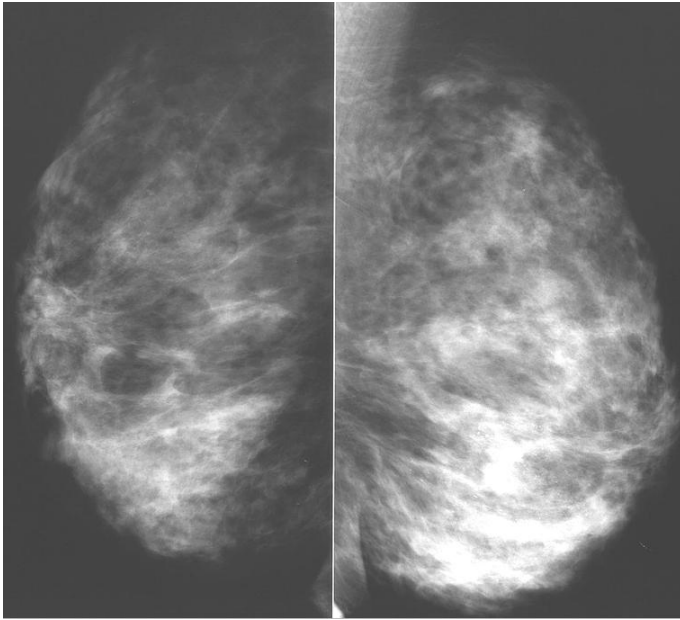
b)

(Same breast as above)

Right breast – MLO view

Fatty composition breast that has a dense mass with spiculated margins in the upper compartment
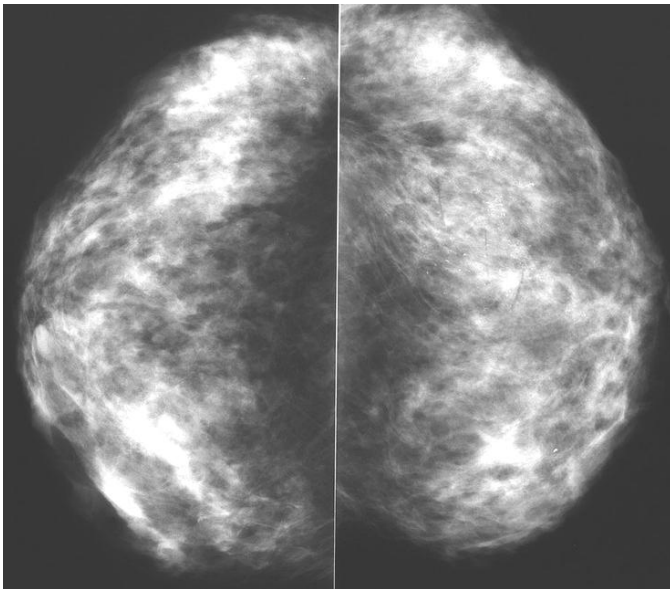
PLATE 2

a)

MLO VIEW – Bilateral heterogenously dense breast tissue.

Pleomorphic calcification in the left lower quadrant.

b)
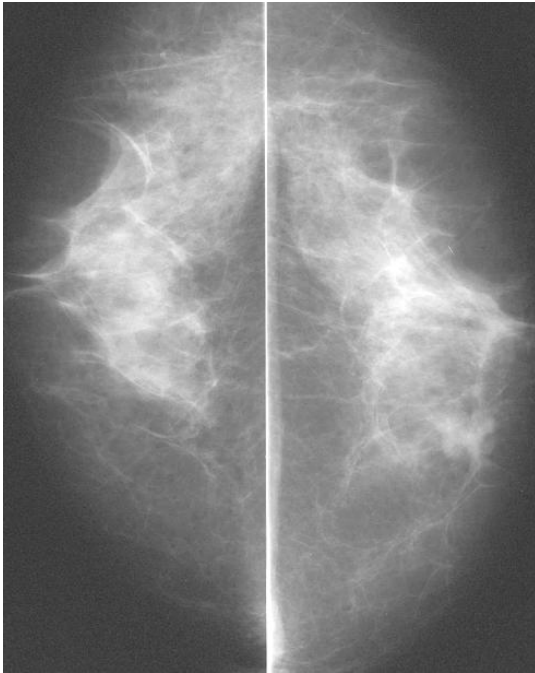

CC VIEW – Bilateral heterogenously dense breast tissue.

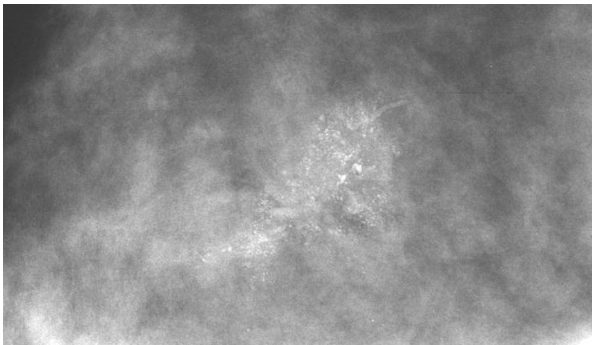Pleomorphic calcification in the left lower quadrant.
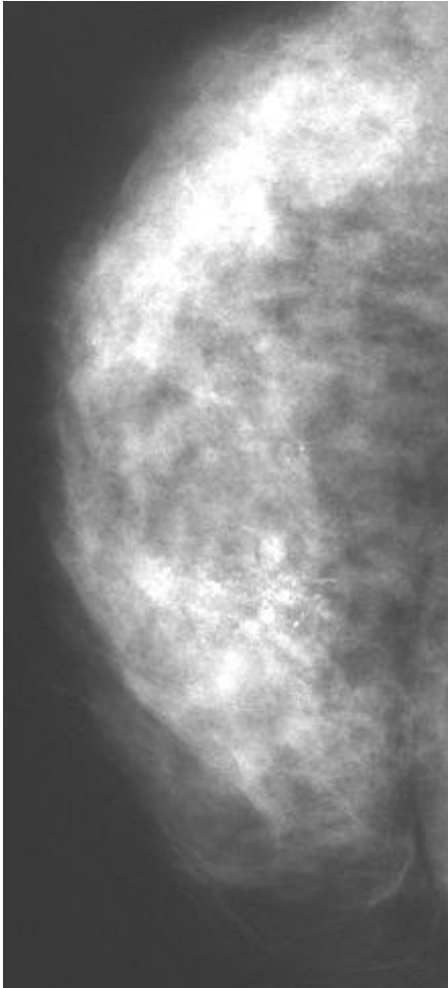
PLATE 3

a)

MLO VIEW – lobulated dense mass in left lower quadrant

b)

SPOT COMPRESSION VIEW -   pleomorphic calcification

PLATE 4

RIGHT BREAST CC VIEW –

Heterogeneously dense breast tissue with pleomorphic clustered calcification in retroareolar region

DISCUSSION

Developed in the early 1990s, the BI-RADS scoring method has been used extensively as a surrogate to histo-pathological reporting of breast cancer. In BI-RADS mammograms are categorized from 0 – 6, with category 0 requiring further investigation and category 6 being biopsy proven malignancy. Categories 1 to 5 are further broken down into negative, benign finding, probably benign finding, suspicious and highly suggestive of malignant lesion respectively. Prior to implementation of BI-RADS there was a lack of uniformity in reporting of mammography findings and this often resulted in varied reporting and management strategies. This ambiguity had also led to increased difficulties in establishing performances standards across settings. This had been the main impetus in developing the BI-RADS system and several research studies have shown the scoring system to be useful in predicting the likelihood of cancer [29, 30, 31]. These results are also seen in my study and hence further show the value of BI-RADS in effective management of breast cancer.

In this study a total of 64 patients were examined by both mammography and histo-pathology. These patients were aged between 23 and 80 years with mean age being 47.5 years (SD 11.1). The majority of the participants (43.8%) had breast lesions classified into BI-RADS category 5 that corresponds to highly suggestive of malignancy. Category 4 was next most common (40.6%) corresponding to suspicious abnormalities. There were 9 cases (14.1%) of known biopsy proven malignancies (BI-RADS category 6) and only one case of Category 3 lesion (1.6%).

On histopathology all lesions were proved to be malignant. The single (1.6%) lesion classified as BI-RADS category 3 proved to be malignant on histopathology, yielding a high sensitivity (98.4%, n = 63 out of 64).The absence of benign breast lesions using histology implied that it was not feasible to calculate specificity of BI-RADS for diagnosing breast cancer in the current study. The largest majority of the lesions were found to be

infiltrating ductal carcinoma (85.9%). Ductal carcinoma in-situ accounted for 6%. The mammographic BI-RADS descriptors of ovoid mass with spiculated margins and suspicious calcifications with focal asymmetry and architectural distortion were found to be highly predictive of malignancy (Category 5). Ovoid masses with indistinct margins and suspicious calcifications were predictive of suspicious abnormalities (Category 4).

Larger longitudinal studies done by Orel S. G. and colleagues used over a 1000 patients to look at PPV for each BI-RADS categorization and its predictive usefulness for malignancy [7]. Showing effectiveness of placing mammographic lesions into BI-RADS categories, the study further highlighted the varying PPV values amongst the BI-RADS categories. Category 4 showed PPV of 30% and Category 5 had 97% PPV. In another related study, Lieberman et al found that the standardized terminology of the BI-RADS lexicon does allow quantification of the likelihood of malignancy for various lesions [32]. In that study, the features with the highest PPV were spiculated margins, irregular shape, linear morphology of microcalcifications, and segmental or linear distribution of microcalcifications. The PPVs for lesions classified as BI-RADS categories 4 and 5 were 34% and 81%, respectively. This is also seen in our study as over 80% of our participants were categorized as 4 or 5 in the BI-RADS system. The predictive accuracy in these two categories is large enough to encourage more active utilization of BI-RADS.

CONCLUSION

1) The standardized terminology of the BI-RADS lexicon allows quantification of the likelihood of carcinoma in a breast lesion.
2) The features with highest positive predictive value--spiculated margins and suspicious calcifications in an ovoid mass with focal asymmetry and architectural distortion warrant designation of a lesion as category 5.

LIMITATIONS OF THE STUDY

As a cross-sectional non-probabilistic sampling was used, due to time and funding limitations, I was unable to adequately represent the population at risk as part of my study. As multiple radiologists were used to interpret the images, we were not able to effectively capture inter and intra-rater reliabilities.

This study only included biopsy-proven lesions. Hence the study does not inform on predictive value of BI-RADS on benign-appearing lesions that were interpreted as definitely benign or were recommended for follow-up only (BI-RADS 1,2 and 3).

RECOMMENDATIONS

1) Encourage use of the standardized BI-RADS lexicon among radiologists involved with breast imaging.
2) Further education of referring physicians about the BI-RADS assessment categories and the correlation between the various categories and outcome so that tissue diagnosis is reserved for those lesions that are indeterminate (BI-RADS category 4) or highly suggestive of malignancy (BI-RADS category 5).
3) Strict short interval follow up of patients categorized BI-RADS 3 as a means of surveillance of malignancy. This would require forming a patient database with regular updated contacts and collaboration with referring physicians.

REFERENCES

1. World Health Organization. World cancer report 2008, GLOBOCAN, International Agency for Research on Cancer (IARC), France: World Health Organization; 2008.

2.Mutuma GZ, Rugut-Korir Anne. Cancer Incidence Report, Nairobi 2000-2002. Nairobi Cancer Registry, KEMRI: 20 - 21

3. Vinayak S. The role of mammography as a diagnostic aid in diseases of the breast.Department of Imaging and Radiation Medicine, University of Nairobi, July 1988.

4. Mwangi JK. Usefulness of mammography in the investigation of symptomatic patients under 30 years in KNH. University of Nairobi, 1996

5. Ojeda FH, Nguyen J. How to improve your breast cancer program: standardized reporting using the new American College of Radiology Breast Imaging-Reporting and Data System. Indian J Radiol Imaging. 2009 November; 19(4): 266–277.

6. Eberl MM, Fox CH, Edge SB, Carter CA, Mahoney MC. BI-RADS classification for management of abnormal mammograms. *J Am Board Fam Med.* 2006;19:161– 164.

 7. Orel SG, Kay N, Reynolds C, Sullivan DC. BI-RADS categorization as a predictor of malignancy.*Radiology.* 1999;211:845– 850.

8. World Health Organization. Cancer Fact sheet No 297, February 2011. Geneva: WHO; 2011.

9. Vogel JE, Chu C, McCullough M et al. Breast Cancer in Women Under Age 40 Years: Treatment by Total Mastectomy and Reconstruction. Annals of Plastic Surgery. 2011;66(5): 557 – 560.

10. Lehman CD, Rutter CM, Eby PR, White E, Buist DS, Taplin SH. Lesion and patient characteristics associated with malignancy after a probably benign finding on community practice mammography. *AJR Am J Roentgenol.* 2008;190:511–515

11. Berg WA, D'Orsi CJ, Jackson VP, Bassett LW, Beam CA, Lewis RS, et al. Does training in the Breast Imaging Reporting and Data System (BI-RADS) Improve biopsy recommendations or feature analysis agreement with experienced breast imagers at mammography? *Radiology.* 2002;224:871–880.

12. Berg WA, Campassi C, Langenberg P, Sexton MJ. Breast imaging reporting and data system: Inter- and Intraobserver variability in feature analysis and final assessment. *AJR Am J Roentgenol.* 2000;174:1769–1777.

13. Bjerregaard B, Kung'u A. Breast cancer in Kenya: a histopathologic and epidemiologic study. East African Med J. 1992 Jan;69 (1): 22-26

14. Korir Anne, Incidence rates for most common cancers in Nairobi 2003-2006, Nairobi Cancer Registry, KEMRI.

15. *Breast Anatomy*[Image]. (2011). Retrieved from http://training.seer.cancer.gov/breast/anatomy/

16. *Compression paddle MLO View : Positioning, Film, & Anatomy*[Image]. (2011). Retrieved from http://www.e-radiography.net/articles/mammo/mammo_introduction.htm

17.*Mammography CC positioning*[Image]. (2011). Retrieved from http://www.healthline.com/adamimage?contentId=1-003380&id=17085

18. *Mammography MLO positioning*[Image]. (2011). Retrieved from http://www.answers.com/topic/mammography. Figure 26.1

19.Kline TS, Kline IK, Howell LP. Guides to Clinical Aspiration Biopsy Breast. Philadelphia: Lippincott Williams & Wilkins Publishers, 1999.

20.Masood S. Cytopathology of the Breast. ASCP theory and practice of cytopathology, Chicago:ASCP Press, 1996.

21. Pinder SE, Elston CW, Ellis IO.The role of pre-operative diagnosis in breast cancer. Histopathology 1996;28:563–566.

22. Breast fine needle aspiration cytology and core biopsy: a guide for practice, National Breast Cancer Centre, Camperdown, NSW.2004;4:12-13

23. Stanley MW, Abele J, Kline T, Silverman JF, Skoog L. What constitutes adequate sampling of palpable breast lesions that appear benign by clinical and mammographic criteria?.DiagnCytopathol 1995;13:473–482.

24. Bassett LW. Quality determinants of mammography: clinical image evaluation. In: Kopans DB, Mendelson EB, eds. Syllabus: a categorical course in breast imaging. Oak Brook, Ill: Radiological society of North America, 1995; 57- 67.

25. Hogge JP et al. Quality Assurance in Mammography: Artifact Analysis. Radiographics 1999; 19:503-522.

26. Farria DM, Bassett LW, Kimme-Smith C. Mammographic quality assurance from A to Z. Radiographics 1994; 14: 371-385.

27. Association of Directors of Anatomic and Surgical Pathology. Recommendations on quality control and quality assurance in anatomic pathology. American Journal of Surgical Pathology 1991; 15: 1007-1009.

28. Park CS, Lee JH, Yim HW, Kang BJ, Kim HS, et al. Observer agreement using the ACR Breast Imaging Reporting and Data system (BI-RADS) – ultrasound, First Edition(2003). Korean Journal of Radiology. 2007;8: 397-402.

29. Brenner RJ, Sickles EA. Acceptability of periodic follow-up as an alternative to biopsy for mammographically detected lesions interpreted as probably benign.Radiology 1989; 171:645-646.

30. Elmore JG, Barton MB, Moceri VM, et al. Ten year risk of false positive screening mammograms and clinical breast examinations.NEngl J Med 1998; 338:1089-1096.

31. D'Orsi CJ. American College of Radiology mammography lexicon: an initial attempt to standardize terminology.AJR 1996; 166:779-780.

32. Liberman L, Abramson AF, Squires FB, Glassman JR, Morris EA, Dershaw DD. The breast imaging reporting and data system: positive predictive value of mammographic features and final assessment categories.AJR 1998; 171:35-40.

APPENDIX A

PATIENT CONSENT FORM   **STUDY NO:………………**

My name is Dr. Leena Samay Singh, a postgraduate student in the department of Diagnostic Imaging and Radiation Medicine at the University of Nairobi. I am carrying out a study on the reliability of the way mammography pictures are reported in this hospital (BI-RAD system).

This study involves reading the x-ray pictures of the breasts and giving it a grade. Depending on the grade, further investigations maybe required to diagnose malignancy, such as fine needle aspiration (FNA) or biopsy. Detecting cancer in an early stage will help the doctor manage you better and give you a chance of cure. These procedures are a part of management of disease and will be funded by the patient.

Exposure to x-ray radiation is hazardous and can induce cancer. Further investigations if needed such as FNA or biopsy involve placing a needle or biopsy needle into the breast to obtain a sample. This may lead to pain, bleeding or infection, though precautions will be taken to prevent or minimize the same.

I would like to recruit you in this study. Information obtained from you will be treated with confidentiality. Only your hospital number will be used.

Please note that your participation is voluntary and you have a right to decline or withdraw from the study.

CONSENT:

I agree to participate in this study. I have had an opportunity to ask questions, which have been satisfactorily answered. I understand the aim and objective, risks and benefits of this study and that participation is voluntary and I may withdraw at any time, without losing the benefits to which I am entitled.

Patient number:_____ Signature: _____

Date: _____

I certify that the patient has understood and consented participation in the study.

Dr. Leena SamaySingh - 0720916267

Signature _____

Date _____

Supervisors

1. Prof J. M. Kitonyi - Department of DiagnosticImaging and Radiation Medicine, University of Nairobi.

2. Dr. P. Okemwa - Department of Pathology, University of Nairobi

APPENDIX B:

KIBALI CHA KUSHIRIKI KATIKA UTAFITI.   **STUDY NO:………………**

Jina langu ni Daktari Leena Samay Singh, mwanafunzi katika chuo cha udaktari, Chuo Kikuu cha Nairobi. Ninafanya utafiti kuhusu upatikanaji wa njia ya picha mammography ni taarifa katika hospitali hii (BI-RAD system).

Utafiti huu unahusisha kusoma picha x-ray na kutoa daraja. Kulingana na uchunguzi wa daraja zaidi labda inahitajika kutambua donda kansa, kama vile madhara faini sindano (FNA) au biopsy. Kuchunguza saratani katika hatua za awali itasaidia daktari kusimamia wewe bora na kuwapa nafasi ya tiba. Taratibu hizi ni sehemu ya menejimenti ya ugonjwa na kuwa na unafadhiliwa na subira.

Yatokanayo na mionzi ya x-ray ni hatari na unaweza kutumika kuleta kansa. Uchunguzi zaidi ikiwa inahitajika kama vile FNA au biopsy inahusu kuweka sindano au biopsy sindano ndani ya titi ili kupata sampuli. Hii inaweza kusababisha kutokwa na damu maumivu, au maambukizi, ingawa tahadhari zitachukuliwa kuzuia au kupunguza huo.

Habari zilizopatikana kutoka utakuwa kutibiwa na usiri. Hospitali namba yakotu zitatumika. Tafadhali kumbuka kuwa ushiriki wako ni wa hiari na una haki ya kushuka au kujiondoa katika utafiti.

KIBALI:

Nakubali kushiriki katika utafiti huu. Mimi kuwa na nafasi ya kuuliza maswali, ambayo imekuwa ya kuridhisha akajibu. Naelewa lengo na lengo hatari, na faida ya utafiti huu na ushiriki kwamba ni hiari na naweza kuondoa wakati wowote, bila ya kupoteza faida ambayo mimi ni haki.

Nambari ya mgonjwa: _____ Sahihi: _____

Tarehe: _____

Mimi kuthibitisha kwamba mgonjwa ameelewa na akakubali kushiriki katika utafiti.

Dr. Leena SamaySingh - 0720916267

Sahihi: _____   Tarehe: _____

Wasimamizi

1. Professor J. M. Kitonyi - Department of DiagnosticImaging and Radiation Medicine, University of Nairobi.

2. Dr P. Okemwa - Department of Pathology, University of Nairobi.

APPENDIX C

DATA COLLECTION FORM   CASE NO:...............

1) GENDER	MALE ☐		FEMALE ☐
2) PREVIOUS MAMMOGRAM	YES ☐		NO ☐
a) AGE			
FEMALE b) PARITY	No. of pregnancies		
	No. of live births		
	Presently pregnant		YES ☐ NO ☐
c) LACTATING	YES ☐		NO ☐
d) MENOPAUSAL STATUS			
3) CLINICAL SYMPTOMS Indicate lumps/biopsy scars / moles on diagram	**Right Breast**		**Left Breast**
a) Breast Lump			
b) Breast enlargement Gynaecomastia			
c) Breast - discomfort/- pain			
d) Nipple Discharge			
e) Nipple retraction			
f) Skin retraction			
g) Skin Thickening			
h) Lymphadenopathy			
4) HISTORY OF BREAST SURGERY /BIOPSY Indicate when and which breast			
5) FAMILY HISTORY OF BREAST CANCER			

6) MAMMOGRAPHIC FINDINGS			
BREAST COMPOSITION	Fatty ☐		Heterogeneously dense ☐
	Scattered fibroglandular ☐		Extremely dense ☐
a) MASSES	SHAPE	Round	
		Oval	
		Lobular	
		Irregular	

	MARGIN	Obscured	
		Indistinct	
		Spiculated	
		Microlobulated	
		Circumscribed	
	DENSITY	High	
		Isodense	
		Low	
		Radiolucent	
b) ASYMMETRY	GLOBAL		
	FOCAL		
C) CALCIFICATIONS	MORPHOLOGY		
	BENIGN	Large round (>1mm)	
		Dermal	
		Vascular	
		Coarse	
		Rod-like	
		Lucent center	
		Egg-shell	
		Milk of calcium	
		Sutural calcification	
		Dystrophic	
	INTERMEDIATE	Smaller (<1mm)	
		Amorphous	
		Indistinct	
		Clustered	
	SUSPICIOUS	Punctate (<0.5mm)	
		Fine, pleomorphic	
		Fine, linear	
		Fine, linear branching	
	DISTRIBUTION	GROUPED/CLUSTERED	
		SEGMENTAL	
		REGIONAL	
		DIFFUSE / SCATTERED	
D) ASSOCIATED FINDINGS	Architectural distortion	Spiculations radiating from a point	
		Focal retraction	
		Focal parenchymal edge distortion	
	Skin /nipple retraction		
	Trabecular thickening		
	Skin lesions		
	Axillary lymph-nodes		

7) BI-RADS ASSESSMENT CATEGORY		0	INCOMPLETE	
		1	NEGATIVE	
		2	BENIGN FINDING	
		3	PROBABLY BENIGN FINDING	
		4	SUSPICIOUS ABNORMALITY	
		5	HIGHLY SUGGESTIVE OF MALIGNANCY	
		6	KNOWN BIOPSY PROVEN MALIGNANCY	
8) HISTO-PATHOLOGICAL FINDINGS	**a) Benign lesion**	Fibroadenoma		
		Fibrocystic change		
		Fat necrosis		
		Fibrosis		
		Cysts		
		Adenoma		
		Lipoma		
		Abscess		
		Mastitis		
		Others (specify)		
	b) Risk lesion	Atypical ductal hyperplasia		
		Atypical lobular hyperplasia		
		Lobular carcinoma in-situ		
		Papilloma		
		Mucocele – like lesion		
		Radial scar		
	c) Locally aggressive lesions	Fibromatosis		
		Granular cell tumor		
		Phylloides tumor		
	d) Malignant lesion	Ductal carcinoma in-situ		
		Infiltrating ductal carcinoma		
		Infiltrating lobular carcinoma		
		Inflammatory breast disease		
		Invasive papillary carcinoma		
		Medullary carcinoma		
		Mucinous carcinoma		
		Others (specify)		