Predicting adverse drug reactions using machine Learning:
Is Malaysia ready?

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BACKGROUND

Osteoarthritis (OA) is a major cause of disability worldwide, and its prevalence has been increasing steadily in recent years. There is currently no cure for this condition; the primary goals of therapy are to reduce inflammation, manage and alleviate joint pains using analgesics, including non-steroidal anti-inflammatory drugs (NSAIDs), and to slow the progression of joint damage.

Researchers continue to investigate the influence of predictors such as age, gender, frailty, ethnicity, and genetic variation on the severity of OA. One study revealed that women had a higher risk than men, with a risk ratio of 1.69 (Coppola et al., 2024). Additionally, existing evidence suggests that frequent NSAID use is associated with toxicity and adverse effects, particularly among older patients.

Older people have increased risks due to greater frailty, multiple comorbidities, and polypharmacy. The severity of adverse effects reported ranged from mild skin rashes to gastrointestinal toxicity, cardiovascular disorders, and renal complications. According to data from the National Pharmaceutical Regulatory Agency, analgesics accounted for the highest proportion of adverse effects reported in Malaysia (NPRA et al., 2024).

In the current healthcare practice, there is no locally validated and reliable AI-based model made available to predict NSAID-induced adverse drug reactions (ADRs). This gap is reflected in the findings of several studies, which demonstrated that 47.8% of high-risk patients did not receive adequate gastroprotective agents that should have been co-prescribed with the NSAID, 22.4% were prescribed a high-dose NSAID, and 25% of those with cardiovascular diseases were inappropriately prescribed an NSAID (Hwong et al., 2020). This has resulted in a substantial burden on the healthcare system. NSAID-induced ADRs were significant causes of approximately 20% of all hospital admissions (Gibson et al., 2006). NSAID-induced ADRs were also linked to increased morbidity and mortality rates, particularly among the older population (Akhideno et al., 2019). This age group is more susceptible to severe complications that require longer hospital stays and contribute to higher healthcare costs. The financial burden is further compounded by the incremental costs associated with managing serious complications such as gastrointestinal bleeding and chronic kidney disease (Goyal et al., 2024).

IMPLEMENTATION AND APPLICATION OF MACHINE LEARNING IN MALAYSIA'S HEALTHCARE

Several healthcare-related studies conducted in Malaysia have demonstrated that the implementation of machine learning (ML) can lead to significant improvements across various aspects of the healthcare ecosystem. Abas et al. (2025) developed an ML-based model to predict complications among patients with type 2 diabetes, thereby enabling early intervention and improved health outcomes. Similarly, Kasim et al. (2025) developed a reliable model for predicting 10-year cardiovascular disease (CVD) risk. The model outperformed traditional risk scores like the Framingham Risk Score, thereby enhancing both risk stratification and clinical decision-making for improved disease management. Additional applications of ML in the Malaysian healthcare setting included predicting medication wastage based on patient beliefs and evaluating medication administration errors in neonatal intensive care units. (Josephine et al., 2024; Aziz et al., 2025).

By leveraging an ML model capable of analysing patient-specific data to predict the susceptibility to NSAID-induced ADRs, healthcare professionals can effectively identify high-risk patients and initiate early interventions. Such personalised treatment approaches could minimise the risk of having an ADR event and promote safer medication use (Tharun et al., 2025). Moreover, an accurate ADR prediction could prevent severe reactions, such as anaphylaxis, that lead to hospitalisation, hence reducing the financial burden on the healthcare system and enabling more efficient allocation of healthcare resources to preventive care and other critical services (Dsouza et al., 2025).

In addition, these models can detect complex patterns and drug-patient interactions and, as such, support clinicians in making more informed clinical decisions and optimising treatment plans. Following early detection of potential ADR signals generated by the model, timely, data-driven interventions can be implemented to mitigate the adverse effects (Zhou et al., 2024). Finally, such models can be very valuable for pharmacovigilance and for preventing ADR events. These models can feasibly be introduced as part of routine clinical practice. Healthcare providers can undergo targeted training and educational programmes to enhance their ability to interpret those model outputs and make informed, evidence-based clinical decisions on the basis of such predictions (Dsouza et al., 2025).

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Despite the significant advantages offered by ML-based models, policymakers are likely to encounter several challenges that require careful consideration. The performance of ML models is highly dependent on the quality and the completeness of the available data. Therefore, accurate and comprehensive patient records are essential for model effectiveness. Additionally, the models require validation across diverse clinical settings to ensure generalisability for varying patient populations (Tharun et al., 2025; Dsouza et al., 2025).

In summary, the adoption of ML-based prediction models for NSAID-induced ADRs in Malaysia has the potential to substantially improve resource allocation, treatment outcomes, and patient safety. Through advanced data analytics and personalised treatment strategies, these models may ultimately enhance overall healthcare outcomes by preventing adverse drug events and improving their management. With ongoing investments and concerted efforts channelled toward strengthening digital health infrastructure, electronic medical records, data integration, and regulatory frameworks, Malaysia is increasingly well-positioned to facilitate the integration of ML-based models into routine clinical practice.

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