IMAGING LAB
MPHY 487

Mammography Machines

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Contents

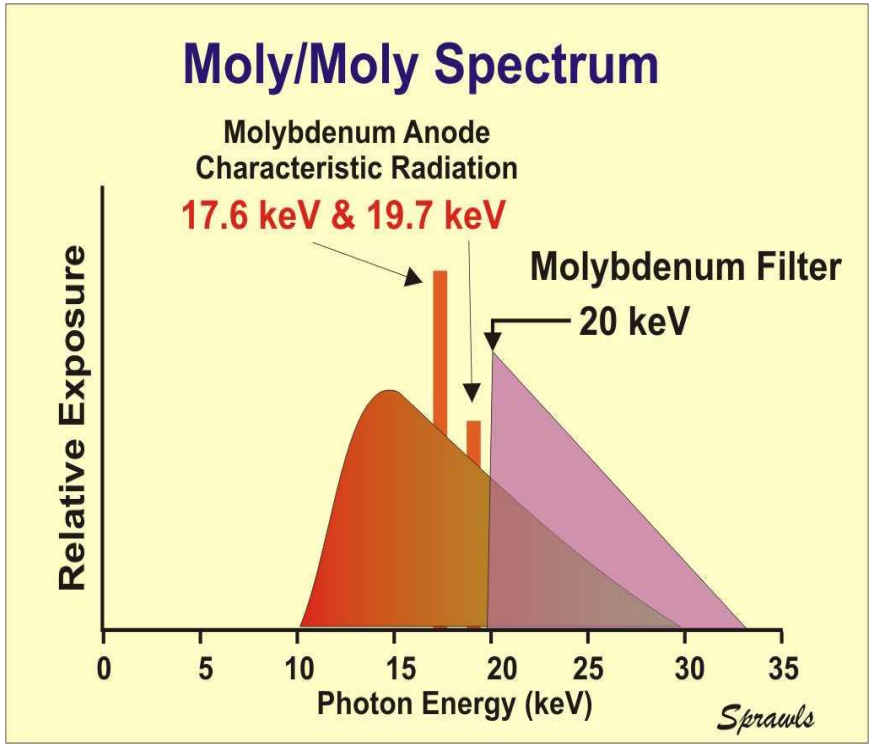
Statics Information

- About 1 in 8 U.S. women (about 12%) will develop invasive breast cancer over the her lifetime.
- In 2016, an estimated 246,660 new cases of invasive breast cancer are expected to be diagnosed in women in the U.S., along with 61,000 new cases of non-invasive (in situ) breast cancer.
- About 2,600 new cases of invasive breast cancer are expected to be diagnosed in men in 2016. A man’s lifetime risk of breast cancer is about 1 in 1,000.
- About 40450 women in the U.S. are expected to die in 2016 from breast cancer.
- For women in the U.S., breast cancer death rates are higher than those for any other cancer, besides lung cancer.
- Besides skin cancer, breast cancer is the most commonly diagnosed cancer.

Mammography Machine

- Using low-energy X-rays around 30 kVp to examine the human breast.
- The goal of mammography is the early detection of breast cancer, typically through detection of characteristic masses and/or micro calcifications.
- Mammography has 2 plates that compress or flatten the breast to spread the tissue apart. This gives a better picture and allows less radiation to be used.
- On average the total dose for a typical mammogram with 2 views of each breast is about 0.4 mSv.
- A newer type of mammogram is **3D mammography**. The breast is compressed once and a machine takes many shots as it moves over the breast. A computer then reconstruct the images into a 3D.
- This uses more radiation than most 2D, but it give clearly images.

Mammography Machine



- Uses molybdenum anodes or in some designs, a dual material anode with an additional rhodium track.
- These materials are used because they produce a characteristic radiation spectrum that is close to optimum for breast imaging.
- Molybdenum use as a target Because Z have two energies and two characteristic radiation at 17.9keV and 19.5keV

Spatial Resolution

- Human eye can see 200 μm object size
- spatial resolution of the eye is 200 μm

Gamma Camera	0.1 lp/mm
Magnetic Resonance Imaging	1.5 lp/mm
Computed Tomography	1.5 lp/mm
Diagnostic Ultrasound	2 lp/mm
Fluoroscopy	3 lp/mm
Digital Radiography	5-7 lp/mm
Screen-Film Radiography	8-10 lp/mm
Mammography	15 lp/mm

Types of Mammograms

- **Screening Mammograms**

- Used to look for signs of breast cancer in women who don't have any breast symptoms or problems. X-ray pictures of each breast are taken from 2 different angles.

- **Diagnostic Mammograms**

- Used to look at a woman's breast if she has a breast problem or a change is seen on a screening mammogram.

- They may include extra views (images) of the breast that aren't part of screening mammograms.

- Sometimes diagnostic mammograms are used to screen women who were treated for breast cancer in the past.

What do mammograms show?

- Mammograms can’t prove that an abnormal area is cancer, but they can help physicians decide whether more testing is needed.
- The 2 main types of breast changes found with a mammogram are calcifications and masses.
- **Calcifications** are tiny mineral deposits within the breast tissue. They look like small white spots on the pictures. They may or may not be caused by cancer.
- **A mass**, is a tumor, may or may not have calcifications, and is another important change seen on mammograms. Masses can be many things, including cysts (fluid-filled sacs) and non-cancerous solid tumors, but they could also be cancer. Any mass that’s not clearly a simple fluid-filled cyst usually needs to be biopsied.

Limitations of Mammogram

False Positive Mammogram

- looks abnormal but no cancer is actually present.
- Abnormal mammograms require extra testing (Diagnostic Mammograms, US, MRI or biopsy) to find out if the change is cancer.
- False-positive results are more common in women who are younger, have dense breasts, have had breast biopsies, have breast cancer in the family, or are taking estrogen.
- **About 50% of the women getting annual mammograms over a 10-year period will have a false-positive finding.**
- False-positive mammograms can cause anxiety. The extra tests needed to be sure cancer isn't there cost time and money and maybe even physical discomfort.

Limitations of Mammogram

False Negatives Mammogram

- Mammograms may missed tumors "false negatives."
- Accurate data regarding the number of false negatives are very difficult to obtain, simply because mastectomies cannot be performed on every woman who has had a mammogram to determine the false negative rate accurately.
- women ages 40 to 49, 25% of cancer is missed at each mammography.
- Researchers have found that breast tissue is denser among younger women, making it difficult to detect tumors. For this reason, false negatives are twice as likely to occur in premenopausal mammograms (Prate).
- This is why the screening program in the UK does not start calling women for screening mammograms until the age of 50.

Limitations of Mammogram

Over Diagnosis and Over Treatment

- The central harm of mammographic breast cancer screening is over diagnosis, the detection of abnormalities that meet the pathologic definition of cancer but will never growth and spread or death during a patient's lifetime
- Treating cancers that would never cause problems is called over-diagnosis. This means the cancer never been found or treated if the woman had not gotten a mammogram.
- Treating women with cancers that would never cause problems would be considered over-treatment.
- Doctors often can’t be sure, all cases are treated.

Women expose to the side effects of cancer treatment that’s not needed between 0-10%.

Other Breast Cancer Diagnosis Modalities

Ultrasound US

- Use for some cases can be felt or not seen on a mammogram or changes in women with dense breast tissue.
- It also can be used to look at a change that may have been seen on a mammogram.
- Used to see the difference between fluid-filled cysts and solid masses.
- Use to help guide a biopsy needle into an area of change so cells can be taken out and tested for cancer.

MRI Modality

- Can find some cancers not seen on a mammogram, it's also more likely to find false positive.
- False-positive findings have to be checked out to know that cancer isn't present. This means more tests and/or biopsies. This is why MRI is not recommended as a screening test for women at average risk of breast cancer, because it would mean unneeded biopsies and other tests for many of these women.
- The most useful MRI exams for breast use a contrast, to clearly show breast tissue details.

Benefit and Risk

- Mammograms require very small doses of radiation. The risk of harm from this radiation exposure is extremely low, but repeated x-rays have the potential to cause cancer.
- Mammography not safe for pregnant, because radiation can harm a growing fetus.
- The majority of health experts agree that the risk of breast cancer for asymptomatic women under 35 is not high enough to warrant the risk of radiation exposure. For this reason, and because the radiation sensitivity of the breast in women under 35 is possibly greater than in older women, most radiologists will not perform screening mammography in women under 40. However, if there is a significant risk of cancer in a particular patient (BRCA positive, very positive family history, palpable mass)
- The benefits of screening mammography vary by age. Women ages 50-69 get the most overall benefit for a number of reasons .
- Getting regular screening mammograms lowers the risk of dying from breast cancer, but it doesn’t completely remove the risk.

Benefit and Risk

- Although the benefits of mammography, a woman who gets regular mammograms may still be diagnosed with breast cancer and unfortunately may still die from the disease.
- Over-diagnosis and over-treatment are two main risks of mammography screening.
- Some researchers estimate about 20-30% of DCIS and invasive breast cancers found with mammography may be over-diagnosed .
- Even without treatment, these over-diagnosed breast cancers would never progress to invasive breast cancer and would never have caused problems.
- For example, after one screening, 1,212 out of 10,000 women ages 40-49 will have a false positive result. Among older women, there are fewer false positive results.
- Some time, a woman may get a false positive result on her mammogram and have an unnecessary biopsy. This adds up to unneeded medical procedures, anxiety and cost.

Benefit and Risk

Mammography benefits by age group		
Age group	**Risk of dying from breast cancer compared to women who did not get mammograms**	**Number of breast cancer deaths avoided per 10,000 women screened for 10 years**
39-49	Women who got mammograms on a regular basis had the same risk of dying from breast cancer	3
50-59	Women who got mammograms on a regular basis had a 14 percent lower risk of dying from breast cancer	8
60-69	Women who got mammograms on a regular basis had a 33 percent lower risk of dying from breast cancer	21

Adapted from U.S. Preventive Services Task Force, 2016 [17].

Benefit and Risk

Risks of screening mammography per 10,000 women (estimates for a single screening)			
Age	**False positive result (false alarm)**	**Need a biopsy**	**False negative result (missed cancer)**
40-49 years	1,212	164	10
50-59 years	932	159	11
60-69 years	808	165	12
70-74 years	696	175	13

Adapted from U.S. Preventive Services Task Force, 2016 [17].

Benefit and Risk

Lifetime risks and benefits of screening mammography per 1,000 women ages 50-74		
	Mammography every year	Mammography every other year
Benefits		
Fewer breast cancer deaths	9	7
Risks		
False positive results (false alarms)	1,798	953
Unnecessary breast biopsy	228	146
Over-diagnosis	25	19

Adapted from U.S. Preventive Services Task Force, 2016 [17].

Negative Analysis Studies

- Mammography has a false-negative rate of at least 10 %. This is due to dense tissues obscuring the cancer and the appearance of cancer on mammograms has a large overlap with the appearance of normal tissues.
- Analysis review of programs in countries with organized screening found 52% over-diagnosis.
- Newman points out that screening mammography does not reduce death overall, but causes significant harm by inflicting cancer scare and unnecessary surgical interventions
- The Nordic Cochrane Collection notes that advances in diagnosis and treatment of breast cancer actually may make breast cancer screening no longer effective in decreasing deaths in breast cancer, and therefore no longer recommend routine screening for healthy women as the risks might outweigh the benefits