A Systematic Review on Artificial Intelligence in Cancer Pain: Trends, Challenges, and Opportunities

POSTER NUMBER: WE500

Yayu Nidaul Fithriyyah [1*]
Department of Medical Surgical Nursing, Universitas Gadjah Mada Yogyakarta, Indonesia, yayu.n.f@ugm.ac.id

Astrid Pratidina Susilo [2]
Department of Medical Education and Bioethics, Universitas Surabaya, Surabaya, Indonesia

Benjamin H. Kann [3]
Harvard Medical School
Clinical Faculty at Dana-Farber Cancer Institute/Brigham and Women's Hospital.
Mass General Brigham Artificial Intelligence in Medicine (AIM) Program

Introduction

Pain due to cancer is one of the biggest challenges in patient care, so it requires innovative approaches in its management. Research has showed that artificial intelligence (AI) enhances prediction and decision-making in pain management (1-3). However, several studies are not specific to cancer pain, indicating the need for more specialized models and better integration for a holistic approach to cancer care.

Objective

To understand how AI has been applied in the context of cancer pain, thus providing insights into its effectiveness and potential.

Methodology

- Reported based on PRISMA
- PROSPERO: CRD42023429925 (June, 2023)
- The selection criteria were English full-texts (2013-2023), using the PICO and D framework: (P) all cancer patients, (I) Artificial Intelligence, and (O) assessment or management of cancer pain. All study designs were accepted, excluding reviews, comments, and editorials.
- MI-CLAIM, STROBE, and CONSORT-AI checklists were used to assess the risks of bias and study quality. The results were classified as good (≥75%), fair (50-75%), or poor (<50%).
- Rayyan Systematic Review was used to organize the data. Data synthesis used the Synthesis Without Meta-analysis (SWiM) approach

Result/ Finding

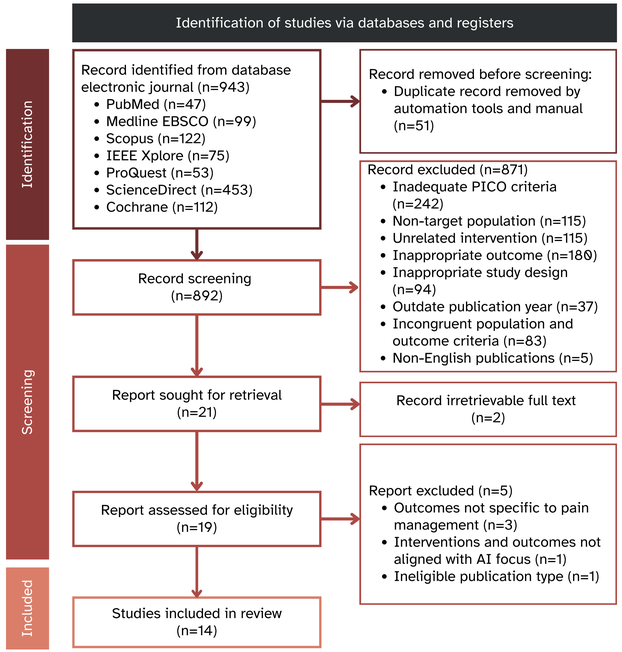

Figure 1. A flow diagram is used in selecting studies based on PRISMA (4)

- Of 943 abstracts, 14 articles were included, and most studies were of good quality. Trends showed that 50% of articles were published in 2018-2019.
- The study designs are heterogeneous, e.g. cohort (14.2%), cross-sectional/observational/longitudinal (14.2%), and secondary analyses (7.1%); therefore, we could not conduct a meta-analysis.
- The characteristic studies mostly focused on lung, breast, pancreatic, and colorectal cancers, with participant ages ranging from 18 to 97 years. 85.7% of studies were conducted in hospitals, mainly from Europe and North America.
- All studies utilized Machine Learning (ML) techniques with varying accuracies: Measure of Performance (72-73%), Random Forest, Support Vector Machine (71.7%), and Artificial Neural Networks (94%). The challenges in ML use, including variable model performance, overfitting risks, and limitations in NLP documentation, emphasize the need for diverse data and model customization.
- We mapped the findings into the Cancer Care Continuum (CoCC) framework from diagnosis, treatment, and survivorship to end-of-life care (Table 1). AI has been implemented in two areas: pain assessment (pain detection, classification, prediction) and pain management (prediction and classification of drug response or outcome and teleconsultation).

Table 1. Use of ML in cancer pain based on the cancer care continuum (CoCC) (5,6,7)

The cancer care continuum (CoCC)	Machine Learning Applications in Cancer Pain	
Diagnosis		**Pain Assessment:** • Detection and Classification (Naseri et al., 2021; DiMartino et al., 2022; Saha et al., 2019) • Classification (Moscato et al., 2022) **Pain Management:** • Prediction and classification to require drugs (Olesen et al., 2018) • Prediction and classification to response treatment (Facciorusso et al., 2019) • Prediction to response drugs (Pantano. F et al., 2020) • Prediction of satisfaction (Z Lou et al., 2022) • Predictions for remote consultations (Cascella et al., 2022) • Prediction post-treatment toxicity (Chao et al., 2018)
Treatment		
Survivorship	**Additional Pain Assessment for Survivorship** • Detection and Classification (Sipilä et al., 2020) • Detection and prediction (Lötsch et al., 2018a,b) • Prediction (Kringel et al., 2019)"	
End-of-Life		

Discussion

This review revealed that ML is predominantly used in cancer-related pain (8.9). Access to advanced technology and expertise in oncology, as well as integrated health infrastructure and extensive electronic databases, supports this research innovation (10). Several challenges with the use of ML require rigorous testing for calibration and external clinical validation before implementation in healthcare settings (9,10). We found that AI is widely used in all stages of CoCC cancer care, from diagnosis to end of life, particularly to improve the accuracy of pain assessment and management (2). The holistic CoCC model is proven to improve quality of life and patient satisfaction, reduce readmission rates, and increase cost-effectiveness .

Conclusion

AI has the potential to enhance cancer pain management. Existing studies showed heterogeneity in study designs and participants' characteristics. Challenges include using cross-validation with large datasets and techniques to reduce overfitting. Future research should focus on developing stage-specific, sensitive, and accurate algorithms across the Cancer Care Continuum, accommodating complexities in treatment, integrating broader data in survivorship, and responding sensitively to changing needs in end-of-life care.

References

1. Shao D, Dai Y, Li N, et al. Artificial intelligence in clinical research of cancers. Brief Bioinform. 2022;23(1). doi:10.1093/BIB/BBAB523
2. O'Connor S, Vercell A, Wong D, et al. The application and use of artificial intelligence in cancer nursing: A systematic review. European Journal of Oncology Nursing. 2024;68:102516. doi:10.1016/J.EJON.2024.102516
3. Hagedorn JM, George TK, Aiyer R, Schmidt K, Halamka J, D'souza RS. Artificial Intelligence and Pain Medicine: An Introduction. Published online 2024. doi:10.2147/JPR.S429599
4. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. The BMJ. 2021;372. doi:10.1136/BMJ.N71
5. Ferrell BR, Smith TJ, Levit L, Balogh E. Improving the quality of cancer care: implications for palliative care. J Palliat Med. 2014;17(4):393-399. doi:10.1089/JPM.2013.9553
6. Levit L, Balogh E, Nass S. Introduction - Delivering High-Quality Cancer Care - NCBI Bookshelf. National Academies Press (US); 2013. Accessed May 11, 2024.
7. Tong EK, Wolf T, Cooke DT, Fairman N, Chen MS. The Emergence of a Sustainable Tobacco Treatment Program across the Cancer Care Continuum: A Systems Approach for Implementation at the University of California Davis Comprehensive Cancer Center. Int J Environ Res Public Health. 2020;17(9). doi:10.3390/IJERPH17093241
8. Matsangidou, M., Liampas, A., Pittara, M., Pattichi, C. S., & Zis, P. (2021). Machine learning in pain medicine: an up-to-date systematic review. Pain and therapy, 1-18.
9. Kamdar, M., Centi, A. J., Agboola, S., Fischer, N., Rinaldi, S., Strand, J. J., ... & Jethwani, K. (2019). A randomized controlled trial of a novel artificial intelligence-based smartphone application to optimize the management of cancer-related pain
10. Wu, T., Duan, Y., Zhang, T., Tian, W., Liu, H., & Deng, Y. (2022). Research trends in the application of artificial intelligence in oncology: A bibliometric and network visualization study. Frontiers in Bioscience-Landmark, 27(9), 254.