Integration of artificial intelligence (AI) and machine learning (ML) for personalized medicine and early cancer detection

Cyprus University of Technology

AUTHORS: Nikolina Dodlek[1,2], Stavroula Chante[3] Andreas Charalambous[1,4]

[1] Cyprus University of Technology, Department of Nursing, Limassol, Cyprus; [2] Faculty of Dental Medicine and Health Osijek, Croatia; [3] The Royal Wolverhampton NHS Trust [4] University of Turku, Department of Nursing Science, Turku, Finland

Introduction

Artificial Intelligence (AI) and Machine Learning (ML) have emerged as powerful tools in oncology, capable of analyzing large volumes of complex data to support clinical decision-making. In the realm of **supportive cancer care**, their integration enables earlier identification of complications, symptom trajectories, and individualized treatment needs—essential for improving patient quality of life, a key objective of MASCC. This review highlights the critical role of AI/ML in enhancing supportive care delivery by:

Predicting treatment-related toxicities such as nausea, fatigue, and neuropathy;
Supporting real-time monitoring through wearable and sensor data;
Facilitating risk stratification for hospital readmission, psychological distress, and symptom escalation;
Enabling personalized interventions via genomic, imaging, and behavioral data analytics.
Nurses are pivotal in integrating AI into clinical pathways by interpreting outputs, educating patients, and advocating for ethical, culturally sensitive, and transparent AI use. AI-enhanced tools also allow nurses to better communicate risk, personalize supportive interventions, and participate in digital care navigation—bridging technology with person-centered care.

Methods

This systematic review followed PRISMA guidelines to ensure methodological rigor. A comprehensive search was conducted in **PubMed, CINAHL, MEDLINE**, and **Scopus**, covering publications from **2009 to 2025**.

Search terms combined **MeSH**
Technology: “artificial intelligence”, “machine learning”, “deep learning” **Clinical focus**: “personalized medicine”, “early cancer detection”, “supportive care”
Context: “oncology”, “nursing”, “oncology nursing”

Filters were applied for English-language, peer-reviewed human studies.
Inclusion criteria: original studies applying AI/ML in oncology with relevance to early detection, prognosis, monitoring, care personalization, or supportive care.
Exclusion: non-oncologic, non-human, or non-AI/ML studies; editorials, reviews, and treatment-only efficacy studies.

Study Selection

Two reviewers independently screened the titles and abstracts of identified studies. Eligible full-text articles were then assessed for inclusion. Any discrepancies were resolved through discussion and consensus with a third reviewer where needed.

Data Extraction and Synthesis

Data were extracted into a pre-defined template including:
Study characteristics (year, country, design, sample size);
Cancer type and stage;
AI/ML methodology used (e.g., CNN, NLP, SVM, random forest);
Clinical application domain (e.g., imaging, genomics, symptom prediction);
Outcome metrics (e.g., sensitivity, specificity, AUC, predictive accuracy);
Relevance to nursing practice and implications for supportive care

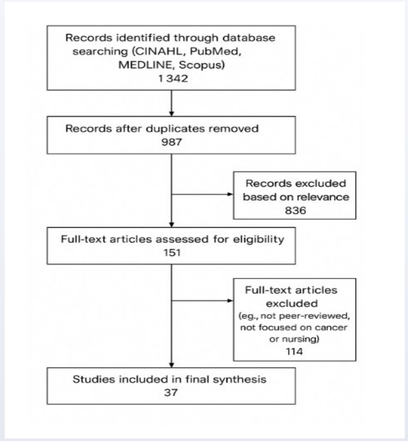

Figure 1. PRISMA

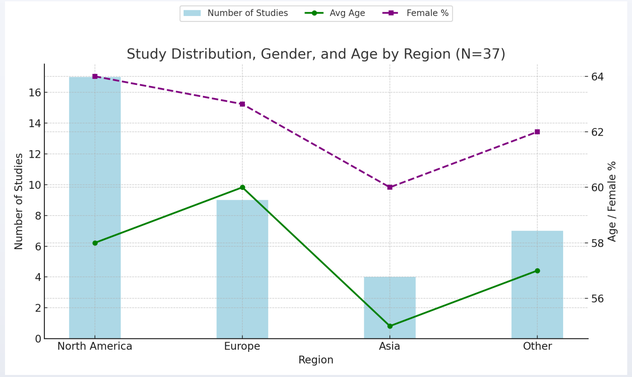

Figure 2. Regional Distribution of Studies with Demographic Overview

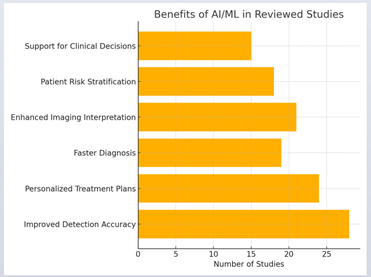

Figure 3. AI and Machine Learning Techniques Applied Across Studies

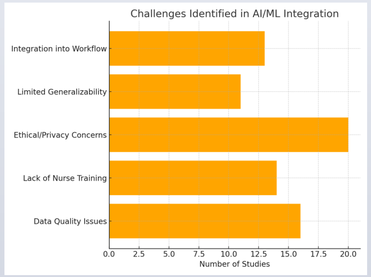

Figure 4. Challenges Identified in AI/ML Integration for Cancer Care

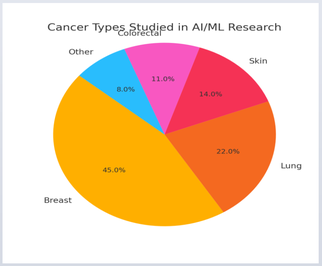

Figure 5. Distribution of Cancer Types in Included Studies

Results

Out of **1,342 records** identified, **37 studies** met inclusion criteria and were included in the final synthesis.
Cancer types studied: ▪ Breast (45%) ▪ Lung (22%) ▪ Skin (14%) ▪ Colorectal (11%) ▪ Other (8%)
AI/ML model performance: Sensitivity ranged from **85–98%**, specificity from **83–97%&** Most accurate in image-based early detection (e.g., mammography, dermoscopy, CT)
Supportive care applications identified:
▪ **Symptom prediction**: models forecasted fatigue, nausea, neuropathy
▪ **Toxicity monitoring**: predicted mucositis, cardiotoxicity, neutropenia
▪ **Survivorship planning**: supported follow-up schedules and recurrence risk stratification
▪ **Triage tools**: flagged high-risk patients for urgent supportive interventions
Nursing relevance: 43% of studies highlighted the role of nurses in AI integration, patient education, and ethical oversight & Emphasized the need for **digital literacy** and **nurse-led interpretation** of AI tools
Main barriers to implementation: Ethical/privacy concerns (54%), **data limitations** (46%), **lack of training** (38%), and **workflow challenges** (35%)

Discussion

AI and ML significantly enhance early detection and personalization of cancer care, offering real opportunities to elevate holistic, nurse-led care models. This systematic review demonstrates that AI and ML technologies offer promising advances in early cancer detection and personalized supportive care. Most models achieved high diagnostic performance, particularly in breast and lung cancers, and several showed utility in predicting symptoms and monitoring treatment-related toxicity.

Importantly, supportive care applications remain underexplored compared to diagnostic tasks, despite their potential to enhance quality of life and reduce treatment burden. Symptom prediction, toxicity alert systems, and survivorship planning emerged as key areas where AI can inform timely, individualized interventions.

Nurses were identified as essential actors in the ethical and effective implementation of AI tools—supporting patient education, shared decision-making, and digital care navigation. However, widespread integration is limited by ongoing challenges including ethical concerns, data quality, lack of training, and workflow compatibility.

These findings underscore the need for:

Nursing-specific digital training frameworks
Equitable access to AI-powered supportive care tools
Interdisciplinary collaboration to ensure transparent, patient-centered implementation.

To fully realize the benefits of AI in supportive care, future research should prioritize nurse-led innovation, address algorithmic bias, and focus on underrepresented populations. Personalized medicine powered by AI is most effective when combined with compassionate, context-aware nursing care — ultimately leading to **better outcomes, greater satisfaction, and improved quality of life for patients**

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