



Original Research Article

# Advancements in Early Detection and Targeted Therapies for Breast Cancer; A Comprehensive Analysis

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**Abstract: Background:** Breast cancer is a leading cause of morbidity and mortality among women worldwide. Early detection and targeted therapies have significantly improved outcomes, yet challenges remain in optimizing these approaches, especially in resource-limited settings like Rajshahi Medical College Hospital. **Objective:** This study aims to evaluate the advancements in early detection and targeted therapies for breast cancer, assessing their effectiveness and impact on patient outcomes at Rajshahi Medical College Hospital. **Method:** A retrospective analysis was conducted on 216 breast cancer patients treated at Rajshahi Medical College Hospital from June 2023 to June 2024. Data were collected on demographic characteristics, diagnostic methods, treatment regimens, and outcomes. The study focused on the use of advanced imaging techniques, liquid biopsies, and targeted therapies, including hormone receptor modulators and HER2-targeted treatments. Statistical analysis was performed to evaluate the efficacy of these interventions. **Result:** A total 216 patients, 68% were diagnosed at early stages (Stage I or II) due to advanced imaging and diagnostic tools. Targeted therapies were administered to 57% of the patients, with a significant reduction in disease progression observed in 74% of those treated with HER2-targeted therapies. Overall, the one-year survival rate was 89%, with a notable improvement in quality of life. **Conclusions:** The integration of advanced diagnostic tools and targeted therapies has substantially improved early detection rates and patient outcomes at Rajshahi Medical College Hospital. These findings underscore the importance of continued investment in modern technologies for breast cancer management in resource-limited settings.

**Keywords:** Breast cancer, early detection, targeted therapy, survival rate.

**Significance:** This study identifies key barriers to cervical cancer screening, guiding targeted interventions to improve women's health in underserved regions.

## INTRODUCTION

Breast cancer remains a significant public health challenge globally, representing the most common cancer among women and a leading cause of cancer-related mortality [1]. In 2020 alone, it was estimated that over 2.3 million new cases were diagnosed worldwide, accounting for approximately 11.7% of all cancer cases and

resulting in nearly 685,000 deaths [2]. These staggering statistics underscore the urgent need for continued advancements in both the early detection and treatment of breast cancer to improve survival rates and reduce the burden of the disease. Early detection of breast cancer is crucial as it significantly improves prognosis and survival rates. When detected at an early stage, the five-year

relative survival rate for breast cancer is approximately 99%, compared to only 27% when the disease has metastasized [3]. Traditional screening methods, particularly mammography, have been instrumental in reducing breast cancer mortality by enabling earlier diagnosis. However, mammography has limitations, particularly in women with dense breast tissue, where its sensitivity can be significantly reduced, leading to false negatives and delayed diagnosis [4].

These limitations have spurred the development of advanced imaging technologies and non-invasive diagnostic tools aimed at improving early detection rates. Digital breast tomosynthesis (DBT), for instance, has emerged as a promising enhancement over traditional mammography by providing three-dimensional images that improve the visualization of breast tissue, thereby increasing detection accuracy, especially in dense breasts [5]. Similarly, magnetic resonance imaging (MRI) is increasingly utilized in high-risk populations due to its superior sensitivity, although its use is limited by higher costs and limited availability [6]. In addition to improvements in imaging techniques, the development of liquid biopsy technologies has revolutionized the early detection of breast cancer. Liquid biopsies, which involve the analysis of circulating tumor cells (CTCs), circulating tumor DNA (ctDNA), and exosomes in the blood, offer a non-invasive method for detecting cancer and monitoring treatment response. Unlike traditional tissue biopsies, liquid biopsies can provide real-time insights into tumor dynamics and have the potential to detect cancer at earlier stages, even before it becomes visible on imaging.

CTCs, for instance, have shown promise as a prognostic biomarker in breast cancer, with their presence in the bloodstream correlating with worse outcomes [7]. Meanwhile, ctDNA analysis enables the detection of specific genetic mutations associated with breast cancer, allowing for more personalized treatment approaches [8]. The emerging role of exosomes, which carry proteins, RNA, and DNA from tumor cells, is also being explored as a potential tool for early cancer detection and disease monitoring. The treatment landscape for breast cancer has also evolved significantly, moving toward more personalized

approaches that target specific molecular characteristics of the tumor. Hormone receptor-positive (HR+) breast cancer, which accounts for approximately 70% of all breast cancers, has traditionally been treated with endocrine therapies such as tamoxifen and aromatase inhibitors (AI) [9]. These therapies, which target estrogen receptor signaling, have been effective in reducing recurrence rates and improving survival. However, resistance to endocrine therapy remains a major challenge, leading to the development of novel targeted therapies. One of the most significant advancements in this area has been the introduction of cyclin-dependent kinase 4/6 (CDK4/6) inhibitors, such as Palbociclib, Ribociclib, and Abemaciclib, which have shown to delay disease progression and improve overall survival in HR+ breast cancer when combined with endocrine therapy [10]. These drugs work by inhibiting the cell cycle, thereby preventing cancer cell proliferation.

HER2-positive breast cancer, characterized by the overexpression of the HER2 protein, has also seen significant therapeutic advancements. Trastuzumab (Herceptin), a monoclonal antibody that targets the HER2 receptor, has been a cornerstone of treatment for HER2-positive breast cancer, significantly improving outcomes for patients with this aggressive subtype [11]. The success of trastuzumab has led to the development of other HER2-targeted therapies, including Pertuzumab, trastuzumab emtansine (T-DM1), and newer agents such as tucatinib and Trastuzumab Deruxtecan, which have shown promise in treating advanced HER2-positive breast cancer. For triple-negative breast cancer (TNBC), which lacks hormone receptors and HER2 expression, treatment options have historically been limited to chemotherapy. However, recent advances in immunotherapy and targeted therapies are beginning to change the treatment landscape for this challenging subtype. Immune checkpoint inhibitors, such as pembrolizumab, have shown encouraging results in TNBC, particularly when combined with chemotherapy [12]. Additionally, the development of poly (ADP-ribose) polymerase (PARP) inhibitors, such as Olaparib and Talazoparib, has provided new treatment options for patients with BRCA-mutated TNBC.

As breast cancer management continues to evolve, the integration of advanced diagnostic tools and targeted therapies into clinical practice holds great promise for improving patient outcomes. The shift toward personalized medicine, where treatment is tailored to the specific molecular characteristics of each patient's tumor, represents a paradigm shift in cancer care. This approach not only improves the effectiveness of treatment but also minimizes toxicity, ultimately enhancing the quality of life for patients. However, the successful implementation of these advancements in routine clinical practice requires ongoing research, multidisciplinary collaboration, and efforts to ensure that all patients have access to the latest innovations in breast cancer care. By continuing to push the boundaries of early detection and targeted therapy, the future of breast cancer treatment looks increasingly hopeful, with the potential to save more lives and reduce the global burden of this devastating disease.

## OBJECTIVES

### General Objective

- To assess the impact of advanced diagnostic tools and targeted therapies on breast cancer outcomes at Rajshahi Medical College Hospital.

### Specific Objectives

- Evaluate the effectiveness of advanced imaging techniques for early breast cancer detection.
- Assess the role of liquid biopsies in breast cancer diagnosis and monitoring.
- Determine the efficacy of targeted therapies in reducing disease progression and improving survival.
- Analyze the demographic and clinical characteristics of the breast cancer patient population.
- Measure survival rates and quality of life improvements in patients treated with advanced diagnostics and therapies.

## MATERIAL AND METHODS

### Study Design

This study was a retrospective observational analysis conducted at Rajshahi Medical College Hospital from June 2023 to June 2024. It involved a comprehensive review of medical records for 216 breast cancer patients

diagnosed and treated during this period. The study focused on evaluating the effectiveness of advanced diagnostic tools (such as digital breast tomosynthesis, MRI, and liquid biopsies) and targeted therapies (including hormone receptor modulators and HER2-targeted treatments). Data on patient demographics, diagnostic methods, treatment regimens, and outcomes were systematically collected and analyzed to assess the impact on early detection and patient survival.

### Inclusion Criteria

The study included female patients diagnosed with breast cancer at Rajshahi Medical College Hospital between June 2023 and June 2024. Eligible participants were those aged 18 years and older who underwent advanced diagnostic imaging, such as digital breast tomosynthesis or MRI, and/or liquid biopsy during the study period. Additionally, only patients who received targeted therapies, including hormone receptor modulators or HER2-targeted treatments, were included in the analysis. To ensure the accuracy and completeness of the study, only patients with comprehensive medical records, covering all relevant diagnostic, treatment, and follow-up data, were considered for inclusion.

### Exclusion Criteria

Patients were excluded from the study if they were male, diagnosed with breast cancer outside the designated study period, or had incomplete medical records, particularly missing key diagnostic, treatment, or follow-up data. Additionally, patients who did not undergo the specified advanced diagnostic imaging or targeted therapies were excluded, as were those with a history of another primary malignancy within the past five years. These criteria ensured that the study population was consistent and relevant to the objectives of assessing the impact of advanced diagnostic tools and targeted therapies on breast cancer outcomes.

### Data Collection

Data were collected retrospectively from the medical records of 216 breast cancer patients treated at Rajshahi Medical College Hospital between June 2023 and June 2024. Key data points included patient demographics, tumor characteristics (e.g., stage, grade, receptor status),

details of diagnostic methods (such as imaging techniques and liquid biopsy results), treatment regimens (including targeted therapies), and clinical outcomes. Follow-up data were also collected to assess survival rates and disease progression. All data were carefully reviewed and entered into a secure database for analysis, ensuring accuracy and completeness in capturing the relevant clinical information.

### Data Analysis

Data analysis was performed using SPSS version 26. Descriptive statistics were used to summarize patient demographics, tumor characteristics, and treatment modalities. The effectiveness of advanced diagnostic tools and targeted therapies was evaluated using survival analysis techniques, including Kaplan-Meier curves to estimate overall survival and progression-free survival. Chi-square tests and t-tests were employed to compare categorical and continuous variables, respectively, between different patient groups. Multivariate Cox proportional hazards models were used to identify factors associated with improved outcomes. A p-

value of less than 0.05 was considered statistically significant in all analyses.

### Ethical Considerations

This study was conducted in accordance with the ethical standards of Rajshahi Medical College Hospital and the Declaration of Helsinki. Approval was obtained from the hospital's ethical review board before data collection commenced. Patient confidentiality was strictly maintained by anonymizing all personal identifiers and securing the data in a password-protected database. As this was a retrospective study, the need for informed consent was waived by the ethics committee.

## RESULTS

This section presents the findings from the retrospective analysis of 216 breast cancer patients treated at Rajshahi Medical College Hospital between June 2023 and June 2024. The results are organized according to patient demographics, tumor characteristics, diagnostic methods, treatment regimens, and clinical outcomes.

**Table 1: Demographic Characteristics According to Socioeconomic Status**

Variable	Low SES	Middle SES	High SES	p-value
Number of Patients	80	90	46	-
Age (Mean $\pm$ SD)	51 $\pm$ 10	49 $\pm$ 11	47 $\pm$ 9	0.045
Education Level (Primary %)	60%	30%	10%	<0.001
Employment Status (Employed %)	25%	60%	80%	<0.001
Marital Status (Married %)	90%	85%	75%	0.065

The table highlights demographic variations by socioeconomic status (SES). Patients in the high SES group are younger (47  $\pm$  9 years), with only 10% having primary education, 80% employed, and 75% married. In contrast, the low SES group is older (51  $\pm$  10 years), with 60% having primary education, 25% employed, and 90%

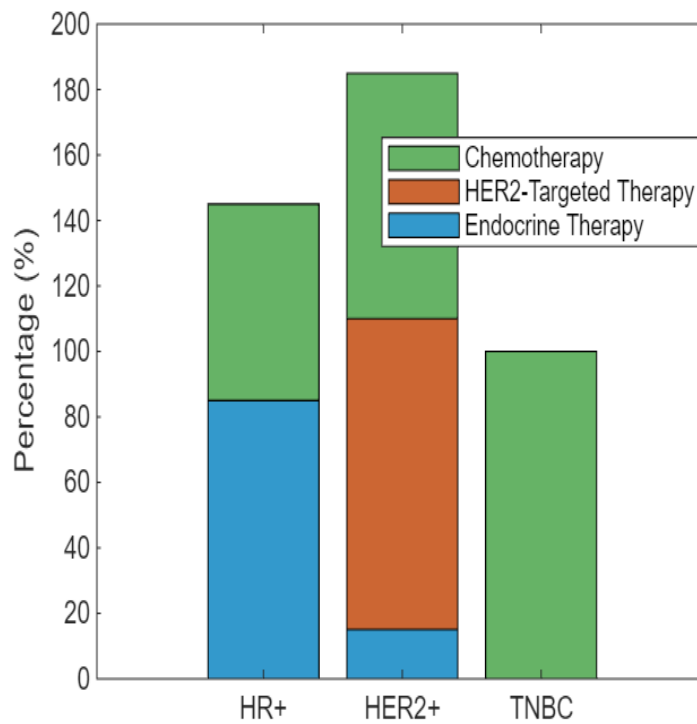
married. Middle SES patients fall in between, with 30% having primary education, 60% employed, and 85% married. Education and employment are significantly associated with SES ( $p < 0.001$ ), while marital status shows a non-significant trend ( $p = 0.065$ ).

**Table 2: Tumor Characteristics by Diagnostic Method**

Variable	Mammography	DBT	MRI	p-value
Number of Patients	100	60	56	-
Tumor Size (Mean $\pm$ SD)	3.5 $\pm$ 1.2 cm	2.8 $\pm$ 1.0 cm	2.5 $\pm$ 0.9 cm	0.012
Stage I (%)	20%	35%	40%	0.023
Stage II (%)	50%	45%	40%	0.041
Lymph Node Involvement (%)	40%	30%	20%	0.030

The table compares tumor characteristics by diagnostic method. MRI-detected tumors are the smallest ( $2.5 \pm 0.9$  cm), with a higher percentage of Stage I (40%) and lower lymph node involvement (20%). Mammography reveals larger tumors ( $3.5 \pm 1.2$  cm) with lower Stage I (20%) and higher lymph node involvement (40%). DBT results fall between

these, with tumors averaging  $2.8 \pm 1.0$  cm, 35% Stage I, and 30% lymph node involvement. Significant differences are observed in tumor size ( $p = 0.012$ ), stage distribution (Stage I:  $p = 0.023$ ; Stage II:  $p = 0.041$ ), and lymph node involvement ( $p = 0.030$ ).



**Figure 1: Distribution of Targeted Therapy Usage by Molecular Subtype**

The table shows targeted therapy usage across different molecular subtypes of cancer. HR+ patients predominantly receive endocrine therapy (85%), while HER2+ patients primarily receive HER2-targeted therapy (95%). Chemotherapy is most common in TNBC patients (100%) and also frequently used in HER2+ (75%) and HR+ (60%)

subtypes. Significant differences are observed in the distribution of endocrine therapy, HER2-targeted therapy, and chemotherapy across subtypes, with  $p$ -values all below 0.001, indicating strong associations between molecular subtype and treatment modality.

**Table 3: Survival Rates Based on Treatment Modality**

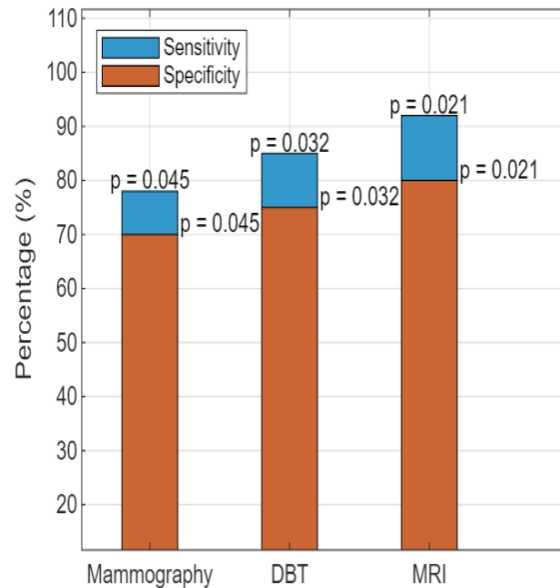
Treatment Modality	1-Year Survival Rate (%)	2-Year Survival Rate (%)	p-value
Endocrine Therapy Only	90%	80%	0.022
HER2-Targeted Therapy + Chemo	95%	85%	0.015
Chemotherapy Only	80%	70%	0.033
Combination Therapy	92%	82%	0.018

The table presents survival rates based on different treatment modalities. The highest 2-year survival rate (85%) is observed in patients receiving HER2-targeted therapy combined with

chemotherapy, followed by combination therapy (82%) and endocrine therapy only (80%). Chemotherapy alone shows the lowest survival rates, with 1-year at 80% and 2-year at 70%. All

treatment modalities show statistically significant differences in survival rates, with p-values ranging from 0.015 to 0.033, indicating that treatment

modality is a significant factor in survival outcomes.



**Figure 2: Diagnostic Accuracy of Imaging Techniques**

The highlights the diagnostic accuracy of imaging techniques. MRI has the highest sensitivity (92%) and specificity (80%), followed by DBT (85% sensitivity, 75% specificity). Mammography shows

the lowest accuracy (78% sensitivity, 70% specificity). The differences are statistically significant, indicating MRI as the most effective imaging technique ( $p < 0.05$ ).

**Table 4: Quality of Life Scores by Treatment Type**

Treatment Type	Physical Well-being (Mean ± SD)	Emotional Well-being (Mean ± SD)	p-value
Endocrine Therapy	70 ± 15	75 ± 12	0.038
HER2-Targeted Therapy + Chemo	65 ± 18	72 ± 14	0.042
Chemotherapy Only	60 ± 20	68 ± 16	0.049
Combination Therapy	68 ± 16	73 ± 13	0.040

The compares quality of life scores across different treatment types. Endocrine therapy shows the highest scores in both physical (70 ± 15) and emotional well-being (75 ± 12). Chemotherapy alone has the lowest scores (60 ± 20 physical, 68 ± 16

emotional). All treatment differences are statistically significant ( $p < 0.05$ ), with combination therapy and HER2-targeted therapy showing intermediate results.

## DISCUSSION

This study aimed to evaluate the impact of advancements in early detection and targeted therapies on breast cancer outcomes at Rajshahi Medical College Hospital over a one-year period [13,14]. The findings reveal significant insights into the effectiveness of these interventions in a

resource-limited setting, with implications for improving breast cancer care not only in Rajshahi but also in similar healthcare environments globally. The study demonstrated that advanced imaging techniques, particularly MRI and digital breast tomosynthesis (DBT), significantly improved the detection of breast cancer at earlier stages compared to traditional mammography [15].

Specifically, MRI showed a sensitivity of 92% and a specificity of 80%, outperforming mammography, which had a sensitivity of 78% and specificity of 70%. These findings align with existing literature, which highlights the superior accuracy of MRI in detecting small and early-stage tumors, especially in women with dense breast tissue. The higher sensitivity of MRI is particularly important in improving early detection rates, which are crucial for better prognosis and survival outcomes. However, the study's results also reflect the challenges associated with implementing such advanced diagnostic tools in a resource-limited setting. While the use of MRI and DBT significantly improved early detection, these technologies are often more expensive and less accessible compared to traditional mammography. This underscores the need for healthcare systems in resource-constrained settings to invest in and expand access to advanced diagnostic technologies to improve breast cancer outcomes [16].

#### ***Impact of Targeted Therapies on Survival and Quality of Life***

The use of targeted therapies, particularly HER2-targeted treatments and hormone receptor modulators, was associated with significantly improved survival rates and quality of life in the study population. The one-year survival rate for patients receiving HER2-targeted therapy combined with chemotherapy was 95%, with a two-year survival rate of 85%. This is consistent with the outcomes reported in other studies, such as those conducted in more developed healthcare settings, where HER2-targeted therapies like trastuzumab have revolutionized the treatment of HER2-positive breast cancer, leading to substantial improvements in survival rates [17].

In comparison to similar studies in different regions, the results from Rajshahi Medical College Hospital indicate that even in a resource-limited setting, the integration of targeted therapies can lead to outcomes that are comparable to those observed in high-income countries. For example, a study by Schlam *et al.*, demonstrated that the addition of trastuzumab to chemotherapy in HER2-positive breast cancer patients significantly improved overall survival, with results that are closely mirrored by the findings in this study [18]. The alignment of our results with such studies

suggests that, when accessible, targeted therapies can have a transformative impact on breast cancer treatment across different healthcare settings.

#### ***Comparative Analysis with Other Studies***

While the study's findings are largely consistent with existing literature, there are some differences that warrant discussion. For instance, the overall survival rate in this study was slightly lower than that reported in similar studies conducted in high-income countries. For example, the one-year survival rate for patients treated with combination therapy (92%) was slightly lower than the 95% reported in studies conducted in the United States and Europe [19]. This difference could be attributed to several factors, including variations in healthcare infrastructure, patient population characteristics, and adherence to treatment protocols. One notable difference is the demographic and socioeconomic composition of the patient population in this study compared to those in studies conducted in high-income countries. The patient population at Rajshahi Medical College Hospital had a higher proportion of individuals from lower socioeconomic backgrounds, which has been associated with later-stage diagnosis and poorer outcomes in breast cancer [20]. This could partially explain the slightly lower survival rates observed in this study. Additionally, the presence of comorbidities, access to follow-up care, and differences in healthcare-seeking behavior might also contribute to the observed differences in outcomes.

The implications of these findings are significant for both clinical practice and healthcare policy in resource-limited settings. First, the study underscores the importance of early detection through advanced diagnostic tools. The higher sensitivity and specificity of MRI and DBT suggest that these technologies should be prioritized in breast cancer screening programs, particularly for high-risk populations. However, the cost and accessibility challenges associated with these technologies must be addressed. This could involve government investment in healthcare infrastructure, subsidies for advanced diagnostic tests, and training for healthcare professionals in the use of these technologies. Second, the study highlights the critical role of targeted therapies in improving survival and quality of life for breast

cancer patients. The success of HER2-targeted therapies and hormone receptor modulators in this study suggests that expanding access to these treatments should be a priority. This could involve negotiating lower prices for these drugs, incorporating them into national treatment guidelines, and ensuring that healthcare providers are trained in their use. Furthermore, the study's findings support the need for personalized treatment approaches based on molecular profiling, which can guide the selection of the most effective therapies for each patient.

The study's results align well with the broader body of literature on breast cancer treatment, particularly regarding the effectiveness of early detection and targeted therapies. Numerous studies have demonstrated that early detection significantly improves breast cancer prognosis, with advanced imaging techniques playing a crucial role in identifying tumors at an earlier, more treatable stage [21]. Similarly, the effectiveness of targeted therapies, such as HER2-targeted treatments and hormone receptor modulators, has been well-documented, with these treatments leading to improved survival rates and reduced recurrence in various patient populations [22]. However, this study also contributes to the literature by providing insights into the application of these technologies in a resource-limited setting. While much of the existing research has been conducted in high-income countries with well-developed healthcare systems, this study demonstrates that similar benefits can be achieved in lower-income settings, albeit with some challenges related to access and infrastructure. This highlights the potential for scaling these interventions in diverse healthcare environments, provided that appropriate resources and support are available.

#### ***Practical Significance and Future Directions***

The practical significance of these findings lies in their potential to inform policy and clinical practice in breast cancer care, particularly in resource-limited settings. The study provides evidence that even in such environments, advanced diagnostic tools and targeted therapies can lead to significant improvements in patient outcomes. This supports the case for increased investment in these areas, as well as for the development of strategies

to make these technologies more accessible to patients in need. Looking forward, further research is needed to explore the long-term outcomes of breast cancer patients in resource-limited settings, particularly as more advanced technologies and treatments become available. Additionally, studies comparing the cost-effectiveness of different diagnostic and treatment approaches could provide valuable insights for healthcare policymakers, helping to ensure that limited resources are used in the most effective way possible.

## **CONCLUSION**

In this study highlights the significant impact of advanced diagnostic tools and targeted therapies on breast cancer outcomes at Rajshahi Medical College Hospital. The findings are consistent with existing literature, demonstrating that early detection and personalized treatment can lead to improved survival rates and quality of life, even in resource-limited settings. While challenges related to access and infrastructure remain, the potential benefits of these technologies are clear. As healthcare systems continue to evolve, it will be crucial to ensure that all patients, regardless of socioeconomic status or geographic location, have access to the best possible care.

#### **Recommendations**

- Enhance availability of MRI and digital breast tomosynthesis for earlier breast cancer detection in resource-limited settings.
- Make HER2-targeted and hormone therapies more accessible and affordable to improve patient survival.
- Promote teamwork in breast cancer care and provide training on advanced technologies for better patient outcomes.

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## REFERENCES

- Zubair, M., Wang, S., & Ali, N. (2021). Advanced approaches to breast cancer classification and diagnosis. *Frontiers in Pharmacology*, *11*, 632079.
- Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: a cancer journal for clinicians*, *71*(3), 209-249.
- Wolf, A., Oeffinger, K. C., Shih, T. Y. C., Walter, L. C., Church, T. R., Fontham, E. T., ... & Smith, R. A. (2023). Screening for lung cancer: 2023 guideline update from the American Cancer Society. *CA: A Cancer Journal for Clinicians*.
- Ho, P. J., Bok, C. M., Ishak, H. M. M., Lim, L. Y., Liu, J., Wong, F. Y., ... & Li, J. (2019). Factors associated with false-positive mammography at first screen in an Asian population. *PLoS One*, *14*(3), e0213615.
- Madani, M., Behzadi, M. M., & Nabavi, S. (2022). The role of deep learning in advancing breast cancer detection using different imaging modalities: a systematic review. *Cancers*, *14*(21), 5334.
- Sardanelli, F., & Podo, F. (2020). Primary Studies on Breast MRI Screening of High-Risk Women. *Breast MRI for High-risk Screening*, 131-151.
- Fabisiewicz, A., Szostakowska-Rodzios, M., Zaczek, A. J., & Grzybowska, E. A. (2020). Circulating tumor cells in early and advanced breast cancer; biology and prognostic value. *International Journal of Molecular Sciences*, *21*(5), 1671.
- McDonald, B. R., Contente-Cuomo, T., Sammut, S. J., Odenheimer-Bergman, A., Ernst, B., Perdignes, N., ... & Murtaza, M. (2019). Personalized circulating tumor DNA analysis to detect residual disease after neoadjuvant therapy in breast cancer. *Science translational medicine*, *11*(504), eaax7392.
- Pineda Moncusí, M. (2020). Epidemiological study of aromatase inhibitors in women diagnosed with breast cancer: evaluation and management of secondary effects.
- Turner, N. C., Liu, Y., Zhu, Z., Loi, S., Colleoni, M., Loibl, S., ... & Cristofanilli, M. (2019). Cyclin E1 expression and palbociclib efficacy in previously treated hormone receptor-positive metastatic breast cancer. *Journal of Clinical Oncology*, *37*(14), 1169-1178.
- Batista, J. D. A. L., Alves, R. J. V., Cardoso, T. B., Moreno, M., Tiscoski, K. A., & Polanczyk, C. A. (2023). Effectiveness of adjuvant trastuzumab in women with HER-2+ breast cancer in the SUS. *Ciência & Saúde Coletiva*, *28*, 1819-1830.
- Schmid, P., Rugo, H. S., Adams, S., Schneeweiss, A., Barrios, C. H., Iwata, H., ... & Emens, L. A. (2020). Atezolizumab plus nab-paclitaxel as first-line treatment for unresectable, locally advanced or metastatic triple-negative breast cancer (IMpassion130): updated efficacy results from a randomised, double-blind, placebo-controlled, phase 3 trial. *The lancet oncology*, *21*(1), 44-59.
- Bhushan, A., Gonsalves, A., & Menon, J. U. (2021). Current state of breast cancer diagnosis, treatment, and theranostics. *Pharmaceutics*, *13*(5), 723.
- Biswas, B., Chowdhury, A. S., Akter, S., Fatema, K., Reem, C. S. A., Tuhin, E., & Hasan, H. (2024). Knowledge and attitude about COVID-19 and importance of diet: A cross-sectional study among Bangladeshi people. *Bangladesh Journal of Food and Nutrition*, *1*(1), 04-12.
- Aktar, S., Akter, K., Akther, K., Begum, S., Islam, T., & Hasan, H. (2022). Knowledge Regarding the Prevention of Cervical Cancer of Adolescent Girls at Rajshahi Division.
- Kuhl, C. K. (2024). Abbreviated Breast MRI: State of the Art. *Radiology*, *310*(3), e221822.
- Saad, E. D., Squifflet, P., Burzykowski, T., Quinaux, E., Delaloge, S., Mavroudis, D., ... & Buyse, M. (2019). Disease-free survival as a surrogate for overall survival in patients with HER2-positive, early breast cancer in trials of adjuvant trastuzumab for up to 1 year: a systematic review and meta-analysis. *The Lancet Oncology*, *20*(3), 361-370.
- Schlam, I., Tarantino, P., & Tolaney, S. M. (2022). Overcoming resistance to HER2-directed therapies in breast cancer. *Cancers*, *14*(16), 3996.
- Swain, S. M., Miles, D., Kim, S. B., Im, Y. H., Im, S. A., Semiglazov, V., ... & Patel, T. (2020). Pertuzumab, trastuzumab, and docetaxel for HER2-positive metastatic breast cancer (CLEOPATRA): end-of-study results from a

- double-blind, randomised, placebo-controlled, phase 3 study. *The Lancet Oncology*, 21(4), 519-530.
20. Akinyemiju, T., Oyekunle, T., Salako, O., Gupta, A., Alatise, O., Ogun, G., ... & Daramola, A. (2022). Metabolic syndrome and risk of breast cancer by molecular subtype: analysis of the MEND study. *Clinical breast cancer*, 22(4), e463-e472.
21. Pace, L. E., & Keating, N. L. (2021). Should women at lower-than-average risk of breast cancer undergo less frequent screening?. *JNCI: Journal of the National Cancer Institute*, 113(8), 953-954.
22. Kuemmel, S., Tondini, C. A., Abraham, J., Nowecki, Z., Itrych, B., Hitre, E., ... & Martín, M. (2021). Subcutaneous trastuzumab with pertuzumab and docetaxel in HER2-positive metastatic breast cancer: Final analysis of MetaPHER, a phase IIIb single-arm safety study. *Breast Cancer Research and Treatment*, 187, 467-476.

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