Objectives

On completion of the chapter, the reader will be able to:

1. Define the term breast self-examination and describe how the examination is done
2. Define the term clinical breast examination and describe how the examination is done
3. Describe the breast cancer screening guideline as outlined by the American Cancer Society (ACS)
4. List the benefits versus risks of mammography screening
5. Identify the dose received during a routine mammogram
6. Discuss the advantages and disadvantages of mammography imaging
7. Describe digital mammography imaging
8. Describe computer-aided detection (CAD) technology
9. Discuss the advantages and disadvantages of the following:
   - Digital Imaging
   - Breast ultrasound
   - Magnetic resonance imaging (MRI) of the breast
   - Position emission mammography (PEM)
   - Breast scintigraphy/Breast-Specific Gamma imaging (BSGI)
   - Lymphoscintigraphy
10. Identify the major and minor risk factors for breast cancer
11. Describe myths and misconceptions associated with breast cancer imaging and screening

KEYWORDS AND PHRASES

- **Accessory breast** is any breast tissue growing in the axillary region or inferior to the actual breast.
- **Background radiation** comes from various sources including space and the earth itself. The earth is constantly bombarded by particles from space. Fortunately, most are stopped before reaching the earth’s surface, but all soil and rock contain trace quantities of naturally occurring radioactive elements.
- **BRCA1, BRCA2** are the symbols used to indicate an abnormal breast cancer gene. Normally, the breast cancer gene produces a protein that protects against unwanted cell growth. If the gene is defective, the protein produced is unable to prevent the growth of abnormal cancer cells.
- **Breast augmentation** is also called augmentation mammoplasty or augmentation. It is a method used to increase breast size by inserting an implant. Common implants are made of saline, a saline solution contained in a silicon shell, or silicone, which is a silicone shell filled with silicone gel. Mammaplasty is the surgical procedure used to reduce, reconstruct or reshape the breast.
- **Breast reduction** is the removal of excess breast fat, glandular tissue and skin and the shifting or repositioning of the nipple and areola. It can be performed for cosmetic reasons, to achieve a breast size in proportion with body, or for medical reasons, to alleviate the discomfort or pain associated with overly large breasts.
- **Breast self-examination** is a thorough examination of the breast by oneself.
- **Breast-Specific Gamma Imaging (BSGI)** is a functional imaging study of the breast. A radioactive pharmaceutical that will concentrate in malignant lesions is injected into an arm vein and the patient is scanned using a high-resolution, small field-of-view gamma camera.
- **Clinical Breast Examination (CBE)** is a thorough examination of the breast, including the lymph nodes in the axilla and clavicular area, by a qualified health professional.
- **Color Doppler ultrasound** is the shift in frequency when ultrasound is used to visualize a part in motion. Doppler can be used to measure the velocity of the blood flowing in a vessel.
• **Computer-Aided Detection (CAD)** is a technology used to analyze a diagnostic image. The technology can be used to increase the productivity of the interpreting physician by highlighting suspicious areas or areas of interest on the radiographic image from an analog or digital mammography unit.

• **Curie** (symbol: Ci) was named in honor of the French physicist Marie Curie. The Curie measures the amount of radioactivity emitted from a radioactive source and is mainly used in nuclear medicine. The SI unit is the Becquerel, symbol: Bq. Radioactivity \((3.7 \times 10^{10} \text{ Bq} = 1 \text{ Ci})\).

• **Digital imaging** is an electronic and computerized detection system that is used to form digital images of the breast. It replaces the screen/film combination system in mammography. The resultant image can be transmitted, manipulated, and efficiently stored using a variety of methods.

• **Eczema** refers to a general term for a rash, which may be itchy or red due to allergy, chemicals, or drugs. Scratching or rubbing a skin rash can cause oozing or a thick scaly crust to develop.

• **Effective dose** takes into account the different types of radiation and their different biological effect. Effective dose also considers that various tissues and organs have different radiosensitivity and are affected more or less by radiation doses.

• **Entrance skin exposure (ESE)** is often referred as the patient dose and is easiest to measure. It is a measure of the dose to the individual’s skin from the radiation source.

• **False negative** is a test result that falsely indicates that a condition is not present when in fact it is.

• **False positive** is a test result that falsely indicates the presence of a condition when in fact the condition is not present.

• **Glandular dose** is used in mammography to describe radiation dose to the glandular tissues of the breast.

• **Gray (Gy)** is the international unit (SI unit) measuring the amount of radiation energy absorbed in a medium (e.g., body tissue). The biological effects of radiation will vary by the type and energy of the radiation and the organism and tissues involved. The older unit is the rad, Radiation Absorbed Dose, symbol: rad \((1 \text{ Gy} = 100 \text{ rad} = 1 \text{ J/kg})\).

• **Hodgkin’s disease** is named after Thomas Hodgkin, an English physician (1798–1866). It is a malignant disorder characterized by painless progressive enlargement of lymphoid tissue. Untreated, it will lead to death.

• **Hormone replacement therapy** is the use of hormones as a therapeutic treatment.

• **Laser mammography** is an experimental technology that uses a computerized laser beam to scan the breast and generate three-dimensional cross-sectional images of the entire breast. The technique involves no ionizing radiation and is not painful.

• **Lymphedema** is the accumulation of lymph in the soft tissues causing swelling and inflammation. It can be caused by obstruction or by the removal of lymph channels.

• **Lymphoscintigraphy** is a technique of injecting a radioactive isotope into the lymphatic system to track the path of metastatic cancer.

• **Matrix** is an array of pixels where each pixel is a sample of the image represented by a numerical value.
• Milk ridge or line extends from the armpits in the axilla to the groin region of the body. Breast tissue can form anywhere along the milk ridge, also known as the mammary line.

• MRI, magnetic resonance imaging, can be used to show the interaction of body tissues with radio waves in a magnetic field. These interactions result in high or low intensity signals that appear as bright or dark areas on an image. It does not use x-rays or sound waves but uses very complex magnetic properties of elements.

• Nephrogenic Systemic Fibrosis/Nephrogenic Fibrosing Dermopathy (NSF/NFD) are rare conditions associated with some Gadolinium-based contrast used in MR imaging. It was first identified in 1997 and most often will occur in patients with impaired renal function. The condition can develop within 2 days to 18 months after receiving the contrast injection and is characterized by tight, rigid skin that will eventually make any movement at the joints difficult or impossible and may lead to multiorgan failure and death.

• Non-Hodgkin’s lymphoma is the growth of malignant or benign lymphoid tumors. The symptoms and treatment of the disease are similar to Hodgkin’s. The disease can be differentiated only at the cellular level.

• Parity is the terminology used if a woman carries a pregnancy to a point of viability (20 weeks of gestation) regardless of the outcome.

• Parturition is the act of giving birth.

• Positron Emission Mammography (PEM) imaging is a computerized technique that uses a special gamma camera to detect radiation emitted from radioactive isotopes injected into the vein. Because the isotope is carried in the blood and will attach glucose molecules of breast cancer, the metabolic activity and, therefore, incidence of cancer can be assessed.

• Pixel or picture element is the smallest component part of an image. Each pixel has a numerical value and they are normally arranged in a two-dimensional grid represented as dots or squares.

• Polythelia is the presence of more than one nipple on the breast.

• Rad (Radiation Absorbed Dose, symbol: rad) measures the amount of radiation energy absorbed in a medium (e.g., body tissue). The biological effects of radiation will vary by the type and energy of the radiation and the organs and tissues involved. The rad is still used in the United States. The SI unit of radiation-absorbed dose is the gray, symbol: Gy (1 rad = 0.01 Gy (1 rad = 1 × 10⁻² Gy) (Box 2–1).

• Radiopharmaceuticals are radioactive drugs, sometimes referred to as radioactive tracers or radioactive iodine, used in nuclear imaging studies for diagnostic or therapeutic purposes.

• Rem (symbol: rem), is the “roentgen equivalent (in) man.” The rem attempts to gives the biological effects of radiation. It gives the dose equivalent or occupational exposure as opposed to the absorbed dose. The dose equivalent, DE is a measure of the radiation dose to tissues whereas the absorbed dose measures the physical effects of radiation. The SI unit is the sievert, symbol: Sv. One rem equals 0.01 Sv.

• Roentgen (symbol: R) is measure of the ionization produced in air by x-rays or gamma radiation or is a measurement of exposure to radiation. This is the measure made by a survey meter. The unit is
named after the German physicist Wilhelm Röntgen. There is no SI unit for this measurement because it can be expressed in units of coulomb/kilogram (C/kg) \((2.58 \times 10^{-4} \text{C/kg} = 1 \text{R})\).

- **Self-referral** refers to a patient who comes for diagnostic testing without a referral from a health care provider.
- **Scintigraphy** is the injection of a radioactive isotope into the body. The detection of the isotope will reveal body functions and diseases.
- **Sievert** (Sv) is the SI unit that attempts to give the biological effects of radiation. It gives the dose equivalent or occupational exposure as opposed to the absorbed dose. The dose equivalent is a measure of the radiation dose to tissues whereas the absorbed dose measures the physical effects of radiation. It is named after Rolf Sievert, a Swedish medical physicist famous for work on radiation dosage measurement and research into the biological effects of radiation. The older unit is the “roentgen equivalent: man,” symbol: rem \((1 \text{ Sv} = 1 \text{J/kg} = 100 \text{rem})\).
- **Thermoluminescence dosimeter (TLD)** is the instrument often used to measure the entrance skin dose. The TLD consists of lithium fluoride (LiF) in crystalline form, either as a chip or as powder. Once exposed to radiation, the TLD absorbs energy and stores it. This energy is released in the form of light when the TLD is heated. The visible light released is proportional to the radiation dose received by the crystal.
- **Ulcers** occur where the skin or mucous membrane is damaged due to inflammation, necrosis, or trauma.
- **Ultrasound** uses sound waves to outline the shapes of various organs in the body in real time. Ultrasound gives rapid sequence of multiple images to duplicate motion.

### PATIENT CARE AND COMMUNICATION

Breast cancer is the second leading causes of deaths among women in the United States, claiming the lives of thousands annually, and to date although there is no cure, breast cancer in its earliest stages can be effectively treated. The first line of defence against breast cancer is the screening mammogram. It is still the number one option.

Breast cancer screening has had a significant impact on the mortality rates due to breast cancer. With mammography screening, the...
rate of early breast cancer detection has increased significantly and the mortality rate due to breast cancer has declined because of the emphasis on early detection. Studies have consistently shown that the death rate for breast cancer in women has decreased since the 1980s. Although the overall rate of decrease from 1998 through 2006 was 1.9% annually, the early years of screening showed significant decrease at the rate of of 3.3% annually between 1995 and 1998. One clear fact is that early detection is associated with smaller lesions and higher survival rates.¹

Each year, thousands of women have their first mammogram. They come with preconceived notions about the mammogram—stories that they have heard from friends, relatives, or coworkers. They seek compassion, reassurance, professionalism, education, and for some even counseling (Box 2–2). The mammographer will get just one chance to make a good impression on these patients. Remember, every step of the way, from the time the patient walks into the department to the time that the patient heads for home, both the mammographer and the department is under assessment. The mammography examination in fact presents a unique opportunity for mammographers to educate their patients.

Women are more likely to return for a routine mammogram and comply with follow-up request after a pleasant experience with a mammographer. If the patient’s first experience with mammography is painful and the mammographer is unsympathetic, there is a greater chance that the patient will not return for future mammograms or additional studies. The patient will definitely not want to come back to the same facility. Patients will also be reluctant to recommend a mammogram to their friends or family or will perpetuate the myths of mammography being a painful study, if their first experience is unpleasant.

The best way to combat the misconception on mammography is communication. Mammographers should communicate with their patients before, during, and after the mammogram. Communication should not just be questions and answers from the mammographer. Mammographers should always invite questions from the patient, then listen and encourage further comments. Only by communicating with the patient, mammographers will be able to identify concerns and answer questions before the patient leaves. All patient communication should be face-to-face and as informal as possible. When going through routine mammography questioning, the mammographer should also take the opportunity to explain the procedure to the patient.

Mammographers need to have a thorough understanding of the breast in order to understand the importance of medical history and documentation and to help patients with breast examinations. In the course of a casual conversation, the patient can reveal fears or misconceptions that are often a hindrance to routine breast cancer screening. A well-educated and informed mammographer may well be the deciding factor, determining whether the patient will return for further screening or give up on diagnostic testing as a waste of time.

With millions of Americans having no health care coverage, cost can be a critical factor when making the decision to have a mammogram. The cost of mammograms can range from $50 to $300 depending on the region of the country and the extent and nature of the examination. Costs in major cities are higher than in rural areas and the cost of a routine

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**Box 2–2. Factors Influencing a Woman’s Commitment to Breast Cancer Screening**

- Apprehension/anxiety concerning the results
- Cost of the mammogram
- Fear of compression
- Fear of radiation
- Myths and misconception
- Unpleasant or unsympathetic or painful experience

**Communication:**

- Before the exam
- During the exam
- After the exam

**Types of Communication:**

- Listening
- Encouraging comments
- Face-to-face questions
- Informal chats
screening mammogram (the four-projection series with no additional projections) will be less than the cost of a diagnostic mammogram, which can include additional projections (such as magnification, spot compression, or supplementary projections of the breast). Thorough communication will identify these patient concerns and the mammographer can then help by informing the patient of the many low-cost screening mammograms available at many facilities during Breast Cancer Awareness Month or Mobile Mammography screening throughout the year. Most insurance will cover screening mammography for all women following the American College of Radiography (ACR) guidelines.

Another positive aspect of communication is that it helps to relax the patient. An uncooperative patient or one who is not relaxed is a difficult-to-image patient. It is almost impossible to get a good image of the pectoral muscle on the mediolateral oblique projection, if the patient is tense or stiff. Suboptimal images will then prolong the examination, frustrating both the patient and the mammographer.

By establishing a rapport with patients, the mammographer can identify those with unusually sensitive breasts (Fig. 2–1). If the sensitivity is extreme and hormone related, the mammogram can perhaps be rescheduled.

Apprehensions over the results of the mammogram can be such that some women might actually delay having the examination or even fail to seek medical attention for a lump because they are afraid of the results. Mammographers are not interpreting physicians and should not give the patient results unless authorized to do so by a physician. Patients, however, should always be given information on how and when they should expect to get their results. Mammography Quality Standards Act (MQSA) regulations state that all mammography patients—not just their physicians—must receive a copy of the mammogram results. This will relieve those patients who are self-referrals.

For patients in a panic about a possible lump, explain that not all lumps are cancerous. The lumps can be simple cysts—especially painful lumps. Although the diagnosis should be left to the radiologist, mammographer should be honest. They must never lie to the patients by saying that there is nothing wrong or nothing to worry about and never leave the patient with misperceptions about the results or the procedure.

Before leaving the facility, the mammographer should also alleviate patients’ fears of additional projections especially for screening mammograms. Patients should be prepared not to panic if they get a request to return to the facility for additional projections. A particularly nervous patient should be reassured about the possibility of a call-back by informing the patient of the reasons for additional projections (Box 2–3).

**THE ENVIRONMENT**

Remember that little things mean a lot. For perhaps 5–10 minutes, the mammographer will have the patient as a captive audience. The attention of the mammographer will not only make the patients feel good about having a mammogram, but also make them feel comfortable and

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**Benefits of Communication:**
- Relax the patient
- Reduce the chance of suboptimal imaging of the pectoral muscles
- Identify sensitive breast and the reason for the sensitivity
- Possible rescheduling of the mammogram if needed
- Educates the patient
- Reveals fears & misconceptions

**Box 2–3. Reasons for Additional Projections**
1. An area of the breast may need more compression
2. The breast tissue in one area may be obscuring (covering or overlapping) the breast tissue of another area
3. All breast tissue will undergo a certain amount of normal changes yearly. Sometimes, these changes are easy to track and explain, and sometimes they are not. This is when additional radiographs may be required to confirm that the changes are normal
Mammographers will then feel particularly appreciated when the patient comes back the next year and actually remembers not just a face but also a name.

The waiting room should provide comfortable chairs and reflect a calm and relaxing mood (Fig. 2–2). The lighting, wall coloring, and even pictures or the lack of pictures can all contribute to the mood of the patient waiting area. Many facilities now offer videos, information packets, or general magazines for the patient to view or read during the wait (Fig. 2–3). Often, tea or coffee can be provided, along with private,
clean changing rooms with a mirror that will help the patient with reapplying make-up or combing and fixing hair. Something as simple as the patient gown that does not fit or rips easily can have an impact on the patient’s mammography experience (Box 2–4).

**MEDICAL HISTORY AND DOCUMENTATION**

In the fight against breast cancer, mammographers often play an important role. They are often the only link between the patient and the radiologist. The information that they convey can and often will have a profound effect on the diagnosis of the disease. In imaging patients, the mammographer or technologist should take a few minutes to develop a rapport with the patient. Breast cancer can be totally asymptomatic and because a nonpalpable lesion in an asymptomatic woman will present no clinical findings, perception and analysis of the final image is of extreme importance. The interpreting physician, therefore, needs as much help as possible in making a final interpretation.¹

The first step in evaluating a woman, even if the woman is not suspected of having breast cancer, will be a complete medical history and a physical or clinical examination.¹ Medical and family histories will provide information on symptoms or any abnormalities of the breast. Some developmental abnormalities are supernumerary nipples, accessory nipples, or polythelia. All of these refer to extra nipples formed along
the mammary line or milk ridge (see Chapter 3). Patients may also develop accessory breast tissue in the axillary region or inferior to the breast. Occasionally, an extra nipple accompanies the accessory breast tissue. Since accessory breast tissue or nipples can also develop benign or malignant diseases, they should be well documented.

Other congenital abnormalities include asymmetry in breast size, shape, or position. Symptoms of note include inverted nipple or any discharge such as bleeding from the nipple. The nipple can be normally inverted or flattened but any recent change should be documented.

Medical history should also include any history of trauma to the breast or any breast surgery including biopsies, breast augmentation, or reductions. Other breast symptoms are skin thickening, where the affected breast may feel heavier or larger than normal and the pores appear enlarged. Any unusual lumps in the breast or axilla, or dimpling or puckering of the skin should be noted. Moles, eczemas, ulcers, and cysts can all be benign, but must be documented on the clinical history sheet or marked with special radiopaque breast markers because they may or may not be visible on the final breast image and could affect the diagnosis (Fig. 2–4). Scar markers can be used to locate the site of past surgeries eliminating the possibility of a misdiagnosis due to internal scaring. The patient

Figure 2–4. Various breast markers. (A) Nipple or skin marker; (B) scar or surgical marker; (C) marker for a mole or skin lesion; (D) marker for a palpable lump.
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<td>Any history of other cancers?</td>
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<tr>
<td>Any family history of breast cancer?</td>
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<td>Patient signature</td>
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<td>Referring Physician(s) name</td>
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<tr>
<td>Date of last period, or age at menopause?</td>
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<tr>
<td>Age at first pregnancy</td>
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<tr>
<td>Date of last mammogram?</td>
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<tr>
<td>Pain or discomfort in breast? Where? How long?</td>
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<td>If yes, is it a new lump or how long has it been there?</td>
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<tr>
<td>Are you taking hormones medication, or birth control pills?</td>
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<tr>
<td>Any weight gain or lost since last mammogram?</td>
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<tr>
<td>Any nipple discharge?</td>
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<tr>
<td>Any breast surgeries?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>If yes, give date and indicate biopsy, implants, or reduction</td>
<td></td>
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<tr>
<td>Circle any of the following that apply:</td>
<td></td>
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<tr>
<td>Any history of breast cancer/chemotherapy/radiation treatment?</td>
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<tr>
<td>Any history of other cancers?</td>
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<td>Age at first pregnancy</td>
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<td>Date of last mammogram?</td>
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<tr>
<td>Any family history of breast cancer?</td>
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</table>

**Figure 2-5.** Sample documentation sheet.

Use of deodorant, talcum powder, and ointment should be checked as these sometimes have base metals such as zinc or aluminium that can cause artifacts on the radiograph or can mimic malignant breast calcifications. Documentation must also include any other health problems and risk factors for breast cancer and benign breast conditions (Fig. 2–5). Many patients are not aware how important it is for the radiologist to compare the present mammography study with the old study. It is
harder to miss subtle changes in the breast when there are old radio-
grams for comparison. The patient should always have the old radio-
grams available for comparison especially when they move from site to
site to do their mammograms each year.

**BREAST EXAMINATIONS**

Unfortunately, the mammogram is not foolproof. Even under ideal con-
ditions, the mammogram will not find all breast cancers 100% of the
time. Although adjunctive technologies including ultrasound and MRI
are available, a woman's first line of defense against breast cancer is a
thorough breast examination. These are of two kinds: The breast self-
examination (BSE) and the clinical breast examination (CBE). Both are
complementary tests that the ACR still recommends as useful tools in
the detection of breast cancer.1

**Breast Self-examination**

The breast self-examination (BSE) is one of the most important exami-
nations a woman should be performing monthly. Very often, the woman
herself is the first to notice abnormal changes in breasts. The American
Cancer Society (ACS) suggests that women aged 20 and older should
perform a BSE every month.

To recognize and identify abnormalities, the breast must be exam-
nined in a systematic way at regular intervals. The best time to examine
breasts is 1 week after the menstrual period ends when the breast are
the least tender or swollen. For women not having regular menstrua-
tion, the BSE should be done on the same day every month.

Both breasts should be examined in the upright and the supine posi-
tions because a cancer in the upper half of the breast is easier felt when
the woman is upright whereas a cancer in the lower half of the breast is
best felt when the woman is supine. It is essential that a woman learn
the important points in any breast self-examination (Fig. 2–6). The
examination involves two main criteria:

- Looking for changes in the breast
- Feeling for changes in the breast

**Looking for Changes**

Breasts must be examined upright and supine. To examine the breasts
erect, the woman should stand in front of a mirror or sit with both arms
relaxed by the side. The mirror should be large enough to allow the
woman to view both breasts clearly. The woman should check for
indentations, retracted nipples, dimpling, or prolonged skin conditions
such as eczema. Other visual changes can include the development of
unequal breasts; changes in texture, color; or contour; redness; or scal-
iness. Moles and scars should also be noted and recorded.

The entire procedure should then be repeated with both arms raised
above the head. Next, the woman should place a hand on each hip,
tense the chest muscles, and again look for changes or lumps. The
woman can also lean forward, again checking for changes. Both nipples
should be gently squeezed, as a check for discharge.
Feeling for Changes

The next step in any breast examination is the feeling for changes. As with looking for changes in the breast, while feeling for changes, the woman should examine her breast in both the upright and the supine positions. While doing the upright examination, lotion or powder can be used to help the fingers glide across the breast. Some women also prefer to examine their breasts in the shower. Here, wet fingers will glide easily over the breast.

To begin the upright examination, start with one breast. The arm closest to the breast under examination should be raised. The pads of the fingers of the other hand are used to complete the breast examination.

Figure 2–6. Conduction of a breast self-examination (BSE).
then the process is repeated for the other breast.\textsuperscript{1} The woman should use light, medium, and firm pressure with the pads of three fingers in either an up-and-down line, circular, or wedge pattern until the entire breast is checked. The woman has to decide which pattern she is most comfortable with.

For the supine examination, the woman should lie on her back with a pillow or other support under the shoulder closest to the breast under examination. The pads of the fingers of the other hand are then used to perform the examination. Regardless of the position employed, the entire breast and axilla should be examined using light, moderate and firm pressure to locate lumps at different depths of breast tissue.\textsuperscript{1,2}

\textit{Up-and-Down Line Pattern}

To examine the breast using the up-and-down pattern, the woman should start in the axilla or most lateral aspect of the breast. Move the fingers downward little by little until the fingers have covered the entire breast. Start at the top again, a few inches medially, and repeat the downward movement of fingers. The entire process is repeated until the full breast is examined.

\textit{Circular Pattern}

The circular examination method involves starting at the outer edge of the breast and moving the fingers in ever decreasing concentric circles around the entire breast, working toward the nipple.

\textit{Wedge Pattern}

In an examination using the wedge pattern, the woman begins at the outer edge of the breast and moves inward to the nipple. Once at the nipple, the fingers are again placed at the outer edge of the breast to begin another journey to the nipple. This process is repeated covering one wedge at a time until the entire breast is covered (Fig. 2–7).

\textbf{Clinical Breast Examination}

The clinical breast examination (CBE) is done to locate any lumps or suspicious areas and to examine the texture, size, and shape of the breast, but the clinical breast examination is a check of the breast by a qualified health professional. The clinical breast examination takes the same format as the BSE—looking and feeling for changes in the breast. The ACS recommends that women between the ages of 20 and 39

\begin{figure}
\centering
\includegraphics[width=0.7\textwidth]{fig2_7}
\caption{Breast examination patterns showing (A) vertical, (B) circular, and (C) wedge patterns of BSE.}
\end{figure}
should have a CBE every 3 years and women older than 40 years should have a CBE every year.\textsuperscript{1,2}

A thorough clinical examination will locate any lumps or suspicious areas and any changes in the nipples or skin of the breast. In a clinical breast examination, special attention is paid to lumps attached to the skin or deeper tissue. Since breast cancer leaves the breast via the lymph nodes, nodes in the axilla or above the clavicle must be checked for enlargement or firmness. Another point to note is that almost 75\% of breast cancers are located in the upper quadrants of the breast, so the health professional will pay particular attention to this area.\textsuperscript{1}

Once the medical and clinical examinations are completed, biopsies or breast imaging tests such as mammography can be performed as indicated (Fig. 2–8).

**BREAST EXAMINATION GUIDELINES**

Since the early 1970s, clinical studies have repeatedly shown that the periodic mammography screening of asymptomatic woman older than 50 years can reduce the mortality rate of breast cancer. Today, although not a perfect solution, the mammogram still remains the best detection tool in the treatment of breast cancer.\textsuperscript{3} The ACS suggests that other modalities are useful in imaging dense fibroglandular breast tissue, but it is also committed to mammography as offering the best screening solution for the general public. The American Cancer Society recommends that women who fall in high risk categories—because of family history, genetic tendency, or other factors—be screened with MRI in addition to mammograms. In general, the number of women meeting these conditions is small: less than 2\% of all women in the United States.\textsuperscript{1,4–6}

Originally, the ACR recommended a 2-year screening schedule for women between 40 and 50 years; however, the earlier breast cancers are detected, the better are the treatment results. The ACS, therefore, suggested the following guidelines for routine mammography screening (Box 2–5).\textsuperscript{1,2,4}

In opposition to the ACS, the US Preventive Services Task Force (USPSTF), a group of independent health experts, are now recommending that routine screening of the average-risk women should begin at age 50, instead of age 40. They also suggest that screening should end at age 74, that women should be screened every two years instead of every year, and that breast self-examination have little value. The USPSTF followed with recommendations against the teaching of breast self-examination, although they did not find sufficient evidence to recommend for or against performing clinical breast examination. The USPSTF and the NCI continue to oppose regular screening. They consider the harmful effects of screening to include the dangers of false negatives, false positives, over diagnosis, and radiation risks.\textsuperscript{5–8}

**BENEFITS VERSUS RISKS OF BREAST IMAGING**

**Mortality Reduction**

Breast cancer in its early stages is asymptomatic. Since the advent of modern mammography in the late 1960s, studies have conclusively shown that regular screening mammograms will significantly reduce
the mortality rate from breast cancer in women aged more than 50 years. Since 2002, some of these studies have been under attack and questions have been raised about the efficacy and interpretive quality of mammography, especially for women younger than 50 years.

It is recognized that mammography cannot detect all breast cancers. Some cancers will present no imaging findings and others are difficult if not impossible to detect when the woman has dense breasts. Mammography, therefore, should not be the only imaging solution when screening for breast cancer. Digital imaging is quickly replacing analog mammography as a screening tool and other modalities such as ultrasound and MRI are becoming increasingly useful in detecting cancers in dense fibroglandular breast tissue, especially in younger women who are at risk.

**RISK FROM RADIATION EXPOSURE IN MAMMOGRAPHY SCREENING**

Fear and misconception about the radiation dose in mammography are still a concern today, although the dose does not have the potential to produce any negative late effects. In general, patient dose from diagnostic imaging is measured as the entrance skin exposure (ESE) because it is easiest to measure. The ESE is also commonly referred to as the patient dose. A thermoluminescence dosimeter (TLD) can be taped to a patient’s skin and used to take accurate readings during the exposure.

In mammography screening, however, because of the low energy beam, the dose falls off very rapidly as the beam penetrates the breast. The biological effect of a mammogram is, therefore, assumed to be more closely associated with the total energy absorbed by the glandular tissue of the breast. The glandular dose is, therefore, the dose of choice when calculating radiation doses associated with mammography.

The ESE for a typical single exposure during a mammogram using screen-film combination with grid can be as high as 1000 mrad (8–10 mGy): however, the dose to the midline of the breast may only be 100 mrad (1.0 mGy). The ACR recommends that the average glandular dose on the mammogram should be no greater than 0.3 rad (300 mrad or 3 mGy) with a grid or 0.1 rad (100 mrad or 1 mGy) without a grid. With modern mammogram equipment, the patient will usually receive only approximately 0.1–0.2 rad (1–2 mGy) per projection. Despite these low glandular doses, negative misconceptions about radiation are still affecting the public’s confidence in mammography screening.

One recent fear is the threat of thyroid cancer. The mediolateral-oblique projection gives the patient twice the amount of skin dose to the thyroid than the craniocaudal projection; however, while the average skin dose to the thyroid is in the range of 0.022–0.039 rad (0.22–0.39 mGy) per projection, the dose falls off rapidly leaving a tissue dose of approximately 0.004 rad (0.04 mGy). This is considered insignificant even when compared with the average breast dose of 0.3 rad (3 mGy). Since patients are unlikely to understand the scientific units for radiation, another way of looking at radiation is to take the effective dose from a single mammography projection and converting it into the amount of time it would take to accumulate the same effective dose.

**Radiation Dose in Mammography**

- ESE for a typical single exposure = 800–1000 mrad (8–10 mGy)
- Glandular dose = 100 mrad (1.0 mGy)
- ACR recommends a glandular dose of:
  - 0.3 rad (300 mrad or 3 mGy) with a grid
  - 0.1 rad (100 mrad or 1 mGy) without a grid
from background radiation. The theory here is that each would have the same potential for cancers and hereditary effects. Since the average background rate in the United States is approximately 300 mrem (3 mSv) per year, for mammography it would be approximately 4 months. The attraction of effective dose is that a single value would then be used to compare one situation with another, or give an overall risk assessment. In reality, the various organs and tissues in the body receive different doses and a complex calculation would be necessary to keep track of all the specific organs or tissue risk factors. In mammography, because only the breasts are radiated, theoretically it could be possible to convert mammography doses to an effective dose using a female-based tissue-weighting factor. This method of explaining radiation is called Background Equivalent Radiation Time or BERT and has been recommended by the US National Council for Radiation Protection and Measurement (NCRP). This concept would help a patient having difficulty understanding the radiation effects of mammography screening (see Box 2–6; JR Cameron [jrcameroo@facstaff.wisc.edu], Online Interview, 2003).14

Another aspect to consider is that there are no reported cases of breast cancer developing as a result of mammography even in the early days of breast imaging, with multiple examinations at doses many times higher than the current levels. Long-term studies have shown conclusively that regular mammography screenings results in a 30% reduction in breast cancer deaths in women older than 50 years. The mortality reduction benefits of mammography far outweigh any possible risks from screening. Also, patients should be made aware that the smaller the thickness of the area through which the radiation passes, the lower the dose of radiation the breast will receive. Simply by compressing the breast 1 cm more, the radiation dose to the patient can be reduced to almost half of its original value—yet another reason why the breast should be compressed.

Box 2–6. Radiation Dose Made Easy

Using the background equivalent radiation time or BERT to explain radiation to patients.

The effective dose from mammography is approximately 1 mSv. The average background rate in the United States is approximately 3 mSv per year. Using the conversion, it would take approximately 4 months for the patient to accumulate the same effective dose of radiation as given in a single mammogram projection. This does not imply any risk, it simply emphasizes that radiation is a natural part of everyday life on the earth.

<table>
<thead>
<tr>
<th>X-ray Study</th>
<th>Effective Dose (mSv)</th>
<th>BERT (time to get dose from nature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single chest projection</td>
<td>0.08</td>
<td>10 days</td>
</tr>
<tr>
<td>Mammogram</td>
<td>1</td>
<td>4 months</td>
</tr>
<tr>
<td>Lumbar spine</td>
<td>3</td>
<td>1 year</td>
</tr>
<tr>
<td>UGI</td>
<td>3</td>
<td>1 year</td>
</tr>
<tr>
<td>Head CT</td>
<td>2</td>
<td>243 days</td>
</tr>
<tr>
<td>Abdomen CT</td>
<td>10</td>
<td>3.3 years</td>
</tr>
</tbody>
</table>

Comparison of Radiation Dose

Radiation is found in our atmospheres and in our soil. Radiation can also be inhaled or ingested through food or water:

- The average person in North America receives about 3 mSv (300 mrem or 0.3 rem) per year of naturally occurring radiation
- A CT of the abdomen gives about 10 mSv (1000 mrem) of radiation
- A lumbar spine x-ray gives about 3 mSv (300 mrem) of radiation
- We inhale 2 mSv (200 mrem or 0.2 rem) of radiation annually from radon in the atmosphere
- A single mammogram projection gives about 1 mSv (100 mrem) of radiation to the breast tissue
- We get about 0.9 mSv (90 mrem) annually from TVs and about 0.1 mSv (10 mrem) from cooking with natural gas or from radon gas in the natural gas supply.
- We get less than 0.1 mSv (10 mrem) per year from smoke detectors, which have radioactive elements
- A single chest x-ray projection gives about 0.08 mSv (8 mrem) of radiation
- During a mammogram the radiation to the thyroid glands is about 0.04 mSv (4 mrem)
- A round trip coast-to-coast airplane flight across the United States can give an average person 0.03 mSv (3 mrem) of radiation.
Unfortunately, breasts of younger women—especially those with dense fibrous breasts—are more sensitive to radiation and usually receive a higher dose of radiation. Also, the skin dose is even higher during magnification mammography. At these high doses, there have been reports of skin erythema from repeated magnification imaging. (Box 2–7). Mammographers should always practice ALARA (As Low As Reasonable Achievable) by avoiding unnecessary radiation to younger women, avoiding repeats. By carefully studying of positioning and knowledge of all the routine and supplementary projection, the mammographer will be able to ensure that the minimum number of images is taken during each patient mammography examination (Fig. 2–9).

### METHOD OF IMAGING

The field of breast cancer detection is still evolving. It is now acknowledged that the mammogram is not 100% effective. The reality is there is no screening tool available that is 100% effective. There is still no known cure for breast cancer, so a woman’s best strategy is early detection, reducing her known risks, and the judicious use of adjunctive modality imaging. The 5-year survival rate is lower for women whose cancer is diagnosed at a more advanced stage. Five-year survival rates are also lower for younger women because researchers suspect that younger women have tumors that are more aggressive and less responsive to therapies.

**Box 2–7. Radiation Doses from Typical Projections in Digital Mammography**

<table>
<thead>
<tr>
<th>kVp</th>
<th>mAs</th>
<th>Entrance dose</th>
<th>Glandular dose</th>
<th>Compression</th>
<th>Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>105</td>
<td>14.8 mGy/1480 mrad</td>
<td>2.79 mGy/279 mrad</td>
<td>5 cm 29 lbs</td>
<td>Molybdenum</td>
</tr>
<tr>
<td>32</td>
<td>97.3</td>
<td>14.2 mGy/1420 mrad</td>
<td>2.47 mGy/247 mrad</td>
<td>6.9 cm 31 lbs</td>
<td>Rhodium</td>
</tr>
</tbody>
</table>

The mammogram is not 100% effective in detecting breast cancer.

---

Figure 2–9. Positioning for a screening mammogram. (Courtesy of GE Medical Systems, with permission.)
Depending on the interpretation of the mammogram, women can pursue many adjunctive imaging options. Women should also pursue adjunctive testing if they are at a greater risk for breast cancer, or have dense breast tissue. In addition, women should seek educational resources. All women should be aware of the signs and symptoms of breast cancer. Breast cancer in its early stages is totally asymptomatic, but as the cancer grows there may be changes in the breast such as thickening, swelling, skin irritation, or distortion, and nipple symptoms including spontaneous discharge, erosion, inversion, or tenderness.

The steep decline in the mortality rate from breast cancer over the past few years has been credited solely to mammography screening, but the benefits of emerging technologies cannot be overlooked. These technologies are offering improvement in detection and treatment options and coupled with breast cancer research may well serve the ultimate goal of eradicating breast cancer as a feared and dreaded disease.

**ADVANTAGES AND DISADVANTAGES OF MAMMOGRAPHY SCREENING**

The mammogram is the single most effective tool in early breast cancer detection; however, it is not 100% effective. Cancer is generally visualized as a white area within the background density of the breast. If the background density is “black,” as in fatty tissue, the cancer will be easily seen; but if the background density is “white,” as in dense breast tissue, the cancer will be harder to detect. The sensitivity of the mammogram will be dependent on density, plus the age and hormone status of the patient.

Mammography also tends to understate the multifocality of a lesion. A perfect breast image is also critical in diagnosing breast cancer. Positioning is a very important part of imaging. If there is inadequate compression, or if the breast tissue is not imaged because of poor positioning, a cancer can be missed.3,4,17

Because of these stated disadvantages, mammography screening is generally acknowledged to have a 10–15% miss rate. As the patient ages, the density of the breast generally decreases, thus the diagnostic sensitivity of the mammogram will increase.

**Digital Imaging of the Breast**

Digital mammography and computed mammography (CM) are both digital technologies and are now the technology of choice in many mammography departments (Fig. 2–10). Digital uses a totally cassetteless system whereas computed radiography adapts the analog system with digital technology. In digital imaging, a built-in electronic detection system replaces the screen-film cassette technology. In computed mammography, the cassette has been replaced by the image plate (IP) and the film is replaced with the image receptor (IR), also called a storage phosphor screen (SPS) or photostimulable phosphor (PSP). The IR is the device that receives the energy of the x-ray beam and forms the image.
There are two types of Digital Systems

- Cassetteless system:
  - Digital Mammography
  - Built-in detector technology
- Cassette based system:
  - Computer Mammography
  - Mammography Unit with IP plus Computer Reader (CR)
  - The IP is physically removed from the unit and inserted into the CR

The IR is sensitive to radiation, not light, and can be used repeatedly. In CR imaging, after the exposure, the IP is removed from the x-ray unit and inserted into a computer device that removes the IR. The IR is then scanned with a laser-scanning device. The IR phosphor will release light that is output to an electrical then digital format. The IR is reusable because, after scanning, it can be erased using a powerful beam of light and then reloaded into the IP. These steps all take place within the computer device, also called the computer reader.

The digital image is formed as a two-dimensional matrix of pixels where the greater the number of pixels per inch, the greater the resolution. Both these technologies are described in further detail in Chapter 8.

Digital technology provides ease of use plus enhanced imaging quality and performance. This specialized detection system generally reduces the radiation dose to the patient. Positioning, however, is just as important in digital as in analog imaging. Digital does, however, have the advantage of ease of access to picture achieving and communication systems (PACS) and filmless storage. Digital also enables teleradiography, allowing radiologists to access images from remote locations via the Internet or telephone.18–20

**CAD Technology**

Interpreting mammograms can be a complex process where humans will visually examine the images in search of subtle, and often complicated indicators of breast cancer. This can be a difficult, tedious, and time-consuming task since mammograms are complicated images and screening mammography will show few abnormalities that are of concern. By combining digital or computed mammography with a computer, the computer can in effect preread the mammograms, scanning every part of the image and reporting any suspicious area. The computer can then display or analyze these suspicious areas to make the interpretation consistent from patient to patient.

The technology is called CAD or computer-aided diagnosis (the technology is discussed further in Chapter 8). A CAD device can convert analog hardcopy mammography images into a digital signal that can be analyzed by a computer (Fig. 2–11). The technology can also be integrated with digital mammography. CAD is designed to increase the productivity and accuracy of the radiologist’s interpretation. The technology allows radiologists to magnify regions of interest for greater visualization and to highlight suspicious areas. CAD works by first mapping normal healthy breast tissue that is then stored as a reference. Future images or breast maps are compared with the normal reference maps and the computer can then mark certain areas that need special attention. This technology cannot be used as a sole interpretation tool and is only as good as the initial CAD algorithms.19–21

**ADVANTAGES AND DISADVANTAGES OF DIGITAL TECHNOLOGY**

Although the patient positioning for digital and analog imaging is the same, the technology is different. One of the greatest advantages of digital is the ability to correct exposure factors after imaging. Factors 500%
greater than or 80% less than the normal range can be modified in post-processing techniques. The reason is the wide latitude of the digital image. The digital image has a much wider latitude than the analog image. The image latitude is the acceptable range of exposure factors used to produce an image that is of interpretation quality. Digital actually has a linear response to the intensity of x-ray exposure versus the curvilinear relationship of analog imaging. Other advantages of digital imaging include:

- The ability to optimize the image contrast.
- Improve workflow by reducing repeats and reduce cost associated with repeats.
- Reduction in lost images because every reprint is an original, therefore there is lesser medicolegal risk.
- Electronic image storage or archival and compressed storage options to reduce space.
- Multiple archival and storage options, including short-term storage on local computer hard drive, medium and long-term storage using redundant array of independent disks (RAID) or optical disks.
- Multiple viewing options including printing the final image using a laser printer, which offers daylight printing, or viewing the final image on a television monitor or LCD monitor.
- Complete Picture Achieving and Communication System (PACS) where images from multiple modalities can be viewed at one workstation.
- Teleradiography, where images can be transmitted to distant locations, e.g., radiologist’s home or even allowing virtual consultation by having Internet access to the images via telephone, cable, or satellite.

The main disadvantage of digital imaging is the start-up cost.

ADVANTAGES AND DISADVANTAGES ASSOCIATED WITH BREAST ULTRASOUND

Ultrasound imaging of the breast uses high-frequency sound waves measured in units of hertz (Hz) to create images of the breast anatomy (Fig. 2–10). The technology is detailed in Chapter 9. Sound is a
Ultrasound Imaging is Based on Piezoelectric Effect

The transducer:
- Converts electrical energy to acoustic pulses
- Receives the reflected echo and converts it to electrical signals

Mechanical longitudinal wave that cannot travel through vacuum. The technology is based on the piezoelectric effect, which is the ability to produce electricity when subjected to mechanical stress. In ultrasound imaging, the transducer holds the piezoelectric crystals. These crystals are capable of producing sound waves when an electrical charge is applied. This sound is sent throughout the breast tissue. The transducer is also capable of converting the retuning echoes (sound) to an electrical charge. A computer can then analyze the difference between the outgoing and incoming signals to create an image. In ultrasound higher transducer frequencies provide greater resolution but have less penetrating ability. Ultrasound uses no ionizing radiation. There are few documented risks or harmful bioeffects from sound wave.

Ultrasound of dense breasts can detect cancers missed on the mammogram, and many physicians are now recommending a mammogram plus a breast ultrasound on patients with dense breasts (Fig. 2–12). Ultrasound can also be used to determine if a mass seen on the mammogram is fluid-filled or solid.

A major disadvantage of breast ultrasound imaging is that it is only as good as the person holding the transducer. There are no convenient landmarks. If insufficient force is applied to the breast, normal breast tissue may look like a mass. Also, if the lump is not palpable and the technologist is not experienced, the area of interest can be missed entirely. Alternatively, if the incorrect gain (amount of sound) is applied, it can result in false echoes making a simple cyst look solid, indicating malignancy. Ultrasound cannot image microcalcifications and breathing and body size can affect imaging.5,10,17,22

ADVANTAGES AND DISADVANTAGES ASSOCIATED WITH MR IMAGING OF THE BREAST

Magnetic resonance imaging (MRI) uses no radiation. Breast MRI is detailed in Chapter 9 (Fig. 2–13). The technology utilizes the complex magnetic properties of metals and the interaction of body tissue with radio waves in a magnetic field. Imaging is often performed with a
paramagnetic compound, of which the major component includes gadolinium. MR imaging of the breast has been approved by the FDA since 1991. MRI is performed with the patient prone on the table and the breast falling into specialize breast coils. The table slides into the bore of the magnet and numerous points are sampled. Often, the examination can last 30–40 minutes.\textsuperscript{6,18,23}

MRI has numerous advantages in breast imaging, which includes mapping tumor extent, detecting multifocal or multicentric diseases, recurrence of breast cancer, or evaluating dense breast.

The disadvantages of MRI are mainly associated with metallic dangers and use of contrast agents. Some MRI contrast agents have been associated with a rare condition called nephrogenic systemic fibrosis (NSF). At present, the technology is very expensive and time-consuming and it cannot be used for imaging microcalcifications. Although the technology is evolving, currently it is very sensitive but it is associated with a high rate of false-positive biopsies. Patients with cardiac pacemakers, aneurysms clips (intracranial), intraocular ferrous foreign bodies, and pregnant patients should consult their physician before imaging.\textsuperscript{21}

### ADVANTAGES AND DISADVANTAGES ASSOCIATED WITH NUCLEAR IMAGING OF THE BREAST

At present, nuclear imaging technologies are not used as screening technologies because most are associated with high cost and high radiation dose, which limits their use. All nuclear imaging studies involve
Positron Emission Mammography Imaging

PEM imaging with the radiopharmaceutical, 18F-fluorodeoxyglucose (FDG), can be used to differentiate fibrotic scar tissue, necrosis, and tumor. It also provides important information on the staging and restaging of cancerous breast lesion. The radioactive substance is injected into an arm vein, then a special gamma scanner is used to detect the radiation emitted.21,24,25

The technology works on the principle that most cancerous tissues tend to need large amounts of sugar. The radioactive substance used, FDG, is metabolized in the body like sugar. It will therefore go to the tissue that is most active. PEM imaging is a valuable tool used for detecting the metastatic spread of breast cancer. Currently, PEM imaging is not effective as a primary breast cancer detection tool because it does not detect tumors smaller that 1 cm.21

Breast Scintigraphy or Scintimammography

Breast scintigraphy, scintimammography, or BSGI imaging does not detect small breast cancers as effectively as mammography screening, but it is useful in detecting tumors in dense breasts of younger women. The technology is unaffected by anatomical changes seen following chemotherapy and radiotherapy, and therefore this technique can be particularly useful in monitoring the treatment of breast cancer patients, especially when breast-conserving treatment is given. One of the main disadvantages of this technology is suboptimal resolution of the standard...
gamma camera, which makes it difficult to detect lesions of less than 10 mm; however, the development of high-resolution breast-dedicated gamma cameras has offset this disadvantage. The imaging is generally termed BSGI when the dedicated gamma cameras are used.

In any breast scintigraphy study, a small amount of radioactive substance is injected into the arm vein of the patient. The substance is absorbed by cancerous tissue in the breast and is imaged with a gamma camera. Currently, the primary radiopharmaceuticals used are (99m)Tc-sestamibi and (99m)Tc-tetrofosmin (Fig. 2–15).

Lymphoscintigraphy—Sentinel Node Mapping

Lymphoscintigraphy—sentinel node mapping employs a technique similar to scintimammography, in that a small amount of radioactive substance is injected into the patient (Fig. 2–16). The site of choice here is often the subareola lymphatic plexus.

Limitations of lymphoscintigraphy include poor visualization of the deep lymphatic system; however, the procedure can provide prognostic information based on the presence or absence of regional lymph node metastases. Because the cancerous node is identified, fewer lymph nodes are removed. This process of lymphatic mapping can eliminate most of the pain and discomfort of breast surgery for a majority of women with early breast cancer. Lymph node removal causes various side effects including extreme swelling of the arm and hand (lymphedema). By identifying the sentinel node, patients are spared an extensive node dissection surgery with its resultant side effects.

RISK FACTORS FOR BREAST CANCER

Cancer is caused by DNA damage (i.e., mutations) in genes that regulate cell growth and division. When cells acquire mutations in specific genes that control proliferation, such as proto-oncogenes or tumor suppressor genes, these changes are copied with each new generation of...
MAMMOGRAPHY AND BREAST IMAGING

cells. Later, more mutations in these altered cells can lead to uncontrolled proliferation and the onset of cancer. Any factor that causes an increase in the level of mutation or does not suppress the growth of abnormal cell division is considered a risk factor. Risk factors will therefore increase a person’s chance of getting a disease. There are two general risk models that can be used to estimate risk factors. One determines the likelihood that an individual is a carrier of a BRCA1, BRCA2, or other gene mutations while the other calculates a woman’s absolute risk of developing breast cancer over a lifetime.32

Types of Risk Assessments

The first scenario includes the BRCAPRO model, the Myriad I and II, the Breast and Ovarian Analysis of Disease Incidence and Carrier Estimation Algorithm (BOADICEA), and the Ontario-Family History Assessment Tool (FHAT). These all identify approximately 50% of mutation-negative cases but fail to identify 10% of mutation carriers. BRCAPRO model incorporated published BRCA1 and BRCA2 mutation frequencies and also considers the cancer status of first-degree and second-degree relatives. In addition, it provides estimates for the likelihood of finding either BRCA1 mutation or BRCA2 mutations in a family. The major drawback from this breast cancer risk-assessment is that no other ‘genetic’ factor is checked. The model predicted only 49% of the breast cancers that actually occurred in the screened group of 1,900 women.32

The other options of risk prediction models can be used to estimate an individual’s risk of breast cancer over time. These include the Gail Model and Gail Model 2. The original Gail Model was developed in 1989 from data derived from the Breast Cancer Detection and Demonstration Project (BCDDP) and it is used for screening purposes to estimate the probability of developing breast cancer over a defined age interval. The Gail Model 2 includes an assessment of the history of first-degree family members and also predicts the risk of invasive breast cancer. The Gail Model 2 is often used in breast cancer prevention trials; however, it is most accurate for non-Hispanic white women and tends to overestimate risk in younger women. The model also reduces accuracy within the minority populations and does not fully calculate the association between breast density and family history when calculating breast cancer risks. Another major limitation of the Gail Model is the lack of assessment of male relatives and there is no accounting for the age of onset of breast cancer.

A newer model, the CARE Model, is proving more accurate within the minority community by using data from a large case control study of African American women participating in the Women’s Contraceptive and Reproductive Experiences (CARE) Study.

In the future, the prediction is that newer models will consider factors such as breast density, mammographic density change across examinations, use of HRT, pre- and postmenopausal populations, weight, age at birth of first live child, and number of first-degree relatives with breast cancer. The Cuzick–Tyner model, one of the latest assessment tools, is based partly on a data acquired from the International Breast Intervention Study and other epidemiological data.
incorporated extensive family history, hormonal use or exposure and incidence of benign breast diseases.

The Gail Model 2 is often used by the US FDA and is also used by the US National Cancer Institute. To improve the accuracy for minorities, data from the CARE study, from NCI’s Surveillance, Epidemiology, and End Results (SEER) Program and from the Asian American Breast Cancer Study (AABCS) are often incorporated in the risk assessment.12

Risk factors in breast cancer can be categorized into major and minor. Major risk factors are those beyond a woman’s control; these factors cannot be changed. Minor risks can be lifestyle choices, hormonal related or they may be cancer-causing factors in the environment. Major risk factors carry a significantly higher risk for breast cancer than minor risk factors. However, having a risk factor or even several risk factors does not mean that a person will get the disease (Box 2–8).1

**Box 2–8. Risk Factors for Breast Cancer**

<table>
<thead>
<tr>
<th>Risks Factors</th>
<th>Estimated Relative Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major risk factors</strong></td>
<td></td>
</tr>
<tr>
<td>Gender (female)</td>
<td></td>
</tr>
<tr>
<td><strong>Other major factors</strong></td>
<td></td>
</tr>
<tr>
<td>1. Aging</td>
<td>&gt;4</td>
</tr>
<tr>
<td>2. Genetic risk factors including positive BRCA1/BRCA2 mutation</td>
<td>&gt;4</td>
</tr>
<tr>
<td>3. Family history of breast cancer</td>
<td></td>
</tr>
<tr>
<td>• Two or more relatives (mother, sister)</td>
<td>&gt;5</td>
</tr>
<tr>
<td>• One first-degree relative</td>
<td>&gt;2</td>
</tr>
<tr>
<td>• Family history of ovarian cancer in women younger than 50 years</td>
<td>&gt;2</td>
</tr>
<tr>
<td>4. Personal history of cancer or breast cancer</td>
<td>3–4</td>
</tr>
<tr>
<td>• Breast biopsy with atypical hyperplasia</td>
<td>4–5</td>
</tr>
<tr>
<td>• Breast biopsy with LCIS or DCIS</td>
<td>8–10</td>
</tr>
<tr>
<td><strong>Minor risk factors</strong></td>
<td></td>
</tr>
<tr>
<td>• Women who have not given birth</td>
<td>2</td>
</tr>
<tr>
<td>• Having a first child at older than 30 years</td>
<td>2</td>
</tr>
<tr>
<td>• No breast-feeding</td>
<td>2</td>
</tr>
<tr>
<td>• Early menarche (&lt;12 yrs)</td>
<td>2</td>
</tr>
<tr>
<td>• Late menopause (&gt;51 yrs)</td>
<td>1.5–2</td>
</tr>
<tr>
<td>• Use of hormone replacement therapy—combined estrogen/progesterone HRT</td>
<td>1.5–2</td>
</tr>
<tr>
<td>• Current or recent use of oral contraceptives</td>
<td>1.25</td>
</tr>
<tr>
<td>• Adult weight gain</td>
<td>1.5–2</td>
</tr>
<tr>
<td>• Sedentary lifestyle—no exercise</td>
<td>1.3–1.5</td>
</tr>
<tr>
<td>• Alcohol consumption</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Major Risk Factors

The biggest risk factor for breast cancer is gender, i.e., being female. Breast cancer is a disease that primarily occurs in females, although men will occasionally develop the disease. Gender is therefore considered the biggest risk factor for breast cancer.

Other major factors include the following:

1. **Aging:** Age is an important risk factor because as a woman ages the incidence of cancer increases. Approximately 18% of breast cancer is diagnosed in women in their 40s while 77% of women are more than 50 years of age when they are diagnosed. Women younger than 30 years account for only 0.3% of breast cancer cases and women in their 30s account for approximately 3.5% of cases. It is estimated that while the probability of developing breast cancer is only 0.06% for a woman at age 20. That percentage jumps to 1.44% at age 40, 2.39% at age 50, and more than 3% for a woman at age 70. All women have a lifetime risk of approximately 12%, meaning that women face a 12% probability of developing breast cancer. It is from this calculation that the 1 in 8 statistical risk number was developed.1

2. **Genetic risk factors:** Approximately 5–10% of breast cancer cases are hereditary. A woman with a hereditary risk for breast cancer may carry the BRCA1 or BRCA2 genes. BRCA1 and BRCA2 are tumor suppressor genes. They keep cancer tumors from forming. If the genes are mutated, cells will no longer die when they should and a cancer will grow. Some mutations are inherited, while others are caused by exposure to radiation or mutation-inducing chemicals. Mutations can also occur spontaneously as a result of mistakes that are made when a cell duplicates its DNA molecules prior to cell division. Women with a normal gene have a protective effect because the genes make proteins that keep cells from growing abnormally. Therefore, with the mutated gene there is an increased susceptibility to breast cancer. Approximately 1% of the general population carries the mutated gene and molecular tests are available to identify someone with the BRCA mutations responsible for inherited forms of breast cancer. Studies have also shown that not all women who carry the mutated gene will develop breast cancer, so it is important for women considering the test to carefully weigh the benefits and risks of genetic testing.1

Other genetic mutations are much rarer. These include ATM, p53, CHEK2, PTEN, and CDH1. The ATM gene functions to repair DNA damage. In some families, inheriting one mutated copy of this gene carried a risk for breast cancer. The p53 is a tumor suppressor gene. Inheriting this gene carries an increased risk for breast cancer, leukemia, brain cancer, and sarcomas. The CHEK2 gene is also a tumor suppressor that is activated in case of DNA damage. Mutation of this gene increases breast cancer risks. The PTEN gene normally helps in the regulation and growth of cells. Mutations result in Cowden syndrome, which is rare and often results in increased benign and malignant tumors in the breast, digestive tract, thyroid, uterus, and ovaries. The CDH1 gene and the protein associated...
with it works to ensure that cells within tissues are bound together. Mutations are linked to gastric, breast, colorectal, thyroid, and ovarian cancers.

3. Family history of breast cancer: Breast cancer risk is higher among women whose close first-degree relatives have this disease. A first-degree relative can be from either the mother’s or the father’s side of the family, but the closer the relative, the higher the risk factor. For example, a mother, sister, or daughter with breast cancer, will double the risk. The more first-degree relatives with the disease, the greater are the risks. Having two first-degree relatives with the disease increases the risk by fivefold. Women are also at a higher risk if the breast cancer occurs in a relative before age 50. Women with a family history of breast cancer in the male members of the family are also at risk. Although having a family history will increase breast cancer risks, over 85% of women who develop breast cancer have no family history of the disease.

4. Personal history of cancer or breast cancer: A woman with cancer in one breast has a greater risk of developing a new cancer in the other breast. Also, women who have had the chest area radiated because of a previous cancer treatment, such as for Hodgkin’s disease (or non-Hodgkin’s lymphoma), are at a slightly increased risk for breast cancer.

5. Dense breast tissue: The breast is made up of a varying mixture of fatty tissue and glandular or dense tissue. Dense breast is not a disease; however, it is genetic and often a woman will be told of her breast density after the first mammogram. Although the variation of fat and glandular tissue is due to genetics, the amounts can also vary with age. As a woman ages the breast slowly loses its glandular tissue in a process called involution. The glandular tissue is replaced with fat. Glandular tissue therefore predominates in younger women, whereas fatty tissue predominates in older patients. However, weight gain at any age will increase the fat content of the breast leaving the breast less dense. Similarly, as a woman loses weight the fat content of the breast will decrease resulting in an overall denser breast.

   If the breast is mainly fatty tissue with very little lobules/glandular tissue to begin with, even with weight loss it will not fit the definition of a dense breast. If the breast is dense to begin with, gaining weight will disperse the dense tissue and the breast will seem less dense but overall it will still be considered a dense breast.

   There have been conflicting studies on density of the breast and breast cancer risks with the recent studies leaning toward density being a factor in breast cancer risks in younger women. One reason is that breast cancers tend to develop in the dense tissue of the breast. Therefore, if a woman has dense breast tissue, she would be at higher risk of developing breast cancer than a woman of the same age with fatty breast. Other studies also show that women with dense breast face a higher risk of missed breast cancer if the mammogram is the only screening tool used. Analog mammography does not image dense breast very well. Digital mammography imaging is a more effective tool for imaging dense breast. Women with dense breast also
have other options. Although mammography is still the gold standard for breast imaging, women with dense breast should utilize any of the adjunctive modalities including breast ultrasound and breast MR imaging. Ultrasound and breast MR are not effective screening tools for breast cancer; however, when used with digital mammography imaging they improve the odds and can help to prevent missed breast cancer.5,33

Minor Risk Factors

Many minor breast cancer risk factors are associated with hormonal changes in the woman’s body. Studies have suggested that although estrogen, one of the main female hormones, does not appear to directly cause the DNA mutations that trigger the development of human cancer, estrogen does stimulate cell proliferation, therefore promoting cancer growth.1 In other words, if breast cells already possess a DNA mutation that increases the risk of developing cancer, these cells will proliferate (along with normal breast cells) in response to estrogen stimulation. All factors that affect the reproductive hormones, namely estrogen, in a woman’s body will also increase risks for breast cancer.34

These risks include the following:

1. Women who have not given birth or those having a first child are older than 30 years. Pregnancy is thought to have a protective effect against having breast cancer because during the pregnancy the woman is not menstruating and there are no regular cycles of increasing estrogen levels. Therefore, it follows that the longer a woman goes without getting pregnant, the greater are her risks for breast cancer.

2. Some studies suggest that breast-feeding has a protective effect especially if the feeding continues for 1½ to 2 years. A possible reason is that breast-feeding will reduce the total number lifetime menstrual cycles. It, therefore, follows that not breast-feeding will increase the risk of breast cancer.

3. Women who started menstruating at an early age (before age 12) or went through menopause at a late age (after age 55) are at an increased risk for breast cancer. As long as a woman is menstruating, there is a risk of mutating genetic material. The greater the amount of menstrual cycles in the woman’s lifetime, the greater would be the risk of breast cancer. Breast cancer risk rises by approximately 3% for each year of delayed menopause. Delayed generally means onset after age 51, which is the average age of menopause for women in the United States.

4. Another risk associated with hormone use includes the use of birth control pills. This very slight increased risk is limited to the older types of birth control. Most modern birth control is not associated with any cancer risk even after prolonged use. The exception would be with women carrying the BRCA1 or BCA2 gene and women younger than 21 years. Younger women had an increased risk if the pill is taken over 10 years. Older birth control pills were associated with a slight increased risk for developing breast cancer.
5. The use of hormone replacement therapy has been proven to have a significant impact on breast cancer risks. Women taking HRT take either estrogen alone or a combination of estrogen and progesterone. It is thought that the combination of estrogen and progesterone in HRT may increase the risk of developing cancer. Combining estrogen and progesterone for 5 years will double your breast cancer risks. Estrogen therapy alone will result in the lower risk for breast cancer but an increased risk for endometrial cancer. Most studies found that the risks associated with HRT would return to normal within 2 years of stopping HRT. The administration of hormones generally increases the proliferation of glandular tissue and because cancers are harder to detect in dense breast the increase in glandular tissue caused by the HRT reduces the effectiveness of the mammogram.¹

FACTS VERSUS MYTHS AND MISCONCEPTIONS

Abortion and breast cancer: The National Cancer Institute (NCI) has concluded that having an abortion or miscarriage does not increase a woman’s subsequent risk of developing breast cancer. The theory, however, is that terminating an unintended pregnancy sacrifices the protective effects of a term delivery. The effect would be the same as a delayed childbearing therefore the net effect would be an increased risk.³⁴

Accuracy of the mammogram: Many women believe totally in the mammogram without practicing BSE and CBE. On an average, the mammogram will detect only approximately 90% of breast cancer. Mammography is also more accurate in postmenopausal women compared with menopausal women.¹ The accuracy or lack of accuracy of mammograms can actually have an impact on the doctor–patient relationship. The authority figure of the physician is well established and many women will undergo a mammogram on the recommendation of their physician even if they themselves are not entirely convinced that the procedure is necessary. The most meaningful factor affecting many women’s decision to have a mammogram is often the physician’s recommendation. However, the stability of the doctor–patient relationship is one of trust. The patient will not respect the opinion or advice of a physician she cannot trust, and patients will question a physicians’ advice when they or their friends are repeatedly subjected to false-positive readings or unnecessary biopsies. Judicious use of the latest technology in reducing the level false-positive reports should be the goal for all interpreting physicians. Also, since radiology is a dynamic field with the technology constantly changing, proper initial training and regular in-service or continuing education courses, is essential if both the radiologists and mammographers hope to keep the patient informed.¹

Alcohol and breast cancer risks: Some studies have suggested that moderate alcohol consumption can cause a modest increase in breast cancer risks. Heavy drinking, however, will double the risk. Heavy drinking is considered over four drinks per day. Studies have also shown that drinking 3–4 glasses of wine per day will increase the
risks of breast cancer by 37%. Women who drank the equivalent of a half glass of wine a day were 6% more likely to develop breast cancer. Women who drank a glass or two a day faced a 21% increased risk of breast cancer. The theory is that alcohol increases the circulation levels of estrogen, or changes the way the body metabolizes estrogen, which in turn causes cancer to grow. The risks were found to be greater in menopausal women. Menopausal women who drank a half glass of wine daily increased their chance of breast cancer by 18%.35

In addition to the link between alcohol and estrogen, research has identified several genes that are involved with alcohol metabolism. One enzyme, alcohol dhydrogenase (ADH), is responsible for breaking down alcohol into acetaldehyde, which is carcinogenic in animals. Postmenopausal women with a variation in the gene that codes for ADH were at greater risk.35,36

Aspirin and breast cancer: The Journal of Breast Cancer Research has shown that aspirin on a daily basis may lower risk factors. The study showed a reduction of 16% in estrogen receptor-positive (ER+) breast cancers. Approximately 75% of breast cancers are ER+. These cancers have receptor for the female hormone estrogen on their surface. Aspirin can block an enzyme called cyclooxygenase (COX), an activity that disrupts breast cancer development by reducing the amount of estrogen produced in the body.

Augmented breast and cancer risks: Having a silicone or saline implant can cause scarring of the breast tissue; however, neither type of implant is linked to any significant increase in breast cancer risks. In the past, breast cancers were missed in the augmented breast because of the limits of the technology; however, newer methods of mammogram imaging techniques (discussed in Chapters 7–9) and current imaging technology including ultrasound and MRI can be used to complement mammography screening and are effective in diagnosing cancer in the augmented breast. Recently the US FDA announced a possible association between saline and silicone gel-filled breast implants and anaplastic large cell lymphoma (ALCL), a very rare type of cancer. ALCL can appear in different parts of the body including the lymph nodes and skin. The data suggests that patients with breast implants may have a very small but significant risk of ALCL in the scar capsule adjacent to the implant.1

Breast cancer risk: Many women believe that if they do not have a first-degree relative with breast cancer they need not worry about getting the disease. The fact is, however, that approximately 90% of women who develop breast cancer do not have a first-degree relative with the disease.1 The greatest risk for breast cancer is gender, being female. The next is increasing age, and this is the most important reason the patient should be returning for yearly mammograms despite past negative results. Only 17% of breast cancer is diagnosed in women younger than 30 years whereas 50% of all breast cancers are diagnosed in women aged 65 and older.1,35

Chemicals and breast cancer: Some studies suggest certain chemicals in the environment have estrogen-like properties and could affect breast cancer risks. Chemicals of this nature are known as endocrine disruptors. They interfere with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body.
including estrogen. The effects of exposure to endocrine disruptors are permanent, especially if exposure occurs during development.

Chemicals known as endocrine disrupters are Bisphenol A, commonly abbreviated as BPA, often used to make plastic, including baby bottles; DDE, dichlorodiphenyldichloroethylene, which is a breakdown product of DDT. DDT is an organochlorine insecticide that is now banned from use in the United States; PCBs, polychlorinated biphenyls, which is a class of organic compounds used in transformers and coolants. This product has also been banned; and DES, diethylstilbestrol, which is a nonsteroidal estrogen used in the past to prevent spontaneous abortions. It was discovered that children whose mothers used DES have an increased risk for breast and vaginal cancer.

Deodorants and antiperspirant: Some research studies have focused on the preservatives used in antiperspirants and deodorants that can be found in breast tumors. In laboratory tests, these preservatives, called para-hydroxybenzoic acids or parabens, have been shown to act like estrogen in the body. Some scientists, therefore, fear that like estrogen they could increase breast cancer risks, especially because of the proximity of the underarm to the breast. Parabens are also found in many other cosmetic products such as shampoo and makeup. They are also found in medication and food items. A second theory suggests that antiperspirants, which inhibit the sweat glands, will prevent toxins from leaving the body, and a third suggestion is the increased breast cancer risk for women using a blade (nonelectric) razor with an underarm antiperspirant or deodorant, or for women using an underarm antiperspirant or deodorant within 1 hour of shaving with a blade razor.

The National Cancer Institute (NCI) is not aware of any conclusive evidence linking the use of underarm antiperspirants or deodorants and the subsequent development of breast cancer. The US Food and Drug Administration, which regulates food, cosmetics, medicines, and medical devices, also does not have any evidence or research data that ingredients in underarm antiperspirants or deodorants cause cancer.

In 2002, the results of a study looking for a relationship between breast cancer and underarm antiperspirants/deodorants did not show any increased risk for breast cancer in women who reported using an underarm antiperspirant or deodorant. The results also showed no increased breast cancer risk for women who reported using a blade (nonelectric) razor and an underarm antiperspirant or deodorant, or for women who reported using an underarm antiperspirant or deodorant within 1 hour of shaving with a blade razor. These conclusions were based on interviews with 813 women with breast cancer and 793 women with no history of breast cancer.16,37

A different study examining the frequency of underarm shaving and antiperspirant/deodorant use among 437 breast cancer survivors was released in 2003. This study found that the age of breast cancer was significantly lower in women who used these products and shaved their underarms more frequently. Furthermore, women who began both of these underarm hygiene habits before 16 years of age were diagnosed with breast cancer at an earlier age than those who began these habits
Mammography and Breast Imaging

later. While these results suggest that underarm shaving with the use of antiperspirants/deodorants may be related to breast cancer, it does not demonstrate a conclusive link and a serious limitation of the study was the absence of a control group without breast cancer. That means, there could be a simple explanation for the findings: younger women use antiperspirant and shave more often than older women.36,38–40

Diet: The link between diet or weight and breast cancer can often give conflicting results. Being overweight is often linked with a higher risk for cancer, especially if the weight gain took place after menopause. Before menopause, the ovaries produce most of the body's estrogen but after menopause, estrogen comes from fat. This means that having more fat will raise the estrogen levels in the body. Studies also suggest that weight gain as an adult carries a higher risk than overweight since childhood. In addition, weight gain in the waist will affect the risk more than the same amount of fat in the hips and thighs. Higher body fat also leads to higher insulin levels, which is also linked to breast cancer during adulthood. However, the link is complex and researchers are still not sure of the relationship. Since a high percentage of breast cancer is estrogen receptor-positive, excess estrogen can potentially increase the growth rate of the cancer.6,35

Exercise and breast cancer: Girls and young women who exercise regularly between the ages of 12 and 35 have a substantially lower risk of breast cancer before menopause compared to those who are less active. The risks are estimated to be 23% lower for physically active women. Brisk walking 1.25–2.5 hours a week can reduce a woman's risk by 18%. The American Cancer Society recommends 45–60 minutes of physical activity five or more days per week.35

Fibrocystic breast increases the risk: In the past, fibrocystic breast was thought to be a breast disease; however, studies have proven conclusively that fibrocystic changes are not cancerous and do not affect a woman's breast cancer risk.6,35

Gender: Males will not get breast cancer. Only about 1,600 male get a diagnosis of breast cancer each year in the US. However the incidence of breast cancer in males has increased 25% in the past 20 years and one study suggest that breast cancer kills 25% of men who develop it. Some reasons give was the lack of knowledge about the disease, the tendency to ignore breast lumps and reporting for treatment when the cancers are invasive or have already metastasized.39

Injury to the breast: Trauma or injury to the breast has not been proven to cause breast cancer. When breast tissue is injured, fat necrosis can occur and as the body heals, a scar can develop. The scar tissue is sometimes mistaken for cancer on the mammogram. Also, some women will discover a cancer because they are examining their breast after an injury. There is, however, no link between the two.6,38

Mammograms are painful: Mammograms are uncomfortable but the compression takes less than a minute. Mammograms will be more uncomfortable for women with sensitive breasts. To reduce the sensitivity of the breast the mammogram should be scheduled 7–10 days after the start of the period when breasts are least sensitive. Although eliminating caffeine from a woman's diet for a month prior to the mammogram could reduce the sensitive of the breast, it is

The American Cancer Society recommends 45–60 minutes of physical activity five or more days per week.
nearly impossible to remove caffeine completely because it is found in so many products, including tea, chocolate, sofa and coffee, just to mention a few.1,2,3

Mastectomy and breast cancer: Approximately 8–10% of women will have a recurrence in the scar after a mastectomy. Also, before the mastectomy, the cancer could have already spread to the other areas of the body. Most research suggests patients should have either visual inspection of the site by an oncology or imaging should be done yearly within the first 5 years of the mastectomy.3

Prophylactic mastectomy: A prophylactic mastectomy is the surgical removal of the breast for women with a very high risk for breast cancer. Some women opt to have their breasts removed to reduce their risk of developing the disease. Some prophylactic mastectomies might add years to a woman’s life; however, the risk of breast cancer remains and having the breast removed does not guarantee that the cancer will not develop in the small amount of breast tissue remaining after the surgery. Some studies show that having a prophylactic mastectomy can reduce the breast cancer risks by up to 90%. However, a woman is at risk as long as there is breast tissue present and breast tissue will extend to the neck, under the arms, and into the chest wall. This tissue is not removed during a mastectomy.6,15,35,41

Race: Some studies confirm that white women have a slightly higher breast cancer risk than black women, but black women are more likely to die from this cancer. Studies, however, show a more complicated picture, and in fact, race actually plays a very minimal part in mortality rates. Factors such as the environment, lifestyle, staging and treatment, and not race, are often more critical in the prognosis of the disease. Further investigation often determines that the high death rate among blacks can be attributed to finding cancers at a later stage, limited treatment options and poor treatment planning; however, socioeconomic factors and discrimination can and will have a profound influence in both the detection and treatment of breast cancer. Research also shows that although the majority of breast cancers in United States are estrogen receptor-positive this is often not the case of cancers in blacks.30–35

One study showed that blacks were more likely than whites to be diagnosed with large tumors and distant-stage disease.

Another clinical study found that women were 1.4–3.6 times more likely to be diagnosed at a later and more likely fatal stage of the disease, if they were blacks, American Indians, Hawaiians, and women of Indian, Pakistani, Mexican, Puerto Rican, and South and Central American descent. According to the study, blacks as well as women of Mexican and Puerto Rican descent were 20–50% more likely to receive initial treatment that was inappropriate or inadequate, and blacks, American Indian, Hawaiian, Vietnamese, and women of Mexican, Puerto Rican, South and Central American descent had a 20–200% greater risk of dying after a breast cancer diagnosis. In fact, in all minorities the proportion of disease diagnosed at advanced stage and with larger tumor size is greater than whites.34,42–48

Risks factors and breast cancer: A risk factor gives only the probability of breast cancer and even a strong factor is not a certainty. Also, studies
have shown that 80% of women who get breast cancer have no identifiable risk factors.\textsuperscript{35}

**Radiation and breast cancer:** Past chest wall radiation for cancer treatment, such as Hodgkin's disease or non-Hodgkin's lymphoma, can lead to the development of bilateral breast cancer in patients as young as thirty. The risk varies with the patient's age when they were radiated with the highest risk associated with radiation during adolescence when the breasts are still developing. One study however, suggested that if chemotherapy is given, it will stop the production of ovarian hormones, which would lower the risks.\textsuperscript{35}

**Symptoms versus no symptoms:** Despite the increased public awareness about breast cancer, there is still a general feeling among many women that any illness will manifest itself in a physical or visible form. Unfortunately, breast cancer in its early state is symptomless. As the cancer grows, some symptoms may appear. These can include lumps in the breast, nipple discharge, and thickening of the breast skin, puckering or dimpling of the breast, and inverted nipples or a discharge from the nipple. Women who closely monitor their health status in terms of diet and routine exercise or who adopt other preventative health measures often feel more in control of their health. These women are likely to have routine mammograms because doing so is an extension of their health-conscious behavior and need to have control of their lives. Women least likely to obtain a mammogram are those who are less health conscious or who have uncertain attitudes about health care and preventive medicine, including mammography.\textsuperscript{35}

**Women and breast cancer:** Breast cancer does occur primarily in women; however, men do have breast tissue and can get breast cancer. Breast tissue in women is constantly undergoing changes due to fluctuating hormones in the woman's body. Women also have more breast tissue than men and the male breast generally does not have lobules. These are some of the reasons that women are more at risk for breast cancer than men; however, approximately 1600 cases of male breast cancer are diagnosed every year in the United States.\textsuperscript{1,35}

**Summary**

Mammographers should be able to provide compassionate and proficient care. Patients coming for a mammogram often need reassurance, counseling, and education in addition to professional service.

In ensuring patient compliance, the mammographer needs to be understanding, informed, and compassionate. Often, the mammographer is the only link between the radiologist and the patient and action or lack of action can have repercussion in conveying information, or helping in diagnosis.

Communication should take place before, during and after the examination. It should be face-to-face and as informal as possible, and should include listening and facilitator skills to encouraging comments, relax and perhaps educate the patient. There is less chance of suboptimal imaging of the pectoral muscles when the patient is relaxed, and a relaxed patient is more likely to confide details of personal history that can affect diagnosis, perhaps identify
sensitive breasts and the reason for the sensitivity, or reveal myths and misconception that can be addressed.

Patients should consult with their physician on the mammography screening guide that is best for them. The screening can depend on the type of breast tissue (fatty versus dense), the patients’ family history or personal history, or the genetic makeup of the patient. In addition, imaging patients can practice BSE and can request that their physician perform a CBE regularly.

Before any mammography examination, the mammographer needs to take a detailed clinical history. The clinical history documentation include documentation of family or personal history of breast cancer; history of breast surgery including biopsies, lumpectomies, augmentations or reductions; and any history of breast trauma. Mammographers will also need to document clinical symptoms such as skin thickening, unusual lumps, dimpling or puckering, moles, eczema, ulcers, and nipple changes or nipple discharge. Other breast abnormalities such as accessory breast or nipples should be documented.

The radiation dose from a one-projection mammogram is a measure of the glandular dose. It should be no more than 0.3 rad (3 mGy) with a grid and no more than 0.1 rad (1 mGy) without a grid. The entrance skin dose, however, is generally much higher, in the range of 8–1.4 rad (800–1400 mrad or 8–10 mGy).

Breast imaging with mammography is still the gold standard, however, in addition to analog imaging, digital mammography, and computed mammography including computer-aided diagnosis (CAD) are fast becoming the norm. Adjunctive technologies are ultrasound, magnetic resonance imaging (MRI), and molecular imaging included PEM–FDG, breast scintigraphy, and lymphoscintigraphy or sentinel node mapping.

Despite better imaging techniques, improved contrast, increased resolution, reduced radiation dose to the breast, and the increased sensitivity of imaging techniques, myths and misconceptions about breast imaging abound. It is the mammographer’s responsibility to educate the patient and be an informed and responsible imager.
REVIEW QUESTIONS

1. List three reasons for taking and documenting the patient’s medical history.
2. Why should women practice breast self-examination?
3. Describe the differences between the BSE and the CBE.
4. How often should a woman practice a BSE and CBE?
5. State the three different methods used to perform a systematic self-examination of the breast.
6. When is the best time to conduct BSE?
7. What is the recommended guideline for routine mammography screening as suggested by the ACS?
8. What is the maximum average glandular dose for a single mammography projection as recommended by the ACR?
10. List two advantages and two disadvantages of breast ultrasound.
11. List two advantages and two disadvantages of MRI of the breast.
12. How is PEM used to detect breast cancer?
13. How can breast scintigraphy be useful as an adjunct-screening tool?
14. Explain the difference between computed and digital mammography.
15. How is digital mammography imaging similar to analog mammography screening?
16. How can CAD improve mammographic interpretation?
17. What is the difference between a major and a minor risk factor?
18. What is the biggest risk factor for breast cancer?
19. Name four other major risk factors for breast cancer.
20. Name two minor risk factors for breast cancer.
1. The glandular dose is:
   (A) the dose received on the skin of the breast
   (B) associated with dose to the radiosensitive cells of the breast
   (C) the significant background dose recorded in ultrasound
   (D) a record of the dose to the gonads

2. Factors that should be reported on the patient's medical history documentation because of their significant impact on diagnosis include:
   (1) history of breast trauma
   (2) painful lumps or masses
   (3) sudden nipple retraction
   (A) 1 only
   (B) 1 and 2 only
   (C) 2 and 3 only
   (D) 1, 2, and 3

3. BSE describes:
   (A) normal examination of the breast by a clinician
   (B) yearly screening of the breast by the mammographer
   (C) bilateral self-check of the breast by the patient
   (D) monthly examination of both breasts by the physician

4. The ideal time to conduct a breast examination is:
   (A) within the last 10 days of the menstrual cycle
   (B) within 10–14 days after the period ends
   (C) within three weeks after the end of the menstrual period
   (D) on the last day of the menstrual cycle

5. In digital mammography systems, both the film and cassette can be replaced by:
   (A) an electronic detector system
   (B) the CAD technology system
   (C) a flexible storage phosphor
   (D) photostimulatable plates

6. MRI imaging
   (A) uses complex magnetic properties of elements
   (B) explores the behavior of liquids or solids in metal
   (C) images the patient in less than 15 minutes
   (D) is less sensitive than a mammogram

7. CAD is used to
   (A) visually enhance an image for viewing
   (B) modify the contrast and brightness of an image
   (C) analyze or pre-read the image before interpretation by a radiologist
   (D) provide functional details of the breast

8. Minor risk factors of breast cancer are associated with:
   (1) Use of HRT
   (2) family history of breast cancer
   (3) nulliparity
   (A) 1 and 2 only
   (B) 2 and 3 only
   (C) 1 and 3 only
   (D) 1, 2, and 3

9. Major risk factors for breast cancer include:
   (1) use of birth control pills
   (2) age
   (3) genetic risks
   (A) 1 and 2 only
   (B) 2 and 3 only
   (C) 1 and 3 only
   (D) 1, 2, and 3

10. A risk factor is any:
    (A) factor within a person’s control
    (B) factor outside a person’s control
    (C) significant factor that increases a person’s chance of getting a disease
    (D) factor that decreases a person chance of getting a disease
REFERENCES


