EDITORIAL

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# Could Artificial Intelligence help in predicting opioid use disorders? All that glitters is not gold

Marco Cascella, MD, PhD

Despite the persistent and challenging issue of the opioid crisis, ongoing debates exist about the best strategy to implement.[1] In this complex scenario, predictive analytics could provide valuable insights by analyzing large datasets, identifying patterns, and forecasting trends. Additionally, when paired with Artificial Intelligence (AI) strengths such as machine learning (ML) and natural language processing (NLP) systems, these analytics are further enhanced, leading to more accurate, automated processes and informed data-driven decisions. Consequently, AI is being tested in several key healthcare tasks.[2] As pain physicians and AI technology experts, we ask: Can we leverage AI to address this problem? And if so, for what specific goals? Several examples can be found in the literature. Recently, researchers developed an ML-based model aimed at early detection of opioid use disorder (OUD).[3] This study utilized data from a commercial claims database, covering the years 2006 to 2018 and including 10 million medical insurance claims from 55,000 patients. The authors tested ML's effectiveness in creating a prediction model for early OUD diagnosis, analyzing 436 predictors, including demographics, chronic conditions, diagnoses and procedures, medication features, medical costs, and episode counts. They employed the Word2Vec and Gradient Boosting Trees algorithms, which produced a c-statistic of 0.959, with sensitivity and specificity rates of 0.85 and 0.882, respectively. The model showed a positive predictive value of 0.362 and a negative predictive value of 0.998. Significant differences were observed between positive and negative OUD groups across several factors, such as opioid use days, prescription overlaps, and pain-related diagnoses. The findings suggest that this model could potentially reduce the time to diagnose OUD by an average of 14.4 months, leading to reductions in morbidity, medical costs, addiction, and mortality. However, the researchers stressed the need for replication and further evaluation to confirm the model's utility in early OUD diagnosis. Therefore, clinical investigations for testing models in real-world scenarios are needed.

Another key issue concerns the data used for training the model. Electronic Health Records (EHRs) are increasingly employed for various descriptive and predictive analyses. In a recent study, Banks et al.[4] used EHR data from the Veterans Administration, encompassing approximately 28,000 patients diagnosed with OUD, to develop AI models for predicting new OUD diagnoses. They analyzed patient features to assess their predictive value for new OUD diagnoses over two periods: 2000-2012 and 2013-2021. Three different ML techniques were employed—logistic regression, random forest, and deep learning architecture, which achieved over 80 percent accuracy in predicting OUD. The random forest classifier revealed that opioid prescription features, such as early refills and prescription length, were consistently among the top five predictors of new OUD. Additionally, younger age was positively correlated with new OUD, while older age showed an inverse relationship. Age stratification indicated that prior substance use disorder and alcohol use disorder were strong predictors of OUD in younger patients. Interestingly, no significant differences were found in the factors associated with new OUD between the two periods. The authors concluded that opioid prescription characteristics are the most impactful predictors of new OUD both before and after the peak in opioid prescribing rates and that predictive models should be tailored to different age groups.

In recent months, the field of NLP has seen incredible evolutionary development thanks to generative networks and large language model development such as ChatGPT.[5] Notably, unstructured data, such as patient admission notes, can also be analyzed through NLP models. Researchers utilized the freely accessible Medical Information Mart for Intensive Care (MIMIC)-III critical care database[6] to develop a deep learning model for predicting opioid prescription using structured and unstructured EHR data. This model achieved an F1-score of 0.88 with an Area Under the Receiver Operating Characteristic Curve (AUC ROC) of 0.93. Another model focused on predicting OUD diagnosis achieved an F1-score of 0.82 with an AUC ROC of 0.94.[7]

An interesting application of AI involves therapeutic trajectories, particularly concerning the development of side effects. Fibromyalgia is often treated with opioids leading to potential adverse outcomes when these analgesics are used long-term.[8] Identifying factors related to prolonged opioid use in this population is essential for developing targeted interventions. Ramírez Medina et al.[9] conducted a retrospective cohort study using the United Kingdom (UK) Clinical Research Practice Datalink, focusing on patients with fibromyalgia who received new opioid prescriptions. They employed logistic regression, a random forest model, and Boruta feature selection to identify risk factors for long-term opioid use. Among 28,552 individuals affected by fibromyalgia who initiated opioid treatment, 7,369 (26 percent) progressed to long-term use. The study found that a high initial opioid dose, history of self-harm, obesity, high deprivation, substance use disorder, and age were strongly associated with long-term opioid use in patients with fibromyalgia .

Taken together, these studies highlight the potential of AI in tackling at least some aspects of the opioid crisis. However, it is crucial to recognize the limitations of AI. Significant issues must be addressed, particularly in the autonomy and reliability of the systems, and concerning data bias. Moreover, AI development must adhere to stringent data privacy and security standards. In this rapidly evolving technological landscape, political involvement is essential for establishing the regulations needed to balance innovation with strong ethical standards.[10] Finally, as the field progresses, there is a need for specialists in AI ethics. While the way forward is certainly clear, to date, not everything that glitters is gold.

*Marco Cascella, MD, PhD, Anesthesia and Pain Medicine, Department of Medicine, Surgery and Dentistry, Scuola Medica Salernitana, University of Salerno, Baronissi, Italy. ORCID: https://orcid.org/0000-0002-5236-3132.*

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## REFERENCES

1. Rivera BD, Friedman SR: What would it take to solve the overdose epidemic in the United States? *Int J Drug Policy*. 2024; 128: 104435.

2. Davenport T, Kalakota R: The potential for artificial intelligence in healthcare. *Future Healthc J*. 2019; 6(2): 94-98. DOI: 10.7861/futurehosp.6-2-94.

3. Segal Z, Radinsky K, Elad G, et al.: Development of a machine learning algorithm for early detection of opioid use disorder. *Pharmacol Res Perspect*. 2020; 8: e00669.

4. Banks TJ, Nguyen TD, Uhlmann JK, et al.: Predicting opioid use disorder before and after the opioid prescribing peak in the United States: A machine learning tool using electronic healthcare records. *Health Informatics J*. 2023; 29(2): 146045 82231168826. DOI: 10.1177/14604582231168826.

5. Cascella M, Semeraro F, Montomoli J, et al.: The Breakthrough of Large Language Models Release for Medical Applications: 1-Year Timeline and Perspectives. *J Med Syst*. 2024; 48(1): 22. DOI: 10.1007/s10916-024-02045-3.

6. Johnson AE, Pollard TJ, Shen L, et al.: MIMIC-III, a freely accessible critical care database. *Sci Data*. 2016; 3: 160035. DOI: 10.1038/sdata.2016.35.

7. Kashyap A, Callison-Burch C, Boland MR: A deep learning method to detect opioid prescription and opioid use disorder from electronic health records. *Int J Med Inform*. 2023; 171: 104979. DOI: 10.1016/j.ijmedinf.2022.104979.

8. Biancuzzi H, Dal Mas F, Brescia V, et al.: Opioid Misuse: A Review of the Main Issues, Challenges, and Strategies. *Int J Environ Res Public Health*. 2022; 19(18): 11754. DOI: 10.3390/ijerph191811754.

9. Ramírez Medina CR, Feng M, Huang YT, et al.: Machine learning identifies risk factors associated with long-term opioid use in fibromyalgia patients newly initiated on an opioid. *RMD Open*. 2024; 10(2): e004232. DOI: 10.1136/rmdopen-2024-004232.

10. Elendu C, Amaechi DC, Elendu TC, et al.: Ethical implications of AI and robotics in healthcare: A review. *Medicine* (Baltimore). 2023; 102(50): e36671. DOI: 10.1097/MD.0000000000036671.