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Review; impact of digital mammography on patient outcomes and nursing care

Sumayah Sabri Jaha[1]
Makhled Thawab Almutairi[2]
FAHAD MOHAMMED ALMUATIRI[3]
Noura Raddad Alharthi[4]
Nabil Mohammed Almudyir[5]
Ali Abdullah awadh alamri[6]
Jumana Gaza Mohammad Maghrabi[7]
NOUF ABDULLAH ABED HAMEED[8]
Laila Husain Morashed Alamri[9]
Hamzah Hasan Albaghouly[10]
Maha jamil alhawsawi[11]
waad selmi alalwani[12]
Safiah Atiah ALmutairi[13]
Israa Khalid Suda[14]
Abrar Talal Baeisa[15]

1. Nuclear Medicine Specialist , King Abdullah Medical City
2. Specialist Radiological Technology, King Abdullah Medical city
3. Specialist-Radiological Technology, King Abdullah Medical City Specialist Hospital
4. Specialist Radiological Technology, King Abdullah Medical City
5. Specialist-Radiological Technology, King Abdullah Medical City
6. Xray technician, King fahad hospital jeddah, Raidiolegy dept
7. Technican Nursing , Jeddah second Health Cluster Alnahdah PHC
8. Technican Nursing , Jeddah second Health Clus Alnahdah PHC
9. Radiology Technician , King Fahad general Hospital
10. Nurse technician , King Fahad general Hospital
11. Nursing, East Jeddah Hospital
12. Umluj General Hospital, nursing specialist
13. nursing specialist, Medical Services Department, University of Jeddah
14. Technician Nursing, Medical Services Department, University of Jeddah
15. Alnaeem PHC , Nurse

Abstract
Digital mammography has revolutionized breast cancer screening and diagnosis by improving image quality, diagnostic accuracy, and workflow efficiency. It allows earlier detection of breast abnormalities, thereby enhancing patient outcomes through timely intervention and treatment. The shift from traditional film-screen mammography to digital systems has also influenced nursing care, emphasizing the need for patient education, emotional support, and the integration of advanced technologies into routine clinical practice. This review explores the impact of digital mammography on patient outcomes, its advantages over traditional methods, and the evolving role of nursing in providing patient-centered care in this context.

Introduction

Breast cancer is a leading cause of cancer-related mortality among women globally, with over 2.3 million new cases diagnosed annually as of 2020 [1]. Early detection of breast cancer significantly increases survival rates by identifying the disease at a stage where curative treatment is more effective. Mammography has long been established as the cornerstone of breast cancer screening programs, allowing for the detection of small, asymptomatic tumors that may not be palpable during physical examination. Over the past two decades, advancements in imaging technology have led to the development and widespread adoption of digital mammography, revolutionizing the approach to breast cancer detection and management.

Traditional film-screen mammography, while effective, had several limitations, including suboptimal image quality in women with dense breast tissue, higher rates of false positives and negatives, and logistical challenges in image

storage and retrieval [2]. Digital mammography has addressed many of these shortcomings by using electronic detectors to convert X-rays into digital images that can be manipulated for enhanced clarity and accuracy. Furthermore, the integration of digital breast tomosynthesis (DBT), commonly known as 3D mammography, has provided a breakthrough in imaging technology by offering a more detailed, layered view of breast tissue, reducing the challenges posed by tissue overlap.

The transition to digital mammography has had a profound impact on breast cancer detection, particularly in younger women, premenopausal women, and those with dense breast tissue, populations in which traditional mammography often struggles [3]. Digital systems have demonstrated higher sensitivity and specificity, leading to earlier and more accurate detection of breast abnormalities. These advancements contribute to reduced mortality rates and improved treatment outcomes by enabling timely interventions.

The evolution of digital mammography has also transformed the roles and responsibilities of healthcare professionals, particularly nurses. As frontline caregivers, nurses play a pivotal role in ensuring the success of mammography programs, providing patient education, emotional support, and technical assistance during the imaging process. They are instrumental in addressing patient concerns, such as anxiety related to potential diagnoses, and in guiding patients through follow-up care when abnormal findings are detected [4].

This review explores the impact of digital mammography on patient outcomes, focusing on its advantages over traditional systems, the challenges associated with its implementation, and the implications for nursing care. By highlighting the advancements and limitations of this technology, the review underscores the critical role of interdisciplinary collaboration, particularly the contributions of nurses, in optimizing breast cancer screening programs and improving patient experiences.

Review

1. Digital Mammography: Advances in Breast Cancer Detection

Digital mammography, introduced as an advanced alternative to film-screen mammography, has significantly improved breast cancer detection by leveraging technology for better image resolution, storage, and analysis. Key advancements include the integration of digital breast tomosynthesis (DBT) and computer-aided detection (CAD), which have further enhanced diagnostic accuracy and workflow efficiency.

1.1 Enhanced Sensitivity and Specificity

Digital mammography provides higher sensitivity and specificity compared to traditional mammography, especially in younger women and those with dense breast tissue:

Digital mammography detects cancer more effectively in dense breasts, where overlapping fibroglandular tissue can obscure lesions in traditional mammograms [4].Studies report a sensitivity improvement of 15–20% in women with dense breast tissue using digital systems [5].

In premenopausal and perimenopausal women, digital systems outperform traditional methods due to better contrast resolution and adaptability for breast composition variations.

1.2 Digital Breast Tomosynthesis (DBT)

DBT captures multiple low-dose X-ray images from different angles to create a 3D reconstruction of the breast, reducing tissue overlap and enhancing the visualization of abnormalities.Improved detection rates for invasive cancers by 40% compared to 2D mammography [6].Reduced recall rates by 15–40%, minimizing unnecessary biopsies and patient anxiety [7].

1.3 Computer-Aided Detection (CAD)

CAD systems analyze digital mammograms to identify areas of concern, such as microcalcifications and masses, aiding radiologists in accurate diagnosis.CAD-assisted digital mammography has demonstrated a significant reduction in false negatives, ensuring fewer missed cancers in screening programs [8].

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2. Patient Outcomes and Benefits

The advancements in digital mammography have had a profound impact on patient outcomes, including earlier detection, reduced mortality, and improved access to care.

2.1 Early Detection and Reduced Mortality

Digital mammography allows the identification of smaller lesions and early-stage cancers, facilitating timely interventions that improve prognosis.Population-based studies link digital mammography screening programs to a 30–40% reduction in breast cancer mortality, particularly in women aged 50–69 years [9].

2.2 Lower Recall and False-Positive Rates

- False positives, which are common in film-screen mammography, lead to unnecessary diagnostic procedures and anxiety. Digital systems and DBT significantly reduce these rates:
    - Recall rates are lowered by 15–20% with digital mammography compared to film [10].

- The specificity of DBT minimizes false positives, ensuring accurate diagnoses without compromising sensitivity.

2.3 Accessibility Through Mobile Mammography Units

- Digital mammography's ability to integrate with portable devices has expanded access to breast cancer screening in underserved areas, including rural and low-income communities.
- Mobile units equipped with digital systems enable remote telemedicine consultations, ensuring expert diagnosis despite geographic barriers [11].

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3. Challenges in Digital Mammography Implementation

Despite its benefits, digital mammography faces challenges related to cost, access, and overdiagnosis.

3.1 High Costs

The installation and maintenance of digital mammography equipment require significant investment, making it less accessible in low-resource settings [12].Training personnel to operate digital systems and integrate them with existing infrastructure adds to operational expenses.

3.2 Overdiagnosis and False Positives

The increased sensitivity of digital mammography can lead to overdiagnosis, detecting slow-growing or indolent tumors that may not require treatment.False positives, although reduced with digital systems, still occur, leading to unnecessary biopsies and heightened patient anxiety.

3.3 Technological Barriers

Transitioning from film to digital systems requires robust IT infrastructure, including data storage solutions and compatibility with electronic health records (EHRs).Radiologists and nurses must undergo extensive training to maximize the potential of advanced features like CAD and DBT.

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4. Role of Nursing in Digital Mammography

The transition to digital mammography has expanded the responsibilities of nurses, emphasizing patient education, emotional support, and technical proficiency.

4.1 Educating Patients

Nurses play a pivotal role in addressing knowledge gaps and alleviating patient concerns:

Nurses guide patients through what to expect during the mammography process, including the use of compression and its importance for image clarity.Common misconceptions about radiation exposure and mammography discomfort are clarified to encourage compliance with screening guidelines.High-risk populations, such as those with dense breasts or genetic predispositions, receive specific guidance about additional screening modalities like DBT or MRI.

4.2 Providing Emotional Support

Nurses offer reassurance to patients who may feel anxious about the procedure or potential findings.For patients requiring follow-up imaging or biopsies, nurses provide emotional and practical support, ensuring they understand the process and its implications.

4.3 Ensuring Optimal Image Acquisition

Nurses assist radiologic technologists in patient positioning and compression to ensure high-quality images that minimize the need for repeat scans.Proper preparation of the patient, such as avoiding deodorants or powders that may interfere with image clarity, is overseen by nurses.

4.4 Advocating for Equitable Access

Nurses participate in mobile mammography programs and outreach initiatives to bring screening services to underserved populations.They advocate for policies that improve access to advanced technologies in low-resource settings.

4.5 Technical Proficiency

As digital systems become more complex, nurses must stay updated on advancements such as CAD, DBT, and artificial intelligence (AI) integration.Their role in troubleshooting equipment issues and maintaining workflow efficiency is essential in high-volume screening centers.

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5. Future Directions

The field of digital mammography continues to evolve, with promising developments that will further improve patient outcomes and nursing practices.

5.1 Artificial Intelligence (AI) in Mammography

AI-powered algorithms can analyze digital mammograms with high accuracy, reducing radiologist workload and improving diagnostic consistency [13].Nurses will need to understand AI's role to educate patients and support its implementation in clinical workflows.

5.2 Expanded Use of DBT

As the cost of DBT technology decreases, its adoption is expected to become widespread, further reducing recall rates and enhancing cancer detection.

5.2 Enhanced Accessibility

Advances in telemedicine and portable digital systems will expand access to screening in rural and underserved areas.Training programs for nurses in low-resource settings will ensure that digital mammography benefits are realized globally [14].

Conclusion

Digital mammography has emerged as a transformative tool in the early detection and management of breast cancer, offering significant advancements over traditional film-screen systems. Its enhanced image quality, ability to address challenges posed by dense breast tissue, and integration of advanced technologies such as digital breast tomosynthesis (DBT) and computer-aided detection (CAD) have revolutionized breast cancer screening programs. These advancements contribute to improved diagnostic accuracy, earlier detection of malignancies, reduced recall rates, and better overall patient outcomes. The ability to detect smaller and earlier-stage tumors has translated into reduced mortality rates, particularly among women in high-risk groups.

The shift to digital mammography has also brought about substantial improvements in workflow efficiency. Faster image acquisition, the ability to adjust image parameters digitally, and seamless integration with electronic health records (EHRs) have streamlined screening processes, reduced patient wait times, and facilitated longitudinal comparison of imaging results. These benefits are particularly impactful in population-based screening programs, enabling the efficient management of large volumes of patients and reducing barriers to access, especially through mobile mammography units and telemedicine applications.Nurses play a central role in bridging the gap between advanced technology and patient-centered care in the context of digital mammography. Their responsibilities include educating patients about the procedure, alleviating anxieties related to screening, ensuring optimal image acquisition through proper positioning, and advocating for equitable access to screening services. In addition, nurses are instrumental in coordinating follow-up care for patients with abnormal findings, providing emotional support, and promoting public health initiatives to increase screening uptake in underserved communities.

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