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Review Article

Breast cancer screening: a narrative review

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ABSTRACT

Breast cancer (BC) is the most commonly diagnosed cancer and a leading cause of cancer-related mortality among women worldwide, accounting for over 2.5 million cases and 670,000 deaths annually. The burden is disproportionately higher in low- and middle-income countries (LMICs) due to limited access to screening, poor infrastructure, low awareness, and socio-cultural barriers. Early detection through screening plays a critical role in improving survival and reducing morbidity. This review outlines the epidemiology of breast cancer (BC), stratification of risk, and current international and national screening guidelines. Various screening modalities are discussed, including mammography, ultrasound, MRI, clinical breast examination (CBE), and emerging technologies such as artificial intelligence and liquid biopsy. The role of innovative tools such as the iBreastExam and, community-based strategies in resource-limited settings is emphasized. Despite advances, key challenges remain regarding accessibility, affordability, and awareness.

Keywords: Breast cancer, Screening, Early detection of cancer, Mammography, Ultrasonography, Artificial intelligence

INTRODUCTION

Breast cancer (BC) is the most frequently diagnosed cancer in women, and it accounts for 26.6% of all cancer cases.[1] BC affects 99% of women and 0.5-1% of men. BC is the most common cause of mortality among women.[2] In the year 2022, around 2.5 million cases were diagnosed, and around 670,000 people died due to BC. Most of these deaths occur in LMICs due to poor infrastructure, lack of awareness, lack of screening programs, and poor accessibility to health care facilities.

BC originates in the ductal region or the lobular region of the breast. BCs typically progress from localised, non-invasive lesions to invasive and metastatic disease. Prognosis and survival depend on the stage at which the disease is diagnosed and treated. For appropriately treated cases, the survival rate varies from 99% in early-stage disease (I and II) to 20% in BC with distant metastasis. Hence, early disease detection is crucial to reduce the overall morbidity and mortality associated with the disease. Researchers and health care workers have made tremendous efforts over the years to combat BC. Countries have laid out guidelines for screening the general population and women at risk of BC. Still, only 30% of patients are diagnosed in the early stage due to a lack of awareness, health care facilities, and socio-cultural attitudes.[3] The role of screening is to detect asymptomatic cases, allowing for early detection and timely intervention, which can improve outcomes in terms of quality of life and mortality.

Roughly half of all BCs occur in women with no specific risk factor. Risk factors for BC are categorised into modifiable and non-modifiable. Non-modifiable risk factors include female sex, age, early age at menses, late age at menopause, family history of BC, ovarian cancer, or other hereditary breast and ovarian syndrome-associated cancer (e. g., prostate cancer in father, pancreatic cancer), known deleterious gene mutation, prior breast biopsy with specific pathology showing atypical hyperplasia (lobular or ductal) and lobular carcinoma *in situ,* prolonged interval between menarche and first pregnancy, certain ethnicities (e. g., increased risk of BRCA mutation in Jewish women),

dense breasts on mammography and prior exposure to high-dose therapeutic chest irradiation in young women (10 years old). However, obesity, alcohol consumption, smoking, nulliparity, and exposure to hormonal therapy in menopausal women are modifiable risk factors.[4,5] Women may be categorized into average risk and high risk depending on their chances of developing BC in their lifetime. A woman is said to be at average risk of BC if she has no personal history of BC, no family history of BC, no genetic mutations, and no history of chest radiation before the age of 30 years. Those with a history of BC in first-degree relatives, history of BC in the past, positive genetic mutations, chest radiation before the age of 30 years, and Li-Fraumeni syndrome, Cowden syndrome in self or first-degree relatives are categorized as high risk for BC (Table 1).

BC screening is almost nil in developing countries when compared to developed countries. Despite various guidelines, the screen uptake is considerably low due to a lack of knowledge and socio-cultural beliefs. Existing guidelines for BC screening are: guidelines given by BC Society India, ACOG, ACS, NCCN, and USPSTF (Table 2).

Table 1: Risk stratification

Risk factors	Average-risk women	High-risk women
History of BC in the past	No	Yes
History of BC in the first-degree relatives	No	Yes
BRCA gene mutation	No	Yes
History of chest radiation between 10-30 years of age	No	Yes
Associated syndromes	No	Association with Li-Fraumeni syndrome, Cowden syndrome, or a first-degree relative with these syndromes.

Table 2: Different guidelines for BC screening.

Guidelines	Risk stratification	Age to start screening	Interval of screening
The Breast Imaging Society, India has no standard recommendations for BC screening in India, and screening is an opportunistic type.[6]	Average risk	40-70 years	Annual with mammography
		After 70 years, shared decision with the patient, and according to life expectancy	Annual with mammography
	High risk	<40 years in women who had a mastectomy for the other breast	Annual with USG and breast MRI
		30 or 10 years before age of diagnosis of a first-degree relative with BC	Annual with mammography with breast MRI
American Cancer Society[5]	Average risk	40-44 years	Offer screening
		45-54 years	Start annually with mammography
		55 or more	Once every 2 years by mammography
	High risk	Start at the age of 30 years	Annually using mammography and MRI
NCCN[7]	Average risk	25-39 years	CBE 1-3 yearly
		40 years	Mammography with tomosynthesis annually
	High risk	Start screening at 25 years	Mammography with tomosynthesis and MRI annually
ACOG[4]	Average risk	25-39 years	CBE every 1-3 years
		40-49 years	Initiate after counselling with mammography, CBE
		50-75 years	Recommended annually or 2-yearly with mammography
		More than 75 years	Shared decision with the patient to continue screening
	High risk	Start screening at an earlier age with annual mammography, and additional methods like MRI may be considered.	
USPSTF[8]	Average risk	Start from 40 years to be continued till 74 years	Once in 2 years using mammography.

Different screening modalities used for screening BC can be categorized into imaging and non-imaging techniques.

IMAGING AND NON-IMAGING TECHNIQUE

It includes mammography, ultrasound, and MRI

In non-imaging techniques CBE and liquid biopsy were included.

Mammography

Mammography remains the mainstay for screening BC. It uses low-dose X-rays to detect potential tumors. Mammography has a sensitivity of 64-90% and a specificity of 82-93%. Mammography for screening is recommended in various screening guidelines. Screening mammography can miss significant findings in women with dense breasts. Digital breast tomosynthesis (DBT) can detect disease in women with dense breasts. It captures multiple views from different angles and avoids overlapping tissue, so better than screening mammography due to three dimensions. It was approved by the FDA for BC screening and diagnostic setup in 2011 due to better lesion characterization than mammography. Studies done in past has shown mammography is a useful tool for screening BC and has brought about 15-30% reduction BC related mortality.

Breast ultrasound

Breast ultrasound is not routinely used for screening purposes, but it has a role in detecting lesions in dense breasts when combined with other modalities. Moreover, mammography as a screening method is not freely available in resource-limited countries, so ultrasound can be used for screening purposes. Ultrasound has the advantage that it does not cause radiation exposure.

Breast MRI

MRI is sensitive in detecting BC in high-risk populations. It is recommended to have mammography yearly for high-risk women. MRI is not recommended routinely for the general population, as there is no added advantage. The role of MRI mainly lies in the staging of cancer and response to neoadjuvant therapy. MRI screening is highly expensive and has limited availability. It is best to use an MRI with a 1.5 T field strength. Contrast-enhanced MRI with breast coils is best used. It increases the sensitivity for detection and improves the quality of the image by reducing motion artifacts produced by respiratory movements.[9]

CBE

It is used mostly in low-resource settings. Healthcare personnel should be experienced in examining lumps. Emphasis should be given to the training of health workers so that CBE can help detect disease, and we can use the peripheral health system for routine screening. The disadvantage of CBE is that it is observer-dependent, and there is observer bias. It is effective as a part of the community-based strategy.

Self-breast examination is useful for breast awareness and early symptom recognition. Previous studies found that approximately approximately 64% of women self-detected their BC, and only 36% of patients were detected either on screening mammography or CBE. However CBE is not recommended as screening modality (omit because it does not reduce mortality).[10]

Liquid biopsy

It has potential for non-imaging-based early detection for future perspective. These tests are based on the detection of the debris left in the plasma or blood by the tumor cells, cell-free RNA, tumor DNA, autoantibodies, and cellular proteins. These tests are in the experimental stage.[11]

The WHO global BC initiative was established in 2021 to reduce the BC burden by 2.5% per year, which, over 20 years, will save 2.5 million lives.

There are three main strategies to achieve these objectives and to lower the cancer burden by screening and early detection. Strategies are health promotion and early detection, timely diagnosis, and comprehensive BC management.[12,13]

All these strategies will be effective if efforts are put into educating women and creating awareness about the disease, the importance of timely diagnosis, and treatment after diagnosis.

EMERGING TRENDS AND TECHNOLOGIES

Artificial intelligence can be used with the expertise of radiologists to interpret images taken using mammography, DBT, ultrasound, and MRI, and studies show that it will significantly reduce the false positives and, false negatives. Hence, it will reduce the burden on the pathologist by reducing unnecessary biopsies.

Emerging technology of AI, namely Niramai, ibreast exam, and MammoAssist, is seen as a promising tool for early detection of BC by screening in resource-limited settings, and it will improve quality of life. BC using ibreast exam (iBE) is a clinically proven, portable, non-invasive, painless, and radiation-free instrument for the detection of lesions at the site of contact. iBE uses piezoelectric current to generate images, and it can play an important role in screening in resource-limited areas and tough terrains.[14]

LIQUID BIOPSIES AND MOLECULAR MARKERS

Potential for non-imaging-based early detection for future perspective. These tests are in the experimental stage.

BARRIERS AND CHALLENGES IN BC SCREENING

Several challenges are there for the successful implementation of the breast cancer screening program, including geographical, financial, cultural constraints, low awareness due to low health literacy, misconceptions, poor infrastructure with limited radiology and pathology support, weak follow-up and surveillance system.

In LMICs like India, we can increase screening either by implementing opportunistic screening or a community-based screening approach. Integration of BC screening with maternal health services, use of mobile mammography units. More and more health care workers need to be trained to make the BC screening program successful.[15]

CONCLUSION

BC remains a major public health concern, particularly in low- and middle-income countries where late-stage diagnosis significantly contributes to high mortality rates. Early detection by using various screening modalities such as mammography, ultrasound, MRI, and CBE plays a vital role in improving survival outcomes. The main aim is to raise awareness, promote health education, and address barriers such as limited access and socio-cultural stigma are essential to strengthen screening programs. Integration of community-based initiatives like mass screening and emerging technologies like artificial intelligence holds great promise, especially in resource-constrained settings.

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